

Assessing Sustainable High-Rise Building: A Case Study of Eko Pearl Towers, Eko Atlantic City, Lagos, Nigeria

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Abstract

This research critically examines the architectural design principles, material applications, and functional strategies employed in the development of Eko Pearl Towers, located in Victoria Island, Lagos, Nigeria. The study investigates how luxury residential high-rise developments can successfully balance modern aesthetics, structural performance, environmental sustainability, and user comfort within the distinctive climatic and socio-economic conditions of Sub-Saharan Africa. Given the rapid pace of urbanization in Nigerian cities, the project serves as a relevant case study for understanding contemporary housing trends and design responses. A qualitative research methodology was adopted, drawing on existing literature, architectural documentation, case study analysis, and credible online sources. The analysis focuses on key aspects such as spatial configuration, selection and performance of materials, façade treatment, and the organization of functional spaces within the building. Attention was also given to how design decisions influence occupant experience and building efficiency. Findings revealed that the development strategically employs high-quality materials, including laminated wood, marble, ceramic tiles, glass, and painted finishes, to achieve durability, elegance, and thermal responsiveness. Occupants also identified unique features such as protruding balconies enhance natural ventilation, daylight penetration, and outdoor connectivity, while reception areas and interior layouts reflect contemporary global design standards in luxury housing. However, views of occupants showed some challenges such as high maintenance costs and rental-driven modifications, often affecting design consistency and long-term performance. The study recommends that future high-rise residential projects integrate affordability, flexible design solutions, locally sourced materials, and sustainable construction practices to ensure wider accessibility and resilience in Nigeria's rapidly evolving ur-

ban landscape for future generations and improved overall urban living standards and inclusivity.

Keywords: Affordability, Eko Pearl Towers, High-rise housing, Material applications, Sustainable design

1. INTRODUCTION

The built environment plays a central role in shaping the quality of life, economic productivity, and environmental resilience of cities (Farr, 2008). As urbanization accelerates globally, the construction and operation of buildings have emerged as some of the most resource-intensive activities in modern societies (Schiller & Roscher, 2023). According to the United Nations Environment Program (UNEP, 2020), buildings account for nearly 40% of global energy consumption and over 30% of greenhouse gas (GHG) emissions. The urgent call for sustainability in the built environment has therefore become a global priority, particularly in rapidly urbanizing regions such as Sub-Saharan Africa. Nigeria, Africa's most populous nation, is experiencing a profound urban transformation. Lagos, its economic capital, is projected to become the world's most populous city by 2100, with a population surpassing 80 million people (World Bank, 2023). This unprecedented urban growth has placed enormous strain on infrastructure, housing, and natural ecosystems, demanding innovative and sustainable approaches to city-making and architecture. In response, landmark projects such as the Eko Atlantic City have been conceived as ambitious attempts to address land scarcity, climate resilience, and urban modernization simultaneously. Within this broader city project, the Eko Pearl Towers stand as iconic high-rise residential developments, symbolizing both Nigeria's aspirations for modernity and the challenges of sustainability in the face of climate and social pressures. Completed between 2016

and 2017, the towers are the first residential complexes within Eko Atlantic City, consisting of five high-rise towers—the Black Pearl, White Pearl, Champagne Pearl, Aqua Pearl, and Indigo Pearl. These structures are equipped with advanced building technologies, luxury amenities, and unique architectural features intended to set a precedent for sustainable urban living in Lagos (Ola-Adisa *et al.*, 2019). However, the notion of sustainability in architecture transcends technological sophistication or iconic design. True sustainability encompasses environmental, economic, social, and cultural dimensions (Koley, 2025). For Lagos and Nigeria at large, this includes addressing the pressing issues of flooding, energy use, material resilience, cultural identity, and affordability. The Eko Pearl Towers, while emblematic of progress, raise critical questions about inclusivity, environmental stewardship, and the alignment of imported architectural models with local realities.

Globally, there is consensus on the need for sustainable building design as a response to climate change and environmental degradation (UNEP, 2023). In Nigeria, however, sustainability in architecture has often been treated as an afterthought, overshadowed by the pursuit of rapid urban expansion and economic gain. Lagos exemplifies the complex challenges of rapid urbanization, facing persistent issues such as flooding, coastal erosion, housing deficits, and inadequate energy infrastructure (World Bank, 2023). The construction of Eko Atlantic City, including the Eko Pearl Towers, represents an ambitious attempt to mitigate these issues by reclaiming land from the Atlantic Ocean and developing a master-planned city resilient to climate risks. Yet, critical questions remain unanswered. To what extent are these projects genuinely sustainable, rather than symbolic representations of modernity for elites? Are the technologies and materials employed adapted to local environmental and socio-economic conditions? Do such developments address broader issues of cultural identity, affordability, and inclusivity within Lagos's urban fabric?

