

# Adaptive Architecture: Exploring Resilience and Community Engagement in Design

Erekpitan Omoikhefe Ola-Adisa<sup>1</sup>, Inalegwu Inalegwu Ella<sup>1</sup>, Ahmed Isah Ibrahim<sup>2</sup>

<sup>1</sup>Department of Architecture, University of Jos, Jos, Nigeria

<sup>2</sup>The Architects' Resourcery, Lagos, Nigeria

Corresponding author: adisae@unijos.edu.ng

**Abstract:** Adaptive architecture via sustainability, modularity and technology integration, delivers adaptable answers to environmental and economic demands. Currently, Nigeria's economic index: with inflation escalating to 26.00% by 2024, real estate contributing 5.20% to GDP in Q1 2024, and construction 4.01%, stress the necessity, for approaches of this type. Elevated structures, modular adaptability, and digital/analogue engagement platforms, are highlighted by four case studies (Lungu Kal Kal Kano, IDP Camps Maiduguri, Makoko School, Freedom Park). Although local innovations pave pathways forward, financial limitations persist. In order to facilitate comprehensive design and resilience, recommendations stress acceptable policy incentives, components and viable participatory tools.

**Keywords:** adaptive architecture, community platforms, modular design, Nigeria, resilience theory,

## 1. Introduction

Adaptive architecture consists of idealistic approach, portrayed by floating structures, in urban waterways, which integrates with bridges and skylines, consequently exploring community engagement and resilience, in design as exhibited in global networks, of illumined urban spaces, representing interconnected pressures. Adaptive architecture offers new solutions, to solve diverse global, environmental and economic issues.

In Nigeria, while construction adds 4.01%, against a backdrop of inflation, rising from 8.06% in 2014 to 26.00% in 2024F, real estate increased 5.20% to GDP in Q1 2024, with 0.84% growth, with a 10-year average line; mirrored in yearly average patterns For flexible model, this fiscal volatility, highlights its significance (Mannucci et al., 2022).

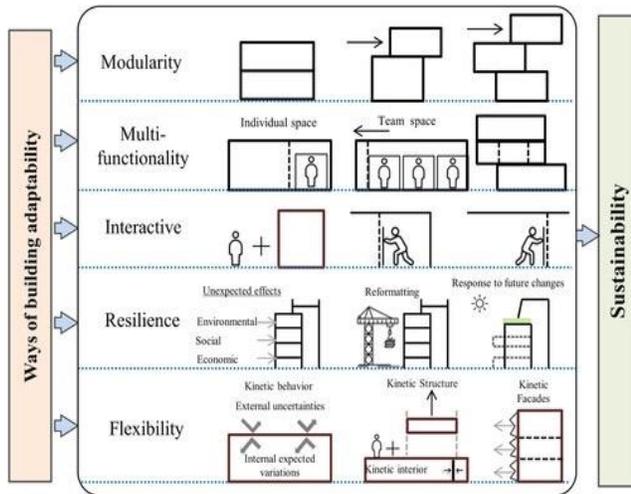
This study incorporates resilience theory and 2020+ scholarship, for empirical insights, examining beliefs, global precedents, Nigerian cases, history, theory, engagement platforms, resilience

technologies, setbacks, and conclusions (Bosman & Van den Berg., 2024).

