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Sustainable Building Practices on Lagos Coastlines: Professional Awareness and Lifecycle Integration

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Abstract

Climate risks are typically extreme for buildings in coastal communities, threatening their performance, resilience and sustainability. Strategies for mitigating climate change remain heterogeneous, particularly in developing countries of the Global South. This study examines the gap between professional knowledge and on-site implementation of climate resilience in the management of construction projects along coastlines, using buildings in the Lekki area of Lagos State, Nigeria, as a case study. A quantitative, cross-sectional survey was conducted with 200 construction professionals. Descriptive statistics were employed to evaluate the awareness of key attributes of building resilience and to analyse the extent to which resilience is taken into account across the project's phases. Results showed that foundation instability (89%), maintenance costs (75%), and material deterioration (60%) were major climate threats. Recovery had the highest resilience awareness, while planning (60%) and design (50%) showed the greatest integration. High resilience awareness (56.5%) was reported, with no significant differences among professionals. The results further indicate moderate to high climate risk awareness and climate principles of resilience, especially robustness, recovery, and adaptability. It was also found that professionals' integration of resilience is significantly concentrated during the planning and design phases; however, this wanes during the execution, handover, and post-construction phases. Conventional engineering solutions predominantly define the implementation strategy, whereas redundancy and nature-based solutions remain constrained. The study concludes that the main barrier to coastal construction is not a lack of awareness but the failure of current project delivery systems to maintain the resilience intent throughout a project's life cycle. The results indicate the importance of adopting a life-cycle approach to integrate resilience, targeted capacity development, and institutional support, thereby enhancing the climate resilience of coastal infrastructure in rapidly urbanising cities such as Lagos.

Keywords: Awareness, Climate change, Coastal construction, Resilience, Practice.

Introduction

The built environment is constantly affected by climate change (Yau and Hasbi, 2013). Changes in temperature, precipitation patterns, sea levels, and extreme heat influence not only the planning and design of construction, but also the operations and maintenance of the building. These conditions exert strains on the built environment (Intergovernmental Panel on Climate Change, 2014; Bulkeley *et al*., 2014). The impacts are pronounced in the construction industry, affecting and threatening its sustainability, safety, and performance. These effects are detrimental, especially in coastal areas, resulting in the disruption and displacement of livelihoods and a corresponding increase in the replacement and maintenance costs of building infrastructure (Faremi *et al*., 2021; Willard-Stepan *et al*., 2024; United Nations International Strategy for Disaster Reduction (UNISDR), 2010). These effects result in damage to structures, utilities and supporting infrastructure with high social and economic costs.

However, the built environment is also a major contributor to climate risk. The sector attempts to mitigate some of the effects of climate change, consequently increasing greenhouse gas (GHG) emissions, which further exacerbates climate change (Mehmood *et al*., 2022). Construction contributes significantly to the greenhouse gas emissions from energy consumption, material production, land-use change, and waste (United Nations Environment Programme (UNEP), 2021). However, buildings are also among the most vulnerable assets to climate-related hazards due to their prolonged exposure to environmental conditions (Faremi *et al*., 2021; Oladokun *et al*., 2020). Increasing incidences of extreme weather events pose significant threats to the structural integrity, functionality, durability, and safety of buildings. The aftermath of this has made resilience, a key concept in the adaptation to climate change and in sustainable urban development, an important point of discourse. Unlike traditional approaches to risk management, which focus on identification and avoidance, resilience focuses on the adaptive and mitigation capabilities of a system to anticipate disturbances, absorb shocks, and recover functionality after disruption (Ayyub, 2014; Chen *et al*., 2020; Irankunda *et al*., 2024; Meerow *et al*., 2016). Resilience in the face of current challenges refers not only to building envelope performance but also to its ability to withstand, adapt, and recover.

Therefore, resilience is no longer viewed as a technical or design attribute but also a socio-cultural outcome advanced by government policies, professional practices, institutional capacity, and decision-making processes (Jabareen, 2012). Well-conceptualised buildings are susceptible to failure under the stress of changing climatic conditions if poorly integrated during planning, construction, or post-construction phases. In view of this, attention has shifted from only design solutions to the holistic processes by which buildings are conceived, delivered, and managed. The risks posed by changing climatic conditions are evident in rapidly urbanising coastal cities in developing countries. The sustained development pressures are often exacerbated by weak regulatory enforcement, limited technical capacity, and fragmented institutional responsibilities. According to Dodman *et al*. (2015), it is common practice to have rhetoric of climate resilience policy, but there is little in practice or in enforcement. This resulted in buildings being constructed to meet short-term functional and economic needs, susceptible to climate hazards over their operational lives.