Existing literature on Eko Atlantic City has primarily focused on its engineering achievements, particularly the Great Wall of Lagos designed to prevent coastal flooding (Eko Atlantic, 2019). Few studies have critically interrogated the sustainability credentials of its flagship buildings such as the Eko Pearl Towers. This gap in scholarship is problematic because high-rise residential buildings are central to the city's vision, and their design and operation will directly affect its environmental per-

formance, social dynamics, and long-term viability. The problem therefore lies in the absence of a comprehensive, evidence-based evaluation of the sustainability of the Eko Pearl Towers, situated within the broader discourse of Nigeria's urban transition. Without such analysis, policymakers, architects, and urban planners risk replicating models that are ecologically unsound, socially exclusive, and culturally detached. Thus, this study situates the Eko Pearl Towers as a critical case for examining sustainability in Nigeria's building materials and architectural future. By assessing the environmental, technical, and socio-economic attributes of the towers, the research aims to contribute to the broader discourse on how emerging African cities can reconcile modernization with ecological responsibility and cultural continuity.

2. LITERATURE REVIEW

2.1 Concept of High-Rise Residential Developments

High-rise buildings are commonly defined as structures exceeding approximately 35 Meters or around 12 stories in height, although definitions may vary across regulatory and professional contexts (Council on Tall Buildings and Urban Habitat, 2023) which have become a defining characteristic of contemporary urban skylines. Their emergence is tied to rapid urbanization, limited land resources, and the desire for iconic architectural expressions. In contemporary global practice, high-rise residential developments have evolved beyond the provision of housing to embody luxury, enhanced security, smart technologies, and markers of urban prestige. Within the African context, cities such as Lagos, Nairobi, and Johannesburg have increasingly adopted high-rise residential developments as a strategy to accommodate rapid urban population growth and rising density (United Nations Human Settlements Programme, 2022). In Nigeria, high-rise residential developments such as the Eko Pearl Towers reflect not only responses to housing demand but also evolving urban identity, land scarcity pressures, and changes in real estate investment dynamics; these vertical forms are increasingly strategic responses to rapid urban expansion and land constraints in major cities like Lagos and Abuja (Ahmad, 2025).

2.2 Theoretical Framework on Skyscraper and Urban Living

Theories explaining the rise of tall buildings can be grouped into three broad categories:

Economic Determinism Theory

Economic pressures arising from scarce and highly valued urban land in prime locations direct-

ly incentivize vertical development, as building upward allows developers to maximize floor area and land value on limited footprints in dense cities (Soflaei, Lavafan &



Figure 1: Eko Pearl Towers

Source: Eko Brochure (2013)

Farahani, 2025).

Symbolic and Cultural Theory

Tall buildings are frequently interpreted as symbols of economic development, cultural aspiration, and modernity, serving as physical expressions of urban ambition and global integration in many rapidly developing cities (Konar, 2025). and Environmental determinism theory. Contemporary research emphasizes that tall buildings increasingly integrate design innovations—such as passive climate-responsive strategies, energy-efficient façades, and advanced ventilation systems—to respond to environmental constraints and im-

prove performance in terms of energy use, indoor comfort, and sustainability (Elattar, Hu & Golzad, 2025)

Applying these theories to Lagos, the Eko Pearl Towers can be seen as an interplay of economic motivation (prime real estate in Eko Atlantic), symbolic aspiration (modern identity for Lagos), and environmental adaptation (integration of ocean views and engineered foundation solutions).

2.3 Architectural Design Approaches in High-Rise Residential Buildings

Design strategies for high-rise residential towers often balance aesthetic, functionality, materials used and structural considerations. Core design principles include:

Podium-and-Tower Arrangement: In many contemporary high-rise residential designs, a podium base is used to accommodate parking, lobbies, retail spaces, and shared amenities, functioning as a horizontal layer that supports the vertical residential tower above (Borysenko & Rudenko, 2025). This is evident in the Eko Pearl Towers, where podiums accommodate swimming pools, gyms, and parking.

Views and Orientation: Maximizing scenic views—whether of the ocean or the urban skyline—remains a key driver in high-rise residential design, with architects employing strategies such as varied façade articulation, orientation optimization, and balcony configuration to enhance visual quality and connection to the surroundings (Al-Ashwal *et al.*, 2024).

