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Review Article

Comparative Qualitative Assessment of High-Performance Sustainable Building Practices in Lagos, Nigeria and Accra, Ghana.

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Abstract

Rapid urbanisation across coastal West Africa has intensified the demand for high-rise residential, commercial, and institutional buildings while simultaneously increasing energy consumption, urban heat stress, and environmental vulnerability. This study comparatively assesses sustainable building practices in selected high-performance buildings in Lagos, Nigeria and Accra, Ghana, to identify context-specific sustainability strategies applicable to tropical urban environments. A qualitative multiple case study approach was adopted, involving six purposively selected buildings chosen based on their sustainability relevance, prominence within their respective cities, and availability of documented performance information. The selected case studies comprise Eko Pearl Tower, Nestoil Tower, and Kingsway Tower in Lagos and the Nearly Zero-Energy Building (nZEB), Ecobank Ghana Head Office, and Ashesi University, Berekuso, in Accra. Data were obtained from architectural publications, project documentation, sustainability reports and other secondary sources. The buildings were evaluated across six sustainability performance domains: energy efficiency, passive climate design, water management, material sustainability, indoor environmental quality, and regulatory alignment. The findings reveal that Lagos developments place greater emphasis on technological resilience, centralised environmental control systems, and infrastructural modernisation. In contrast, the Accra case studies demonstrate stronger integration of passive climate-responsive design, resource efficiency, and sustainability-oriented governance. The study concludes that sustainable building performance in tropical West African cities is enhanced when passive design strategies are integrated with efficient technologies and supported by enabling policy and institutional frameworks.

Keywords: high-performance building, Sustainable design, Tropical Architecture, Passive cooling, Climate-responsive Architecture.

Highlights

- Compared sustainable building practices in six high-performance buildings across Lagos and Accra
- The study provides practical recommendations for sustainable building development in tropical West Africa.
- Governance and institutional support significantly influenced sustainability outcomes

1 Introduction

The twenty-first century has been described as the "urban century", with a significant proportion of future urban population growth projected to occur in sub-Saharan Africa (UN-Habitat, 2022). Rapid urbanization across African cities has increased the demand for residential, commercial and institutional buildings while simultaneously intensifying environmental challenges related to energy consumption, greenhouse gas emissions, urban heat stress, infrastructure deficits and climate vulnerability (Li et al., 2022). Coastal cities such as Lagos, Nigeria, and Accra, Ghana, exemplify these challenges due to their growing populations, economic importance and exposure to climate-related risks, including flooding, sea-level rise and extreme heat events (Okeke, 2022; IPCC, 2022; Kowa et al., 2025). The building sector remains one of the largest contributors to global energy consumption and carbon emissions. According to the International Energy Agency (IEA, 2023), buildings account for approximately 37% of global energy-related carbon emissions through construction activities and operational energy use (Vennapusa et al., 2024; Junyuan & Yuanzhe, 2026). In tropical climates, where cooling demand rather than heating demand dominates building energy consumption, sustainable building design has become increasingly important in reducing operational energy requirements while maintaining thermal comfort and occupant well-being (Santamouris, 2016; UNEP, 2023).

Sustainable buildings are generally defined as buildings that are designed, constructed, operated and maintained in ways that minimise environmental impacts while promoting economic efficiency, social well-being, and occupant health throughout their life cycle (Kibert, 2022). The achievement of building sustainability typically involves the integration of strategies such as passive climatic design, energy-efficient systems, renewable energy technologies, water conservation measures, sustainable material selection, and enhanced indoor environmental quality (Attia et al., 2018). High-performance buildings represent an advanced category of sustainable buildings that seek to optimise multiple performance objectives simultaneously, including energy efficiency, environmental quality, resource conservation and long-term operational resilience (Kibert, 2022).

In tropical coastal environments such as Lagos and Accra, building performance is strongly influenced by climatic conditions characterised by high temperatures, elevated humidity levels, intense solar radiation, and seasonal rainfall patterns (IPCC, 2022). Consequently, architectural strategies such as building orientation, façade design, solar shading, natural ventilation, daylight optimisation and envelope performance become critical determinants of energy efficiency and thermal comfort (Hyde, 2013; Lechner et al., 2021). Studies have shown that climate-responsive design strategies can substantially reduce cooling loads and improve building performance in tropical regions (Hyde, 2013).

Recently, several sustainability initiatives have emerged to encourage resource-efficient building development in Africa. These include green building certification systems such as Excellence in Design for Greater Efficiencies (EDGE), national building energy codes, and various policy frameworks aimed at improving environmental performance within the built environment (Enker & Morrison, 2020; Gaum & Laubscher, 2022; IFC, 2023; World Bank Group, 2024). Despite these developments, the implementation of sustainable building practices remains inconsistent across many African cities due to variations in regulatory enforcement, infrastructure reliability, technological capacity, and investment priorities (Unegbu et al., 2025; World Bank Group, 2024).

Lagos and Accra provide particularly useful contexts for examining these issues because both cities experience similar tropical climatic conditions but differ in their governance structures, institutional frameworks, energy infrastructure, and sustainability policy environments. While Lagos has witnessed significant growth in high-rise commercial and mixed-use developments driven by rapid urban expansion, Accra has experienced a gradual increase in sustainability-orientated developments that incorporate passive design strategies, resource-efficient technologies, and green building certification frameworks such as EDGE (Adjaison & Amoah, 2026; Salami et al., 2021; IFC, 2023). These differences present an opportunity to examine how contextual actors influence the adoption and performance of sustainable building strategies within tropical urban environments.