## 2. Literature Review

### 2.1 Main Principles

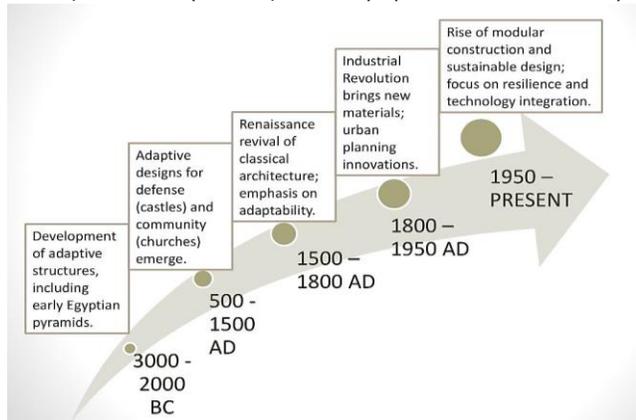
Modular areas, within which people, reconfigure layouts appear key to adaptive architecture. Modular architecture emphasises adaptability to environments and is modelled for fast changing needs (Elshater & Abusaada, 2022). Figure 1 highlights the core ideas consist of sustainability in design, adaptability, with incorporation of technology to elevate user experience. As mapped in conceptual flowcharts, these includes interactivity for unanticipated effects, modularity for individual/team spaces, multi-functionality for spatial overlap, resilience against economic/environmental shocks, and malleability for internal changes (Bosman & Van den Berg., 2024).



**Figure 1:** Ways to building Adaptability  
Source: Atef et al (2024)

**2.2 Historical Context**

Overtime, adaptable structures have evolved; extending from early Egyptian pyramids (3000–2000 BC), to defence designs (castles) and community (churches) in 500–1500 AD. As traced in historical timelines, renaissance stressed flexibility (1500–1800 AD), from Industrial Revolution inventions, with urban planning and new materials (1800–1950 AD), to modern modular building, which focuses on technology and resilience incorporation (1950–present), (Russo et al., 2025).



**Figure 2:** Historical Overview of Adaptable Structures

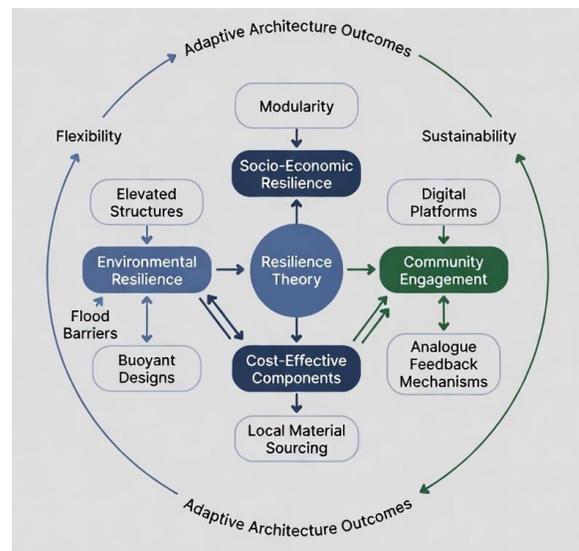
Source: Adapted from Russo et al., (2025)

**2.3 Global Exemplars**

Prominent buildings that were adaptive, consist Forest House in Bangkok with vertical greening, the Eastgate Shopping Centre, in Harare for biomimetic cooling, The Edge Platform, in NYC, as modular waterfronts and Floating Pavilion in Rotterdam, for buoyancy, reflecting context dependent innovation (Elshater & Abusaada, 2022).

**3. Theoretical Framework**

In order to encourage flexibility, to evolving regional situations, resilience theory focuses on stability and sustainability in design (see Figure 3). Highlighting strategies, which mitigates shocks, reorganise, and transform. Architecturally utilised via durable/dependable materials, modular forms, and community ownership (Mannucci et al., 2022; Julliard et al, 2022). This model directs assessment of cases, technologies and setbacks.



**Figure 3:** Resilience Framework

Within the Nigerian context, resilience theory extends beyond environmental responsiveness to include the capacity of built systems to absorb

socio-economic shocks. Fluctuations in material prices, inconsistent cash flows, and stalled project financing function as economic disturbances that test the durability of architectural solutions (Russo et al, 2025). Adaptive architecture thus operates as both a spatial and financial strategy—enabling buildings to maintain functionality despite instability in resource availability or wider economic unpredictability. By embedding modularity, ease of replacement, and cost-flexible components, designers create buffers against uncertainty, ensuring that resilience is not solely structural but also economically sustainable (Yassin, Al-Bustani & Al-Emam, 2022).