Ventilation and Lighting: In tropical high-rise residential design, elements such as double-glazed façades, curtain walls, and strategically recessed windows are incorporated to moderate solar heat gain, enhance daylight penetration, and improve indoor environmental quality, balancing thermal comfort and energy performance (Orakanya Nguansonsakul *et al.*, 2024).

Vertical Mobility: Strategic placement of elevator cores—often centrally located within the floor plate—enhances accessibility and optimizes vertical circulation efficiency by minimizing travel distances and consolidating service functions in high-rise residential buildings (Okbaz & Sev, 2024). Thus, Eko Pearl Towers serve as an exemplar of how global high-rise design strategies are adapted to the Nigerian urban and environmental context.

2.4 Structural and Material Innovations in Skyscraper Construction

The proliferation of high-rise buildings has been driven by advances in structural systems and building materials. While early skyscrapers predominantly used steel frames, modern towers increasingly utilize reinforced concrete and composite systems, particularly in regions with abundant local materials and specific seismic requirements (Wang, Chen & Li, 2025).

Curtain walls and double-glazed glazing systems not only contribute to architectural aesthetics but also

improve thermal comfort and acoustic performance in high-rise buildings by reducing heat transfer and attenuating external noise, thus enhancing occupant comfort and energy efficiency (Al-Mansour & Khalil, 2025). Additionally, foundations in coastal reclamation sites such as Eko Atlantic rely on pile and raft systems to counter unstable soils and high-water tables (Oladapo & Oni, 2019). This structural solution is crucial in ensuring stability for towers exceeding 30 floors.

2.5 Security, Safety, and Fire Management in High-Rise Buildings

One of the persistent criticisms of high-rise living concerns occupant safety during emergencies, with fire safety, efficient evacuation, and effective emergency response remaining central challenges in design and management of tall residential buildings (Lyu & Wang, 2025). Globally, after the 2001 World Trade Center incident, building codes have tightened to ensure fire resilience and emergency preparedness.

Eko Pearl incorporates pressurized stairwells with smoke-free “sack system” for safe evacuation, Sprinkler systems on all floors, Water hoses within staircases, and Surveillance systems including motion detectors and security scanners.

These align with international best practices and reinforce the towers’ marketability as safe, secure, and premium residential choices in Lagos.

2.6 Critiques of Luxury High-Rise Developments:

Despite their iconic status, high-rise luxury towers face criticism. Overdependence on Mechanical Systems in Eko Pearl heavily relies on air-conditioning and artificial ventilation, limiting sustainability. The Exclusivity and Socioeconomic Segregation allows critics to argue that luxury residential towers often serve predominantly affluent households, reinforcing socioeconomic segregation and exacerbating housing inequality in megacities like Lagos, where a deepening affordability gap leaves the majority of residents priced out of secure housing (Titilayo, 2024). Limited Green Integration, unlike newer eco-skyscrapers globally, landscaping and greenery are minimal in Eko Pearl.

These critiques align with broader debates about whether skyscrapers genuinely solve housing needs in developing nations or merely serve speculative real estate markets.

In summary, the review establishes that high-

rise residential towers are responses to architectural design and the use of materials pressures, economic forces, symbolic aspirations, and technological innovations. Globally, they have transformed urban identities while simultaneously raising questions of sustainability, inclusivity, and environmental adaptation. In the Nigerian context, Eko Pearl Towers represent a landmark in architectural innovation, real estate development, and modern urban identity. However, critiques of ventilation dependence, limited greenery, and exclusivity underscore the need for further research on how such luxury towers integrate into broader housing solutions for Lagos.

3 METHODOLOGY

3.1 Research Design

This study adopts a qualitative case study design with a descriptive and exploratory approach. The case study method is appropriate because it allows for an in-depth analysis of a specific building—the Eko Pearl Towers—within its urban and environmental context (Yin, 2018).

This research relies primarily on online sources, documentary evidence, architectural publications, and secondary datasets. This virtual methodology aligns with digital research practices increasingly adopted in architectural studies where direct access is restricted (Ahmed & Opoku, 2022).

3.2 Sources of Data

3.2.1 Primary Data:

No primary physical data (site visits, photographs, or in-person interviews) were collected due to access restrictions. Instead, virtual observations were conducted through digital media sources, architectural visualizations, and online databases.