Although previous studies have examined sustainable architecture, climate-responsive design and green building practices in developing countries, the existing body of literature has primarily focused on green building assessment methods, implementation barriers, policy frameworks and country-specific case studies (Olawumi & Chan, 2020; Ikudayisi & Adegun, 2025). However, there remains a need for comparative evaluations of high-performance sustainable buildings across major West African cities to improve understanding of context-specific design strategies, environmental performance, and transferable sustainability practices. This study addresses this need by comparatively assessing selected high-performance sustainable buildings in Lagos, Nigeria, and Accra, Ghana.

Consequently, existing literature on African urban sustainability has increasingly highlighted the limitations of applying uniform sustainability frameworks across African cities, arguing that such approaches often overlook the continent's diverse governance systems, institutional capacities, infrastructural conditions, socio-spatial dynamics and local development priorities. Consequently, there is growing recognition of the need for context-specific and place-based approaches to sustainable urban planning and assessment in African cities (Afinowi & Monkam, 2025). This critique is strongly supported in contemporary African urban studies, which argue that global urban theories and sustainability metrics frequently fail to account for the contextual diversity and uneven development trajectories of African cities (Cobbinah et al., 2015; Afinowi & Monkam, 2025).

Previous studies have highlighted the importance of adapting sustainable building practices to local climate, institutional and socio-economic contexts in sub-Saharan Africa (Olawumi and Chan, 2020; Lee-Felix et al., 2022). Building on this body of knowledge, this study comparatively examines how such contextual factors influence the implementation and performance of high-performance sustainable buildings in Lagos and Accra.

This knowledge gap constrains the development of evidence-based and context-specific recommendations capable of improving sustainable building performance within rapidly urbanising tropical cities (Ikudayisi & Adegun 2025). Therefore, a comparative assessment of selected high-performance buildings in Lagos and Accra is necessary to identify prevailing sustainability practices, evaluate their performance characteristics, and derive lessons that can inform future sustainable architectural development in West Africa. The study aims to comparatively assess high-performance sustainable building practices in selected buildings in Lagos, Nigeria, and Accra, Ghana, with a view to identifying context-specific sustainability strategies suitable for tropical urban environments. The objectives of the study are to:

i. Identify the sustainable design strategies adopted in selected high-performance buildings in Lagos and Accra.
ii. Evaluate the selected buildings using six sustainability performance domains: energy efficiency, passive climate design, water management, material sustainability, indoor environmental quality, and regulatory alignment.

iii. Compare the sustainability performance of selected buildings in Lagos and Accra to identify similarities, differences, and emerging trends.

iv. Develop recommendations for enhancing sustainable building practices and high-performance architectural design within tropical West African cities.

The study seeks to answer the following questions:

i. What sustainable design strategies are employed in selected high-performance buildings in Lagos and Accra?

ii. How do the selected buildings perform across the six sustainability domains?

iii. What similarities and differences exist between sustainable building practices in Lagos and Accra?

iv. What lessons can be derived from the comparative assessment to improve future sustainable building development in tropical West Africa?

2 Literature Review

2.1 Concept of Sustainable Buildings

The concept of sustainable buildings emerged from the broader principles of sustainable development, which seek to balance environmental protection, economic viability, and social well-being for present and future generations (Burton, 1987; Shahana et al., 2020). Within the built environment, sustainable buildings are designed, constructed, operated and maintained in ways that minimise resource consumption, reduce environmental impacts, and enhance occupant health and comfort through their life cycle (Kibert, 2022). Unlike conventional buildings, sustainable buildings adopt an integrated design approach that considers energy efficiency, water conservation, material selection, indoor environmental quality, and long-term operational performance (Datti, 2025; UNEP, 2023).

The building sector remains one of the largest consumers of global energy and natural resources. According to the International Energy Agency (IEA, 2023), buildings account for approximately 30% of global final energy consumption and nearly 37% of energy-related carbon emissions. Consequently, improving building sustainability has become a critical strategy for mitigating climate change and achieving global sustainability goals. Sustainable buildings seek to address these concerns through resource-efficient technologies, passive design solutions, renewable energy integration, and environmentally responsible construction practices (Elaouzy & El-Fadar, 2022; World Bank Group, 2024; Moreira-Macias et al., 2025).

The sustainability performance of buildings is generally evaluated across environmental, economic, and social dimensions. Environment performance focuses on reducing energy use, greenhouse gas emissions, water consumption, and waste generation (Owusu-Manu et al., 2023; Olaiya et al., 2025). Economic performance considers life-cycle costs, operational savings, and long-term asset value, while social performance emphasises occupant comfort, health, safety, and productivity (Kibert, 2022). The integration of these dimensions has given rise to the concept of high-performance buildings, which represent an advanced approach to sustainable building development (Zekun et al., 2022).

2.2 High-Performance Buildings

High-performance buildings (HPBs) are buildings designed to achieve superior levels of energy efficiency, environmental responsibility, occupant comfort, and operational effectiveness throughout their life cycle. Unlike conventional green buildings that may focus on isolated sustainability measures, HPBs employ integrated design strategies to optimise overall building performance (The Hindu, 2024; European Commission, 2021).

The concept of high-performance buildings has gained increasing attention due to growing concerns about climate change, urbanisation, and resource scarcity. According to the European Commission (2021), high-performance buildings are characterised by reduced energy consumption, improved indoor environmental quality, efficient resource utilisation, and enhanced resilience to environmental challenges. Such buildings often incorporate advanced technologies, including energy-efficient building envelopes, renewable energy systems, smart building controls, and water conservation technologies (Seth et al., 2025; Bak et al., 2025).