#### 4. Case Study Methodology

##### 4.1 Selection

Lungu Kal Kal Kano (flood-prone housing), IDP Camps Maiduguri (displacement shelters), Makoko School (floating education), and Freedom Park (heritage repurposing), were the four Nigerian researches, selected for versatility, as represented, by buoyant structures, in water communities (United Nations Human Settlements Programme, 2025).

##### 4.2 Data Sources

Primary data via research reports and images; secondary data from 2020+ literature and observations (2017–2019).

##### 4.3 Analysis

Thematic coding integrated with resilience: sustainability, modularity, enabling pattern synthesis, engagement and hazard mitigation (Yin, 2018).

#### 5. Findings

##### 5.1 Principles in Nigerian Context

Modularity allows replacement in Makoko's A-frame; multi-functionality supports renovation, in Freedom Park, flexibility supports scaling in IDP Camps' panels; (UNITED NATIONS HUMAN SETTLEMENTS PROGRAMME, 2025).

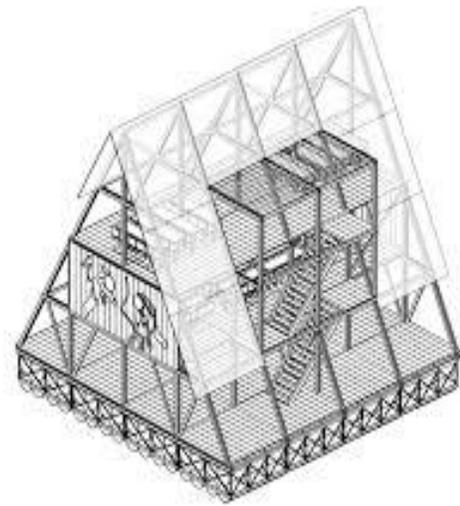


Figure 4: Makoko Floating System

Source: NLE Architects (2021)

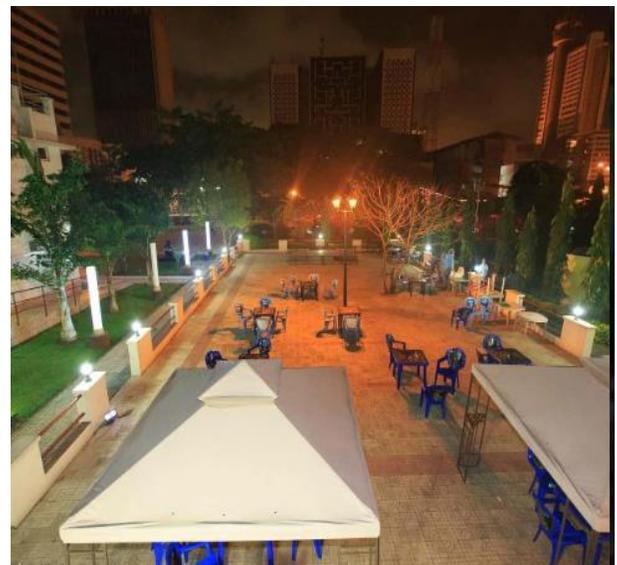


Figure 5: Multifunctionality in Freedom Park

Source: Total Consult (2025)

##### 5.2 Disaster Resilience Technologies

Shown below are the integrated raised frames, with resident areas, above flood levels, for safety, harbour bases, break-away walls, and flood openings. Freedom Park explores penetrable barriers, Lungu Kal Kal and Makoko address drainage and flooding; IDP Camps (Figure 7) use

temporary prefabs (Mannucci et al, 2022). In order to shield against environmental dangers, flood barriers are used.