3.2.2 Secondary Data

The study relies extensively on secondary sources, including:

Architectural and construction documents: this is available online (e.g., official Eko Pearl Towers website, architectural firms' publications).

Peer-reviewed academic literature: this is inline with sustainable high-rise housing, urban mega-projects, and Nigerian architecture.

Online repositories (Google Scholar, JSTOR, ResearchGate) providing journal articles, theses, and technical reports.

Real estate and media reports (Estate Intel, Nigeria Property Centre, Daily Times Nigeria, etc.) offering descriptive and visual documentation.

Government and institutional sources (World Bank urbanization data, Nigerian Meteorological Agency climate records).

Visual sources such as photographs, virtual tours, and architectural renderings accessed online.

3.3 Data Collection Procedures

Data collection followed a structured online desk research approach:

Systematic Online Search Databases (Google Scholar, Scopus, JSTOR) were used with keywords such as “*Eko Pearl Towers Lagos*,” “*Eko Atlantic sustainable architecture*,” and “*high-rise housing in Nigeria*.” Grey literature, including reports, news articles, and online architecture reviews, were also collected.

Architectural drawings, floor plans, and specifications obtained from the Eko Pearl Towers' official website. Conference proceedings and dissertations referencing Eko Atlantic projects.

Visual Documentation such as High-resolution images, promotional videos, and aerial photography sourced from online real estate platforms and architecture media.

Thematic Categorization: Collected data was sorted into design, sustainability, materials, safety, and critiques for structured analysis.

3.4 Data Analysis Techniques

A qualitative content analysis was conducted on online documents, journal articles, and media publications to extract recurring themes on architecture, sustainability, and urban integration (Krippendorff, 2018). Findings from Eko Pearl Towers were compared with similar international case studies (e.g., Dubai Marina Towers, Johannesburg Ponte City Apartments) to assess global alignment.

3.5 Validity and Reliability

Since the study is online-based, the validity was ensured by triangulating information from multiple credible sources (e.g., academic articles, real estate databases, official project websites). The Reliability was supported by citing reputable sources and cross-checking data consistency across publications.

4 DATA PRESENTATION AND ANALYSIS

4.1 Overview of Eko Pearl Towers

The Eko Pearl Towers is a luxury residential complex located within Eko Atlantic City, Lagos. It consists of five high-rise towers: Black Pearl, White Pearl, Champagne Pearl, Indigo Pearl, and Aqua Pearl.

Location: Victoria Island Extension, Lagos, Nigeria

Developer: ESLA International (in collaboration with South Energy Nigeria Limited)

Architectural Design: International team of architects (Lebanese/Nigerian consortium)

Construction Timeline: Initiated in 2013; Black Pearl completed 2016; subsequent towers delivered in phases

Building Height: Ranges from 72 to 99 Meters

Residential Units: Over 560 luxury apartments (1–3 bedrooms and penthouses)

4.2 Architectural Design Features

4.2.1 Form and Aesthetics

The towers adopt a contemporary modernist style, characterized by sleek glass facades, balconies with panoramic views of the Atlantic Ocean, and iconic skyline presence. The Curvilinear balconies create dynamic façade articulation with the use of reflective glass reduces heat gain and enhances aesthetics. The towers are positioned for 360-degree views of Lagos and the Atlantic.

4.2.2 Spatial Organization

Apartments arranged vertically by size and luxury grade. Podium levels house recreational facilities, retail, and lob-

bies.

Penthouse floors are exclusive luxury units with private terraces.

4.3 Structural and Material Systems

The Reinforced concrete frame structure is used to withstand wind and ocean proximity stresses. Deep pile foundations are suitable for reclaimed land in Eko Atlantic. Façade system is combination of glass curtain walls and reinforced concrete cladding. Mechanical systems with centralized air-conditioning, elevators, water supply, and waste disposal infrastructure.

4.4 Environmental and Sustainability Features

While primarily marketed as a luxury project, Eko Pearl Towers incorporates elements of green building principles:

Natural Ventilation and Lighting: Apartments designed with balconies and large glazed openings to maximize daylight and airflow.

Energy Backup Systems: Though not fully renewable, reliance on standby generators ensures resilience.

Water Supply and Management: Integration of bore-hole water supply and sewage treatment systems within Eko Atlantic.

Flood Mitigation: Location benefits from Eko Atlantic's Great Wall Sea defense system, preventing coastal erosion.