Research has demonstrated that high-performance buildings can significantly reduce operational energy consumption while improving occupant satisfaction and productivity (Khovalyg et al., 2023; IEA, 2022). However, the successful implementation of high-performance building principles depends largely on climatic conditions. The successful implementation of high-performance building principles also relies on institutional frameworks, technological capacity, and regulatory support. Consequently, strategies that perform effectively in temperate regions may require adaptation before being applied in tropical environments (Adeogun et al., 2025; Emere & Oguntona, 2026; Govindarajan & Ortner, 2026).

2.3 Sustainable Building Strategies in Tropical Climates

A tropical climate presents unique challenges for building performance due to persistent high temperatures, elevated humidity levels, intense solar radiation, and seasonal rainfall patterns. These climatic characteristics significantly increase cooling requirements and contribute to higher building energy consumption if not properly addressed through design interventions (Santamouris, 2016).

Sustainable building strategies in tropical regions can generally be categorised into passive and active approaches. Passive strategies utilise architectural design elements to improve environmental performance without relying heavily on mechanical systems (Elaouzy & El-Fadar, 2022). These include appropriate building orientation, solar shading devices, natural ventilation, daylight optimisation, thermal mass utilisation, and climate-responsive building envelopes (Hyde, 2013). Amongst these strategies, natural ventilation and solar control are widely recognised as the most effective means of reducing cooling loads in tropical buildings.

Active strategies involve the use of technological systems to improve building performance. Examples include high-efficiency heating, ventilation and air conditioning (HVAC) systems, building automated systems, renewable energy technologies, efficient lighting systems and water recycling technologies (IEA, 2023). While active systems can substantially improve environmental performance, they often require significant financial investment, technical expertise and reliable infrastructure for effective operation. Recent studies have indicated that the most successful tropical buildings combine passive and active approaches to achieve optimal performance outcomes. Ruiz-Valero et al. (2021) observed that climate-responsive facade systems significantly improved thermal performance and reduced energy demand in tropical environments. Similarly, Hyde (2013) emphasised that passive design measures should form the foundation of sustainable building strategies, with technological systems serving as complementary interventions rather than primary solutions.

2.4 Tropical Architecture and Climate-Responsive Design

Climate responsive architecture refers to the design of buildings that respond directly to local climatic conditions in order to achieve thermal comfort, energy efficiency, and environmental sustainability. In tropical regions, climate-responsive architecture seeks to reduce heat gain while maximising natural ventilation, daylight availability, and occupant comfort (Hyde, 2013).

Traditional tropical architecture historically relied on passive design principles such as deep overhangs, courtyards, verandas, operable windows, lightweight materials, and elevated structures to respond effectively to local climatic conditions (Nadiar & Pattisinai, 2020; Nuraini et al., 2025). However, rapid globalization and modernisation have increasingly influenced contemporary architectural practice, resulting in the widespread adoption of glass-dominated facades and imported design styles that are often poorly suited to tropical climates (Adegbie, 2021; Baba-Ahmad & Eryildiz, 2026).

The growing prevalence of curtain wall architecture in tropical cities has generated significant concern among sustainability researchers. Excessive glazing can increase solar heat gain, thereby raising cooling loads and operational energy consumption (Ruiz-Valero et al., 2021). Consequently, scholars have argued for a renewed emphasis on climate-responsive design principles that integrate modern technological innovations with traditional passive cooling strategies (Hyde, 2013). In addition to improving environmental performance, climate-responsive architecture contributes to resilience by reducing dependence on external energy sources and enhancing building adaptability to future climate conditions. This is particularly important in developing regions where infrastructure reliability remains a significant challenge.

2.5 Governance, Certification and Sustainable Building Performance

Architectural and technological factors, as well as governance structures, regulatory frameworks, and institutional capacity, influence the sustainability performance of buildings. Effective building regulations provide standards and guidelines that encourage resource-efficient design, environmental responsibility, and long-term sustainability outcomes (World Bank Group, 2024).

Building certification systems have emerged as important tools for promoting sustainability within the construction industry. Globally recognised certification systems such as Leadership in Energy and Environmental Design (LEED), Building Research Establishment Environmental Assessment Method (BREEAM), and Excellence in Design for Greater Efficiencies (EDGE) establish performance benchmarks that encourage sustainable design and operation (IFC, 2023). Among these systems, EDGE has gained significant traction across developing countries due to its emphasis on affordability and resource efficiency.

The success of sustainable building initiatives depends largely on the effectiveness of policy implementation and regulatory enforcement. Studies have shown that countries with stronger institutional frameworks and enforcement mechanisms generally achieve higher levels of compliance with sustainability standards (World Bank Group, 2024). Consequently, differences in governance structures and regulatory environments may contribute significantly to variations in building sustainability performance between cities and regions.

2.6 Empirical Review

Numerous studies have investigated sustainable building practices, climate-responsive architecture, and energy-efficient design across different regions of the world (Bera et al., 2026). Hyde (2013) examined climate-responsive design strategies in hot-humid environments and found that passive cooling measures such as natural ventilation, shading devices, and building orientation significantly improved thermal comfort while reducing energy consumption. However, the study focused primarily on climatic design principles and did not undertake comparative assessments across different urban contexts.

Ruiz-Valero et al. (2021) investigated the thermal performance of façade systems in tropical climates and reported that appropriately designed building envelopes can substantially reduce heat gain and improve energy performance. Nevertheless, the study concentrated on envelope technologies rather than broader sustainability performance indicators. Koranteng et al. (2021) examined renewable energy integration within commercial buildings in Ghana and found growing adoption of photovoltaic systems and energy-efficient technologies. The study highlighted the importance of supportive policy frameworks but did not compare sustainability performance across different cities.