**Figures 6 a and b:** Drainage in Kano under the Lungu Kal-Kal scheme  
Source: BBC.com (2017)



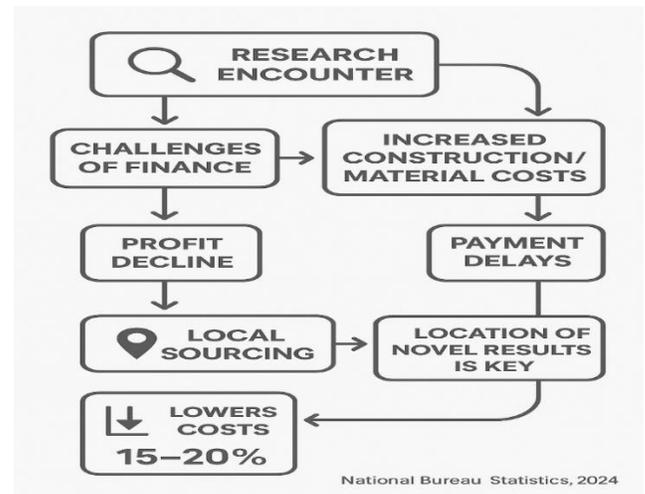
**Figure 7:** Pre Fabs in IDP Housing  
Source: United Nations Human Settlements Programme. (2025)

### 5.3 Community Engagement Platforms

As portrayed in app collections, for input and feedback; facilitates link, via digital platforms, such as Facebook, Discord, Mighty Network, Wild Apricot, Kajabi, Slack, Telegram and Quora. Makoko used analogue co-design; IDP Camps constrained, due to urgency, Freedom Park through forums; (Bosman & Van den Berg., 2024).

### 5.4 Economic Constraints

As depicted in the chart below (Figure 8), research encounter, challenges of finance, prompting increased construction/material costs, profit decline and payment delays. While local sourcing, lowers costs 15–20%, location of novel results is key; (National Bureau of Statistics, 2024).



**Figure 8:** Finance-Related Challenges and Local Sourcing Impacts  
Source: National Bureau of Statistics. (2024)

Nigeria's construction sector continues to experience sustained macroeconomic pressures driven by inflationary surges, currency volatility, and supply chain disruptions (National Bureau of Statistics, 2024; World Bank, 2023). These conditions intensify the cost of imported materials, labour, and machinery, thereby constraining the ability of designers and contractors to implement adaptive solutions at scale. As the cost of structural components rises disproportionately faster than



available project financing, project teams increasingly face trade-offs between quality, innovation, and affordability (Julliard et al, 2022). This economic imbalance weakens resilience outcomes and slows the adoption of modular and technology-enabled interventions critical for adaptive architecture in Nigeria (Mannucci et al., 2022).

**5.5 Synthesis**

Summary of resilient performance can be seen in Table 1.

**Table 1.** Attributes Across Cases

Case	Flexibility/Modularity	Sustainability	Community Platforms	Disaster Technologies
Lungu Kal Kal	High (elevated modules)	Medium	Medium (local input)	High (drainage)
IDP Camps	High (prefab panels)	Low	Low (top-down)	Medium (temporary)
Makoko School	High (floating frame)	High (recycled)	High (co-design)	High (buoyancy)
Freedom Park	Medium (inserts)	High (reuse)	High (forums)	Medium (permeable)

The synthesis of the four Nigerian case studies further demonstrates that adaptive architecture thrives when economic, environmental, and community dimensions are addressed holistically. While modularity and resilience technologies enhance structural durability, their real effectiveness depends on enabling financial ecosystems that support consistent funding, timely payments, and affordable materials (World Bank, 2023). Evidence from comparative countries shows that environments with structured financing mechanisms, supportive policy instruments, and strong local manufacturing bases achieve higher adoption rates of adaptive and modular systems

(United Nations Human Settlements Programme, 2025; Russo et al., 2025). For Nigeria, integrating community participation with cost-efficient construction pathways is essential to ensure that adaptive models translate into sustainable long-term outcomes.