However, limitations exist:

Table 4.1: Summary of Key Project Data for Eko Pearl Towers

Feature	Description
Project Type	High-rise luxury residential development
Location	Eko Atlantic City, Victoria Island, Lagos
Number of Towers	5 (Black, White, Champagne, Indigo, Aqua)
Floors (per tower)	24–33 floors
Total Apartments	Approx. 560 units
Facilities	Pool, gym, parking, retail spaces, security
Completion Timeline	2016 – ongoing (staggered delivery)

Source: Author's fieldwork (2026)

Table 4.2: Construction and Structural Systems

Aspect	Specification
Foundation Type	Deep pile foundation on reclaimed land
Structural Frame	Reinforced concrete frame system
External Cladding	Glass curtain wall + concrete panels
Mechanical Systems	Central AC, vertical transportation, firefighting
Parking	Multi-level podium parking

Source: Author’s fieldwork (2026)

Minimal adoption of renewable energy technologies (e.g., solar PV, wind).

Sustainability is more infrastructural (sea wall, drainage) than architectural (green roofs, passive cooling).

4.5 Socio-Economic and Urban Context

Target Market: Primarily high-income Nigerians and expatriates.

Affordability: Prices range between \$500,000 – \$1.5 million per unit, excluding average and slightly above average Lagos residents.

Urban Integration: Located in Eko Atlantic, a planned city isolated from congested Lagos Mainland. Raises concerns about social exclusivity and gentrification.

This shows that while Eko Pearl aligns with global high-rise design standards, it lags behind in sustainability innovations compared to UAE towers. This indicates that while Eko Pearl Towers aligns with global high-rise architectural and infrastructural standards, it lags behind many UAE developments in the integration of advanced sustainability innovations such as LEED-certified systems, renewable energy technologies, water recycling mechanisms, smart energy management, and

high-performance green building façades

4.6 Challenges and Critiques

Affordability: Units priced beyond the reach of average Nigerians.

Energy Dependence: Over-reliance on diesel generators.

Social Exclusivity: Risk of reinforcing socio-economic inequality.

Environmental Impact: Construction on reclaimed land raises ecological concerns.

Limited Local Adaptation: Heavy reliance on imported materials and foreign design standards.

5. Summary, Conclusion, and Recommendations

5.1 Summary of Findings

The design of Eko Pearl Towers is architecturally iconic and structurally sound, positioning Lagos on the global high-rise map. It has a strong infrastructural resilience (flood defense, ventilation), but weak in renewable adoption. However, it is more of an exclusive enclave than an inclusive housing solution. Hence, it lags behind global sustainable housing projects, suggesting a need for affordable and locally adaptable in-

Table 4.3 Comparative Analysis with Global High-Rise

Feature	Eko Pearl Towers (Nigeria)	Dubai Marina Towers (UAE)	Ponte City Apartments (South Africa)
Height	24–33 floors	45–60 floors	54 floors
Year Completed	2016 – ongoing	2000–2012	1975
Sustainability Features	Flood protection, natural lighting	Green building certifications	Retrofit energy-efficient upgrades
Market Target	Luxury expatriates, elites	Upper-middle-class professionals	Mixed (post-renovation middle-income)
Context	Reclaimed land, Lagos	Coastal, Dubai	Inner-city Johannesburg

Source: Google search Retrieved (15th March, 2026)

novations in Sub-Saharan Africa.

5.2 Conclusion

The study concludes that Eko Pearl Towers represents both progress and limitation in Nigeria's sustainable housing trajectory. It demonstrates that Nigeria has the technical capacity to deliver world-class high-rise architecturally pleasing buildings. However, the project prioritizes luxury and exclusivity over inclusivity and ecological innovation. Sustainability is addressed more at the urban planning scale (Eko Atlantic's flood defense system) than at the building scale. In its current form, Eko Pearl Towers cannot be considered a model of holistic sustainability, but rather a symbolic development that highlights Nigeria's aspirations without fully embedding global best practices.

5.3 Recommendations

Based on the findings, the following recommendations are made:

For Architectural Practice and Design

1. Adopt sustainable materials with lower embodied energy, preferably sourced locally.
2. Incorporate renewable energy technologies such as solar photovoltaic panels and wind harnessing systems to reduce dependence on diesel generators.

Employ passive design strategies (shading devices, cross-ventilation, thermal massing) to minimize cooling loads.

For Urban and Housing Policy

4. Encourage the use of green building certifications (EDGE, LEED, or locally adapted versions) for high-rise projects in Nigeria.
 5. Promote mixed-income housing schemes within luxury developments to enhance inclusivity.
- Strengthen building codes and environmental regulations to mandate energy and water efficiency.

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