(Adegbie, 2021; Baba-Ahmad & Eryildiz, 2026) explored the influence of globalization on contemporary Nigerian architecture and observed increasing dependence on glass-intensive building envelopes that often conflict with tropical climatic requirements. Their findings emphasised the need for climate-responsive architectural approaches but did not evaluate high-performance buildings using a comprehensive sustainability framework. Although these studies have contributed significantly to understanding sustainable architecture and building performance, they largely focus on isolated aspects of sustainability such as energy efficiency, renewable energy integration, façade performance, or climate-responsive design. There remains limited research that comparatively evaluates multiple sustainability performance dimensions within major West African cities.

2.7 Research Gap

The reviewed literature demonstrates substantial progress in the fields of sustainable architecture, high-performance buildings, climate-responsive design, and building sustainability assessment. However, several important gaps remain. First, there is limited comparative research examining high-performance sustainable building practices across major West African cities, despite their shared climatic conditions and rapid urbanisation. Second, existing studies frequently evaluate individual sustainability components rather than adopting an integrated framework that simultaneously assesses energy efficiency, passive climate design, water management, material sustainability, indoor environmental quality, and regulatory alignment. Third, insufficient attention has been given to the influence of governance structures, infrastructure reliability, and sustainability policy implementation on building performance outcomes within tropical African cities. This study addresses these gaps through a comparative assessment of selected high-performance buildings in Lagos, Nigeria, and Accra, Ghana, using a multidimensional sustainability evaluation framework. By examining similarities, differences, and contextual influences on building performance, the study contributes to the growing body of knowledge on sustainable architecture in tropical West Africa.

3 Methodology

This study adopted a qualitative comparative case study design to assess sustainable building practices in selected high-performance buildings in Lagos, Nigeria, and Accra, Ghana. The qualitative comparative case study approach is particularly suitable for investigating complex contemporary phenomena within their real-world contexts while facilitating systematic comparison across multiple cases (Yin, 2018). Comparative case study methods have been widely applied in sustainability and built environment research to examine how environmental, technological, and institutional factors influence building performance across different contexts (Tran et al., 2023).

The selection of this approach was informed by the multidimensional nature of sustainable building performance, which encompasses environmental, architectural, technological, social, and governance-related dimensions that cannot be adequately represented by a single quantitative indicator. Through comparative analysis, the study identifies similarities, differences, strengths, and limitations in sustainable building practices across selected case studies. A multiple-case study design involving six buildings was adopted. Three buildings were selected from Lagos, Nigeria, namely Eko Pearl Towers, Nestoil Tower, and Kingsway Tower, while three buildings were selected from Accra, Ghana, namely the Nearly Zero-Energy Building (nZEB), Ecobank Ghana Head Office, and Ashesi University, Berekuso. All selected buildings were examined using a comparison.

3.1 Study Area

The study was conducted in Lagos, Nigeria, and Accra, Ghana, two rapidly urbanising coastal cities located in the tropical climatic region of West Africa. Both cities experience high temperatures, elevated humidity levels, intense solar radiation, and seasonal rainfall patterns – climatic conditions that significantly influence building energy consumption, thermal comfort, and environmental performance (IPCC, 2022).

Lagos serves as Nigeria's principal commercial and financial centre and has experienced substantial growth in high-rise residential, commercial and mixed-use developments. Similarly, Accra has emerged as a leading centre for sustainable building innovation in West Africa, characterised by increasing adoption of green building technologies, climate-responsive architectural solutions, and resource-efficient development practices (IFC, 2023). The selection of Lagos and Accra was based on their comparable climatic conditions, economic significance, rapid urbanisation, and increasing emphasis on sustainable development in the built environment. These similarities and differences provide an appropriate basis for comparative investigation of sustainable building practices in tropical urban environments.

3.2 Selection of Case Study Buildings

A purposive sampling technique was employed to select buildings that demonstrate identifiable sustainability features and possess sufficient publicly available information to support comparative evaluation. Purposive sampling is widely used in qualitative research where cases are selected based on their relevance to the research objectives and their capacity to provide rich contextual information (Patton, 2015).

The following criteria guided the selection of the case study buildings:

i. Location within Lagos, Nigeria, or Accra, Ghana.
ii. Demonstrated incorporation of sustainable design and environmental performance features.

iii. Recognition as significant contemporary developments within their respective cities.

iv. Availability of architectural, environmental, and operational information from credible sources.

v. Representation of different building typologies, including residential, commercial, institutional, and demonstration projects.

Table 1: Selected case study buildings and justification for selection. *(author's research)*

Building	Location	Building type	Justification for selection
Eko Pearl Tower	Lagos, Nigeria	Residential High-Rise	Represents contemporary high-rise residential development incorporating modern building technologies and sustainability features.
Nestoil Tower	Lagos, Nigeria	Commercial Office Building	Significant commercial development incorporating environmentally responsive building services.
Kingsway Tower	Lagos, Nigeria	Commercial Office Building	Representative example of sustainable commercial office development in Lagos.
Nearly Zero-Energy Building (nZEB)	Accra, Ghana	Office and research facility	Demonstrates renewable energy integration and near-zero-energy building principles.
Eco Bank Head Office	Accra, Ghana	Commercial Office Building	Leading example of resource-efficient corporate architecture in Ghana.
Ashesi University, Berekuso	Accra, Ghana	Educational building	An internationally recognised example of climate-responsive educational architecture is the Green School in Bali, Indonesia.