Kiribou *et al*. (2024) noted that African cities are bearing the highest costs from climate change threats due to rapid urban growth, high population density, and inadequate urban planning. Lagos, one of Africa’s largest megacities with high population density, experiences rapid population growth and extreme urbanisation due to the constant influx of people into the city, leading to expansion into coastal areas with low-lying topography. The state's physical geography is characterised by low terrain and high-water tables, large wetlands, and interconnected lagoon systems. This renders a quite substantial area of the city vulnerable to flooding and its associated hazards (Elias and Omojola, 2015; Obiefuna *et al*., 2021; Orimoogunje and Aniramu, 2025). The effects of flooding in Lagos are widely felt, including damage to residential and commercial buildings, disruption of livelihoods, and adverse health effects (Ajibade *et al*., 2016; Atufu and Holt, 2018; Faremi *et al*., 2021). Ndimele *et al*. (2024) reported that Lagos is one of the cities in the world with a high susceptibility to low sea-level-related flooding, partly due to its low terrain and the extensive range of its aquatic ecosystem. Developments close to the coastlines are particularly at risk of foundation settlement, increased material deterioration, drainage system overload and increased maintenance costs. These impacts have underscored the failure of traditional construction practices to adequately account for long-term climate exposure.

To mitigate the effect of climate change on the built environment, construction practices now include resilience measures, such as raised foundations, use of flood-resistant materials, improved drainage systems, and others, which have been widely promoted in academic and professional discussions (Cutter *et al*., 2008; Ellingwood *et al*., 2018). However, there is little empirical evidence on the range of applications in which these strategies are incorporated into construction processes, especially in a developing country. Much of the existing literature focuses on conceptual resilience frameworks, engineering solutions or policy-level recommendations, and little attention has been directed to understanding resilience and its implementation by construction professionals in their everyday project management practice.

It is opined that the knowledge of resilience concepts does not ensure consistent implementation (Dodman *et al*., 2015). Construction professionals may be aware of the importance of robustness, adaptability and recovery. However, they may not always have the practical experience, institutional support and technical ability to operationalise these principles in an uncertain regulatory environment. This leaves a gap in awareness and practice, where resilience is recognised in principle but inconsistently applied across project phases and professional functions.

Studies on vulnerable buildings under climatic conditions suggest a shift in resilience considerations toward the early design stages, with comparatively less attention given to construction, commissioning, and handover (Bosher and Dainty, 2011). Additional studies show that resilience measures are often undertaken ad hoc, and are based less on formalised project management requirements, and more on individual professional judgement (Shaw *et al*., 2014). These findings point to the need to think of resilience integration not as a fixed set of technical features, but as an ongoing process. Recent research on Lagos further indicates that climate variability and extreme weather events are increasingly generating environmental and socio-economic pressures that threaten the environmental security and long-term sustainability of the megacity (Akiyode and Bob, 2026). These dynamics reinforce the urgency of developing urban infrastructure systems capable of adapting to escalating climatic uncertainties.

To understand this process, we discussed two interrelated dimensions of the studies. First is the level of awareness and understanding of resilience attributes among construction professionals, such as robustness, redundancy, flexibility, adaptability and recovery. Second is the depth to which these attributes permeate the construction project lifecycle, from planning and design through construction, handover, and post-construction. Examining both dimensions together makes it possible to identify where knowledge is strong, where it is weak and where gaps occur between awareness and action. Despite repeated flooding and growing climate risks, resilience remains unevenly prioritised across projects and stakeholders. While some developments include adaptive features, many others do not and rely on conventional approaches that provide short-term cost savings but leave them more vulnerable in the long term. Without an empirical understanding of how construction professionals interpret and implement resilience, efforts to promote climate-resilient construction are likely to be ill-targeted and ineffective.

This study seeks to address this gap through an empirical investigation of the awareness-practice gaps in climate resilience integration in coastal construction project management. Focusing on buildings along the Lekki coastlines, Lagos, the study is a diagnostic study and does not aim to propose new resilience frameworks or review policy texts. It addresses a fundamental question of what construction professionals know about resilience and how this knowledge translates (or does not) into project management practice.