**6. Recommendations and Conclusions**

**6.1 Recommendations**

Strengthening adaptive architecture in Nigeria requires policy and programmatic interventions that directly address the financial vulnerabilities identified in the study. As construction costs continue to rise and payment delays persist across public and private projects, there is urgent need for frameworks that incentivise cost-efficient, resilience-focused building practices (Elshater & Abusaada, 2022). National development goals related to housing, infrastructure resilience, and sustainable urbanisation cannot be met without mechanisms that stabilise supply chains, encourage local material innovation, and provide financial safeguards for adaptive-design projects (United Nations Human Settlements Programme, 2025). Integrating these economic considerations will create a more enabling environment for the widespread adoption of adaptive and modular systems across Nigeria's built environment. Some of these recommendations are

1. Standardise modular components: National guidelines for interchangeability to curb costs.
2. Mandate hybrid engagement: Integrate digital tools with analogue methods.
3. Subsidise resilience technologies: Promote local production of elevated kits and barriers.
4. Address constraints: Establish inflation-indexed funds, favouring vernacular materials.
5. Policy alignment: Incorporate adaptive standards in codes, rewarding green and community elements.

## 6.2 Conclusions

Connecting adaptability, adaptivity, adaptation and adaptiveness is the successful transitional process in achieving flexible design. Flexible buildings promote community coordination, for sustainability, enabling enduring strength, and adaptability, in design. It explores volatility, and guarantees, that built environments thrive in oscillation; from ancient pyramids, to modern structures, like Makoko, and even repurposed urban structures like Old Broad Street Prison now Freedom Park, Lagos.

## References

- Atef, E., Megahe, N, Elgheznawy, D. and Nashaat, B. (2024). Adaptive office buildings: Improving functional flexibility in response to shifting needs using kinetic technology. *Architectural Engineering and Design Management*. 20(4) 946-971
- Bosman, L., & Van den Berg, A. (2024). Making a case for nature-based solutions for a sustainable built environment in Africa. *\*Sustainable Development*, 32\*(3), 1234–1245. <https://doi.org/10.1002/sd.2935>
- Elshater, A., & Abusaada, H. (2022). Climate change adaptation: Strategic planning and urban design practice. *Archnet-IJAR: International Journal of Architectural Research*, 16(2), 299–314. <https://doi.org/10.1108/ARCH-07-2021-0207>
- Juillard, H., Kennedy, J., Minnitt, N., & Labaume, C. (2022). *\*West and Central Africa regional shelter and settlement evaluation\**. United Nations High Commissioner for Refugees. <https://www.unhcr.org/sites/default/files/2023-09/west-and-central-africa-regional-shelter-and-settlement-evaluation.pdf>
- Mannucci, S., Rosso, F., D'Amico, A., Bernardini, G., & Morganti, M. (2022). Flood resilience and adaptation in the built environment: How far along are we? *\*Sustainability*, 14\*(7), 4096. <https://doi.org/10.3390/su14074096>
- National Bureau of Statistics. (2024). Nigeria's gross domestic product (GDP) Q1 2024. <https://www.nigerianstat.gov.ng/elibrary/read/1241506>
- Ola-Adisa, E. O. (2024). *Adaptive Architecture Being paper presented at SETIC 2024 at Federal University of Technology Minna on October 24, 2024*
- Russo, A., Cumo, F., & Sferra, F. (2025). Adaptive urban and architectural strategies for infectious disease resilience: The exceptional convergence of the 2025 Jubilee and Papal events in Rome, Italy. *\*Sustainable Futures*, 7\*, 100020. <https://doi.org/10.1016/j.sftr.2025.100020>
- Total Consult (2025). Freedom park brochure
- United Nations Human Settlements Programme. (2025). Building urban resilience and climate adaptation in African small island developing states after the COVID-19 crisis. <https://unhabitat.org/building-urban-resilience-and-climate-adaptation-in-african-small-island-developing-states-after>
- World Bank. (2023). *\*Nigeria development update: Seizing the opportunity\**. <https://documents.worldbank.org/en/publication/documents-reports/documentdetail/099062623065078024>
- Yin, R. K. (2018). *Case study research and applications: Design and methods* (6th ed.). Sage Publications. <https://doi.org/10.4135/9781506336176>