The selected buildings mentioned in Table 1 do not represent all sustainable buildings in Lagos and Accra. Rather, they provide illustrative examples of contemporary approaches to sustainable building design and operation within tropical urban environments.

3.2 Data Collection Methods

The study relied primarily on secondary data sources. Multiple sources were utilised to improve reliability, facilitate data triangulation, and strengthen the validity of the findings. Data were obtained from peer-reviewed journal articles, architectural and construction publications, sustainability assessment reports, building certification documentation, official project reports and websites, and technical design documentation. The use of multiple evidence sources is consistent with principles of case study research and enhances the credibility of findings through triangulation (Yin, 2018). To facilitate systematic comparison, a sustainability assessment framework was developed based on indicators commonly adopted in sustainable building evaluation literature (Kibert, 2022; IEA, 2023; UNEP, 2023). Similar multidimensional frameworks have been employed in sustainable building assessment systems such as LEED, BREEAM, and EDGE to evaluate environmental, social, and operational building performance (Tran et al., 2023). The framework evaluates each building across six sustainability performance domains.

Table 2: Sustainability performance domains and assessment indicators (author's *research)*

S/N	Sustainability Domain	Assessment Indicators
1	Energy efficiency	Building energy performance, HVAC efficiency, energy-saving technologies, and renewable energy integration.
2	Passive climate design	Building orientation, solar shading, natural ventilation, daylight utilisation, and envelope performance are all important factors.
3	Water management	Water efficiency fixtures, rainwater harvesting, waste water treatment, and water recycling systems.
4	Material sustainability	Use of local materials, recycled materials and low-impact construction materials.
5	Indoor environmental quality	Thermal comfort, indoor air quality, natural lighting, and occupant well-being.
6	Regulatory alignment	Compliance with sustainability standards, certifications, environmental policies, and guidelines

The selected domains shown in Table 2, above, collectively capture the environmental, technological, architectural, and institutional dimensions of building sustainability.

3.3 Data Analysis Methods

The collected data were analysed using qualitative comparative analysis. Information obtained from each case study was systematically organised according to the six domains of sustainability performance.

The analysis involved;

1. Identification of sustainability features within each building.
2. Classification of identified features within each building.
3. Comparative assessment of sustainability practices across the selected buildings.
4. Identification of similarities and differences between Lagos and Accra case studies.
5. Interpretation of findings in relation to sustainable building theory and climate-responsive architectural practice.

The results were synthesised through comparative matrices, thematic analysis, figures, and narrative discussion to facilitate systematic interpretation of findings.

3.4 Reliability And Validity

To enhance reliability and validity, data were obtained from multiple independent sources, including architectural publications, sustainability reports, certification documents, technical reports, and academic literature. Information relating to building sustainability features was cross-checked across sources to improve accuracy and consistency.

Furthermore, the use of a common assessment framework across all six case studies ensured consistency in evaluation and comparison. The triangulation of multiple evidence sources further strengthened the credibility and trustworthiness of the findings (Yin, 2018; Tran et al., 2023). Each case study building was evaluated across the six sustainability performance domains using documented evidence obtained from architectural publications, sustainability reports, project documentation, technical reports, and other credible secondary sources. Rather than assigning numerical scores, the study adopted a qualitative comparative assessment approach. Sustainability features identified within each building were examined and compared according to the six assessment domains. The evaluation focused on the presence, nature, and extent of sustainability strategies implemented in each case study. This approach enables the identification of similarities, differences, strengths, and emerging trends across the selected buildings while avoiding unsupported quantitative judgements that could not be verified through direct measurement.

This study relied primarily on secondary data sources and publicly available documentation. Consequently, direct measurements of building energy consumption, water use, indoor environmental quality, and operational performance were beyond the scope of the research. In addition, the selected case studies do not represent the entire population of sustainable buildings in Lagos and Accra. Nevertheless, the selected buildings provide valuable insights into contemporary sustainable building practices and emerging sustainability trends in tropical West African cities.

4 Results

4.1 Comparative sustainability characteristics of the selected buildings

The comparative assessment revealed varying approaches to sustainable building implementation among the selected case studies. While all six buildings incorporated sustainability strategies. Table 3 presents a summary of the sustainability features identified within the selected buildings across the six assessment domains.

Table 3: Comparative sustainability features of selected buildings. *(author's research)*

Building	Energy efficiency	Passive climate design	Water management	Material sustainability	Indoor environmental quality	Regulatory alignment
Eko Pearl Tower	Energy-efficient building systems	Solar shading and façade treatment	Limited publicly documented measures	Modern construction materials	High occupant comfort standard	Compliance with contemporary building regulations
Nestoil Tower	Efficient mechanical systems	Responsive façade design	Water conservation measures	Modern construction materials	Enhanced indoor comfort systems	Alignment with corporate sustainability initiatives
Kingsway Tower	Energy-conscious building services	Daylighting and shading strategies	Basic water efficiency measures	Conventional and durable materials	Good indoor environmental conditions	Compliance with applicable regulations
Nearly Zero-Energy Building (nZEB)	Renewable energy integration and low-energy systems	Extensive passive cooling strategies	Water-efficient technologies	Sustainable material selection	Optimised indoor environmental quality	Strong sustainability compliance.
Eco Bank Head Office	Energy-efficient technologies	Climate-responsive building design	Water conservation measures	Sustainable construction practices	Improved indoor environmental conditions	Alignment with sustainability standards
Ashesi University, Berekuso	Reduced operational energy demand	Extensive natural ventilation and daylighting	Water management systems	Local and environmentally responsive materials	High-quality learning environments	Sustainability-orientated institutional policies

The results indicate that sustainability implementation varied among the selected buildings, reflecting differences in project objectives, building typology, climatic adaptation strategies, and institutional priorities.