Literature Review

Climate change impact on coastal buildings

The Intergovernmental Panel on Climate Change (IPCC, 2023) defines climate change as long-term shifts in climatic conditions, typically spanning decades, reflected in altered mean values and variability of climate parameters. Human activities such as industrialisation, fossil fuel combustion, gas flaring, urbanisation, and deforestation are primary drivers of these changes. Although global in scope, the impacts of climate change are unevenly distributed. Developing nations are disproportionately affected due to limited adaptive capacity, weak institutions, and inadequate financial and technical resources (Akpodiogaga and Odjugo, 2010). In African coastal cities, including Lagos, vulnerability is heightened by rapid urbanisation, poor regulatory enforcement, and fragmented institutional roles (Akiyode and Bob, 2026; Kiribou *et al*., 2024; Ndimele *et al.*, 2024). Coastal communities face intensified risks from heavy rainfall, storms, and rising sea levels (Faremi *et al*., 2021; Ndimele *et al*., 2024).

Lagos, Nigeria's largest coastal metropolis, exemplifies these challenges. Its low-lying terrain, extensive lagoons, and rapid expansion into environmentally sensitive areas increase susceptibility to flooding (Elias and Omojola, 2015; Obiefuna *et al*., 2021). Flooding has already caused widespread property damage and health risks (Ajibade *et al*., 2016; Atufu and Holt, 2018; Akiyode and Bob, 2026). Buildings near lagoons are particularly vulnerable to high groundwater tables, tidal backflow, and saline intrusion, which accelerate foundation settlement, reinforcement corrosion, and material deterioration (Ayolabi *et al*., 2013; Obiefuna *et al*., 2021). With sea levels projected to rise up to 1m by 2100 under high-emission scenarios (Akpodiogaga and Odjugo, 2010), the need for construction practices that explicitly account for long-term climate exposure is urgent.

Resilience in the built environment

Resilience has emerged as a critical response to the growing susceptibility of the built environment to climate change (Ruiz and Mack-Vergara, 2023). It is defined as the capacity of systems to resist disruptions, adapt to changing conditions, and recover functionality without compromising essential operations (IPCC, 2014; Meerow *et al*., 2016; Scott *et al*., 2022). In urban contexts, resilience entails the ability to act in the face of uncertainty and adapt to evolving hazards (Dodman *et al*., 2015). For buildings and infrastructure, resilience encompasses absorbing shocks, adapting to stressors, and restoring performance (Ghoneem, 2016; Liang, 2021). Importantly, resilience is not static; it is shaped by the interplay of physical design, construction practices, organisational decision-making, regulatory oversight, and stakeholder collaboration (Liang, 2021; Li *et al*., 2023; Meng *et al*., 2021). Thus, resilience cannot be assured solely at the design stage but requires continuous reinforcement throughout the building lifecycle (Orimoogunje and Aniramu, 2025; Kochskämper *et al*., 2025; Ndimele *et al*., 2024).

Resilience characteristics and assessment tools for coastal construction

To operationalise resilience, scholars have identified key attributes that translate abstract concepts into measurable dimensions. Commonly cited attributes include robustness, redundancy, flexibility, adaptability, agility, recovery capacity, and collaboration (Ayyub, 2014; Garmestani et al., 2019; Meerow et al., 2016).

i. Robustness: The ability of structures to resist climatic stresses without major loss of functionality. In Lagos, this includes foundations designed for saturated soils and building envelopes that are resistant to water infiltration and wind pressure.

ii. Redundancy: Backup systems that prevent total failure, such as multiple drainage routes, redundant pumping capacity, or alternative power supplies.
iii. Flexibility and Adaptability: The capacity to retrofit, elevate, or modify protective measures in response to evolving climate conditions.
iv. Agility and Recovery: The speed of restoring functionality after disruption, linked to maintenance planning, resource access, and organisational preparedness (Bruneau *et al*., 2003).
v. Collaboration: Recognition that resilience outcomes depend on coordinated efforts among designers, contractors, regulators, utility providers, and building owners.

Together, these attributes form a practical framework for evaluating resilience in coastal construction. They guide the planning, design, and management of buildings exposed to climate hazards, ensuring that resilience is embedded not as a static feature but as an evolving process responsive to environmental change.