4.2 Energy Efficiency Strategies

Energy efficiency measures were observed across all six case study buildings. The Lagos buildings primarily employed energy-efficient mechanical systems, building management technologies, and modern service installations aimed at improving operational performance. Eko Pearl Tower, Nestoil Tower, and Kingsway Tower incorporated energy-conscious building systems designed to support occupant comfort and operational efficiency. In contrast, the Accra case studies demonstrated broader integration of energy reduction strategies. The nearly zero-energy building (nZEB) incorporated renewable energy technologies and low-energy building systems intended to minimise operational energy demand. Similarly, Ecobank Ghana Head Office and Ashesi University adopted design approaches that combined energy-efficient technologies with passive environmental strategies.

The findings suggest that while energy efficiency was a common objective across all case studies, the Accra buildings demonstrated stronger emphasis on reducing overall energy demand through integrated design approaches.

Examples of energy-efficient features observed in the selected buildings are presented in figures 1-3.

Figure 1: Eko Pearl Tower, Lagos. (Source: Eko Atlantic Official Website, n.d.)

Figure 2: Nestoil Tower, Lagos. (Source: Nestoil Group, n.d.)

Figure 3: Kingsway Tower, Lagos. (Source: SAOTA via ArchDaily, n.d.)

4.3 Passive Climate Design Strategies

Passive climate-responsive design features were identified in all selected buildings, although the level of integration differed considerably.

The Lagos buildings incorporated façade treatments, shading devices, and building envelope strategies intended to moderate solar heat gain and improve indoor comfort. However, mechanical environmental control systems generally complemented passive design strategies. The Accra buildings demonstrated a more extensive application of passive climate-responsive design principles. The nZEB and Ashesi University employed building orientation, natural ventilation, solar control, and daylight optimisation as fundamental design strategies. Ecobank Ghana's head office similarly incorporated climate-responsive architectural features aimed at reducing dependence on mechanical cooling systems. Overall, passive design integration was more prominent within the Accra case studies than within the Lagos developments. *Figures 4-6 illustrate selected climate-responsive buildings in Accra.*

Figure 4: Showing building form and solar features of a nearly zero-energy building (nZEB), Accra. (Source: Energy Commission Ghana, n.d.)

Figure 4: showing the building façade of the Ecobank Ghana Head Office. (Source: Ecobank Ghana/ARC architect, n.d.).

Figure 5: Showing natural ventilation and campus design of Ashesi University, Berekuso. (Source: Sutherland and Sutherland, n.d.)

4.4 Material Sustainability

Material sustainability practices exhibited notable differences between the Lagos and Accra case studies, reflecting varying approaches to material selection, local resource utilisation and environmental responsibility. The Lagos buildings, Eko Pearl Tower, Nestoil Tower and Kingsway Tower, primarily employed modern construction materials commonly used in contemporary commercial and residential developments. These materials included reinforced concrete, structural steel, glass curtain walls, and aluminium composite panels, selected for their durability, aesthetic appeal, and availability within Nigerian construction supply chains. However, comprehensive documentation regarding the use of recycled materials, locally sourced alternatives, or low-impact construction materials was limited across the Lagos case studies.

This pattern is consistent with observations by Adegbie (2021) and Baba-Ahmad & Eryildiz (2026). Adegbie (2021) and Baba-Ahmad & Eryildiz (2026) noted that contemporary Nigerian architecture increasingly relies on imported and energy-intensive materials, often at the expense of locally available alternatives. Glass-dominated facades in Lagos's commercial buildings, while aesthetically contemporary, raise concerns about embodied energy, thermal performance, and long-term environmental impacts. Research by Adegbie (2021) and Baba-Ahmad & Eryildiz (2026) suggested that material selection significantly influences building sustainability outcomes, with locally sourced and low-impact materials contributing to reduced carbon emissions and enhanced climate responsiveness.

In contrast, the Accra case studies demonstrated stronger integration of environmentally responsible material practices. Ashesi University exemplified sustainable material selection through its use of locally appropriate materials and climate-responsive construction techniques. The campus architecture incorporates locally manufactured compressed earth blocks, timber and other materials that respond to climatic conditions while supporting local economies and reducing transportation-related carbon emissions. Ecobank Ghana's head office similarly incorporated sustainable construction practices, utilising materials selected for their environmental performance and durability. The nZEB demonstrated commitment to sustainable material selection through the use of low-impact building materials and energy-efficient building components.

Several factors may explain the differences in material sustainability approaches. First, Ghana's growing emphasis on sustainable building certification, particularly through the EDGE programme, has encouraged developers to consider material sustainability as part of broader environmental performance objectives (IFC, 2023). EDGE certification requires documented reductions in embodied energy and encourages the use of locally available materials, thereby promoting sustainable material practices. Secondly, institutional leadership, particularly with educational and corporate sectors, has influenced material selection decisions in Accra. Ashesi University's commitment to sustainability principles, for example, has resulted in material choices that prioritise environmental responsibility alongside functional and aesthetic considerations (Ashesi University, 2024). Thirdly, the availability of local material alternatives and technical expertise may differ between Ghana and Nigeria, influencing the feasibility of sustainable material selection.

These findings have major implications for sustainable building practice in West Africa. Kibert (2022) emphasises that material sustainability extends beyond environmental considerations to include economic viability, social equity, and cultural appropriateness. The use of locally sourced materials supports local economies, reduces transportation expenses and emissions and promotes traditional building techniques that may offer climatic advantages. Furthermore, research by UNEP (2023) highlights the importance of life cycle thinking in materials selection, advocating for materials with lower embodied energy, greater recyclability and reduced environmental impacts throughout the building life cycle.

To advance material sustainability in Lagos and similar West African cities, several strategies may be considered. Architects and developers should prioritise the use of locally sourced and environmentally responsive materials where feasible, integrating life-cycle assessment principles into material selection decisions. Policymakers should develop building regulations that encourage sustainable material practices, potentially through incentives, certification requirements or procurement guidelines. Additionally, research and development initiatives should support the identification and promotion of sustainable building materials suitable for tropical climates and local supply chains (Ruiz-Valero et al., 2021).

4.5 Indoor Environmental Quality

Indoor environmental quality (IEQ) emerged as a consistent sustainability priority across all six case study buildings, with each development incorporating measures aimed at enhancing occupant comfort, health, and well-being. The Lagos buildings primarily achieved indoor environmental quality through advanced mechanical systems and controlled indoor environments. Eko Pearl Tower, Nestoil Tower, and Kingsway Tower incorporated centralised heating, ventilation, and air conditioning (HVAC) systems designed to maintain consistent thermal conditions, air quality, and lighting levels throughout occupied spaces. These systems typically include air filtration, temperature control, and humidity management features that provide occupant comfort despite external climatic conditions. However, this reliance on mechanical systems also increases operational energy consumption and reduces building autonomy, potentially compromising long-term sustainability objectives (IEA, 2023).

The Accra case studies demonstrated a more balanced approach to indoor environmental quality, combining passive design strategies with technological systems to achieve comfortable indoor conditions. The nZEB incorporated natural ventilation strategies, daylight optimisation, and passive cooling measures that reduce dependence on mechanical systems while maintaining acceptable thermal comfort. The Ecobank Ghana Head Office similarly combined passive design features with efficient building services to create high-quality indoor environments. Ashesi University exemplifies effective integration of passive and active IEQ strategies, with campus buildings designed to maximise natural ventilation, daylight availability, and occupant comfort while minimising energy consumption. These approaches align with recommendations by Hyde (2013), who advocates for climate-responsive design strategies that balance passive and active measures to achieve optimal indoor environmental quality in tropical climates.

The differences in IEQ approaches between Lagos and Accra have major effects on building performance, occupant satisfaction, and operational efficiency. Lechner et al. (2021) emphasise that indoor environmental quality encompasses multiple dimensions, including thermal comfort, indoor air quality, visual comfort, acoustic comfort and occupant health. While mechanical systems can effectively control these parameters, they require substantial energy inputs and may contribute to building related health issues if improperly maintained. Conversely, passive strategies reduce energy demand, enhance building autonomy and may improve occupant connection to outdoor environments, contributing to psychological well-being and productivity (Kibert, 2022).

Research by Santamouris (2016) suggests that tropical buildings incorporating passive design strategies often achieve superior IEQ outcomes compared to fully air-conditioned buildings, particularly when designed with appropriate climate-responsive features. Natural ventilation, for example, provides fresh air, reduces indoor pollutants and promotes thermal comfort through air movement, while daylight optimisation supports circadian rhythms, visual comfort, and energy savings. These findings support the Accra approach of prioritising passive strategies as foundational IEQ measures, with mechanical systems serving complementary roles rather than as primary solutions.

The implications of these findings for Lagos and similar rapidly urbanising West African cities are significant. The growing prevalence of fully air-conditioned buildings in tropical cities raises concerns about energy consumption, carbon emissions and occupant health. As climate change intensifies heat stress and urban temperatures, the demand for mechanical cooling may increase, potentially exacerbating energy and environmental challenges (IPCC, 2022). Therefore, architects, developers and policymakers should consider passive IEQ strategies as fundamental design principles, incorporating natural ventilation, daylighting and passive cooling measures into building designs wherever feasible. Hybrid approaches that combine passive design with efficient mechanical systems may offer optimal outcomes, providing comfort and indoor quality while minimising energy consumption and environmental impacts.

To advance indoor environmental quality in West African buildings, several strategies may be considered. Design teams should integrate IEQ considerations from the earliest stages of building design, using climate analysis, building performance simulation, and occupant engagement to inform decision-making. Building regulations and certification systems should incorporate IEQ requirements that encourage passive design strategies, natural ventilation and daylight optimisation. Additionally, post-occupancy evaluation studies should be undertaken to assess IEQ performance, occupant satisfaction, and building operation, providing evidence for continuous improvement and best practice development.

4.6 Regulatory and Institutional Alignment

Differences were also observed in relation to sustainability governance and regulatory alignment. The Lagos buildings demonstrate compliance with contemporary building regulations and incorporated sustainability measures within broader commercial development objectives. However, sustainability implementation appeared largely project-driven. The Accra case studies exhibited stronger evidence of institutional commitment to sustainability objectives. The nZEB, Ecobank Ghana Head Office, and Ashesi University demonstrated alignment with broader sustainability agendas, environmental performance goals, and organisational sustainability initiatives. These findings suggest that institutional support and governance frameworks play an important role in shaping sustainable building outcomes. The comparative assessment demonstrates that all selected buildings incorporate sustainability principles, albeit through different approaches. The Lagos case studies place greater emphasis on technological and infrastructural solutions, while the Accra case studies exhibit stronger integration of passive climate-responsive design, resource efficiency measures, and institutional sustainability frameworks. These findings provide a basis for the discussion of sustainable building performance and contextual influences presented in the subsequent section.

5 Discussion

The findings of this study demonstrate that sustainable building practices in Lagos, Nigeria, and Accra, Ghana, are influenced by a combination of climatic conditions, technological capabilities, institutional frameworks, and development priorities. The selected case study buildings all incorporated sustainability principles, but they adopted different approaches to achieve environmental performance and operational efficiency.

A major finding of the study is that energy efficiency remains a central sustainability objective across all case studies. The Lagos buildings, namely Eko Pearl Towers, Nestoil Tower, and Kingsway Tower, primarily rely on modern building services, centralised cooling systems, and advanced mechanical technologies to improve operational performance. This trend reflects the increasing focus of high-rise developments in rapidly urbanising cities on addressing sustainability through technological solutions that enhance efficiency while maintaining occupant comfort (IEA, 2023; Kibert, 2022). In contrast, the Accra case studies demonstrated a stronger emphasis on reducing energy demand through passive and climate-responsive design strategies. The Nearly Zero-Energy Building (nZEB), Ecobank Ghana Head Office, and Ashesi University incorporated building orientation, natural ventilation, solar control, and daylight optimisation measures, thereby reducing their dependence on mechanical cooling systems. These findings support previous studies that identify passive design as a critical strategy for improving building performance in tropical climates (Hyde, 2020; Ruiz-Valero et al., 2021).

The study further revealed differences in resource management approaches. Both cities implemented water conservation measures, but the Accra buildings showcased a more comprehensive integration of water-efficient systems and environmentally responsive material selection. In particular, Ashesi University demonstrated the benefits of utilising climate-responsive planning and locally appropriate materials to enhance sustainability outcomes. This finding aligns with sustainable construction principles that advocate the use of context-sensitive design solutions and environmentally responsible material choices throughout the building life cycle (Kibert, 2022).

Indoor environmental quality emerged as another important area of convergence across the case studies. All selected buildings incorporated measures aimed at improving thermal comfort, natural lighting, and occupant well-being. However, the means of achieving these objectives varied. The Lagos building relied more heavily on mechanical systems and controlled indoor environments, whereas the Accra buildings combined passive strategies with technological interventions. This observation reinforces the importance of integrated design approaches that balance environmental performance with occupant comfort and health (UNEP, 2023).

The findings also highlight the significant role of institutional commitment and governance structures in shaping sustainable building outcomes. The Accra case studies demonstrated stronger alignment with sustainability policies, environmental objectives, and organisational sustainability initiatives. This supports previous research suggesting that policy frameworks, institutional leadership, and governance capacity are important drivers of sustainable building adoption and performance (IFC, 2023; World Bank Group, 2024). The study reveals that a uniform regional perspective cannot adequately explain sustainable building development in West Africa. Despite similar climatic conditions, Lagos and Accra exhibit different sustainability priorities and implementation approaches. The findings therefore emphasise the importance of context-specific strategies that integrate technological innovation, passive climatic design, resource efficiency, and institutional support. Such an approach is essential for improving the performance of high-rise and institutional buildings in rapidly urbanising tropical cities and contributes to the growing body of knowledge on sustainable architecture in West Africa.

6 Conclusions

This study comparatively assessed sustainable building practices in selected high-performance buildings in Lagos, Nigeria, and Accra, Ghana, to identify context-specific sustainability strategies suitable for tropical urban environments. Using a qualitative comparative case study approach, six buildings were evaluated across six sustainability performance domains: energy efficiency, passive climate design, water management, material sustainability, indoor environmental quality, and regulatory alignment.

The findings indicate that while sustainable building development is gaining increasing attention in both cities, notable differences exist in the approaches adopted. The Lagos case studies: Eko Pearl Towers, Nestoil Tower, and Kingsway Tower primarily emphasised technological and infrastructural solutions, including advanced building services, centralised cooling systems, and modern building management technologies. In contrast, the Accra case studies, Nearly Zero-Energy Building (nZEB), Ecobank Ghana Head Office, and Ashesi University demonstrated stronger integration of passive climate-responsive strategies such as building orientation, natural ventilation, daylight optimisation, renewable energy utilisation, and environmentally responsive planning.

The study further revealed that institutional commitment, governance structures and sustainability policy frameworks have a major impact on determining sustainable building outcomes. Despite operating under similar tropical climate conditions, differences in regulatory environments, organisational priorities, and investment patterns contributed to varying sustainability approaches and performance levels. These findings underscore the importance of adopting context-specific rather than generalised strategies for sustainable building development in West Africa.

Overall, the study demonstrates that effective high-performance architecture in tropical urban environments requires a balanced integration of technological innovation, passive design principles, resource efficiency measures, and supportive institutional frameworks. The comparative insights derived from Lagos and Accra contribute to the growing body of knowledge on sustainable architecture in Africa and provide practical guidance for architects, planners, developers, and policymakers seeking to enhance building sustainability in rapidly urbanising cities.

Based on the findings of the study, it is recommended that architects prioritise passive design strategies, including appropriate building orientation, natural ventilation, solar shading, and daylight optimisation, to improve environmental performance and occupant comfort. Policymakers should strengthen sustainability regulations and encourage wider adoption of green building standards, while developers should integrate renewable energy systems, water-efficient technologies, and sustainable building materials into future building projects. Educational and professional institutions should also enhance training and awareness programmes to build capacity in sustainable building design and construction practices. Furthermore, future research should incorporate primary data sources, such as site measurements, occupant surveys, and post-occupancy evaluations, to provide more robust evidence, while comparative studies across African cities should be undertaken to improve understanding of context-specific sustainable building strategies and support evidence-based policy and practice.

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