Materials and Methods

This study uses a quantitative, cross-sectional research design. This design is suitable given the study's goal to empirically investigate observable patterns in professionals' awareness and practice of climate resilience. The design enables systematic measurement of perceptions and practice in a population of construction professionals working in climate-exposed coastal environments. A descriptive-analytical survey strategy was used. This approach is well established in built-environment and sustainability research for diagnosing sectoral practices. While purposive sampling ensures relevance and expertise among respondents, it limits generalisability to the broader construction industry. The findings are most applicable to coastal construction contexts similar to Lagos and may not fully represent practices in inland or less climate-exposed regions, identifying implementation gaps, and generating evidence-based findings without making causal inferences. The design is especially well-suited to addressing awareness-practice gaps, as it allows comparison between what professionals know (awareness) and what is operationalised in practice (implementation across project phases).

The study area is Lagos state, a state situated in southwestern Nigeria on the plain of the Bight of Benin. It is bordered to the North and East by Ogun State of Nigeria, to the West by the Republic of Benin, and to the south by the Atlantic Ocean. The total landmass is around 3,345 square kilometres (0.4% of the nation's total land area), of which 22% is water-covered. The geography of Lagos State and its physical attributes, including geology, topography, soil composition, hydrology, and wetlands, make it susceptible to climate change. However, the empirical focus of the study is the Lekki axis of Lagos, Nigeria, a rapidly urbanising coastal and lagoon corridor of the state, characterised by intensive real-estate development and high exposure to climate-related hazards. Located on the coast of Lagos Lagoon and the Atlantic Ocean, the study area is susceptible to flooding, saline water intrusion, high tides, and high groundwater levels. These characteristics make the area an ideal location for examining resilience awareness and practice in coastal construction. Lekki has various types of residential, commercial, and mixed-use developments undertaken by private developers, public agencies, and public-private partnerships. The area, therefore, offers a variety of project management setups and professional roles; thus, the empirical results are more robust and relevant.

The target population is construction professionals and project stakeholders involved in the planning, design, construction or management of building projects located near the lagoon on the Lekki axis. This involves project managers, architects, engineers (structural, mechanical and electrical), builders, quantity surveyors and facility managers. A purposive sampling procedure was used to ensure that the respondents had direct experience with coastal construction projects. The selection criteria included are that respondents must: (1) have a minimum of 2 years professional experience in the construction industry; (2) be a construction professional with direct or indirect involvement in at least one building project located within the Lagos lagoon or Atlantic coastline (3) be a professional registered with relevant Nigerian regulatory bodies (COREN, ARCON, QSRBN); and (4) have active engagement in project planning, design, execution, or management roles. Given the absence of a real database of professionals involved in projects around the lagoons, the sample size calculation is based on Cochran's (1963) formula for large or unknown populations. This approach is particularly suited for construction management research where the total population of specialised professionals is unknown or a complete sampling frame is unavailable, as it provides a statistically defensible sample size based on the desired level of precision and confidence (Israel, 1992; Singh and Masuku, 2014). While the initial target sample size derived from this formula was 385, a total of 243 responses were collected. Following a rigorous data screening process, 43 responses were excluded due to incompleteness, resulting in 200 valid responses for the final analysis. This yields an effective response rate of 51.9%, which is considered high within the construction industry, where benchmarks for professional engagement typically range from 30% to 60% (Lalmi, 2024). The final sample of 200 is supported by the Central Limit Theorem (CLT). The CLT posits that a sample size exceeding 30 is sufficient for the distribution of the sample mean to approximate normality, thereby justifying the use of parametric statistical analyses (Kwak and Kim, 2017). With 200 respondents, the study achieves a margin of error of 6.93%, which remains within the acceptable 5–10% range for exploratory industry research targeting specialised demographics (Memon *et al*., 2020).

Primary data were collected using a structured questionnaire designed to gather information relevant to the study's objectives. The questionnaire was designed based on available literature on climate resilience, resilience attributes, and construction project management practices.

The instrument comprised five parts:

i. Respondent profile: This includes professional role, years of experience and involvement with coastal/lagoon projects,
ii. Threats of climate change to buildings close to the lagoon: this section collects the perception of professionals regarding the threats they consider more important to influence the construction activities close to the Lagos lagoon.
iii. Awareness and understanding of resilience concepts: This measures the adoption of key resilience concepts such as robustness, redundancy, flexibility, adaptability, agility and recovery
iv. Resilience implementation across project phases: This investigates the extent to which resilience considerations are embedded in planning, design, execution, handover and post-construction phases.
v. Resilience measure adopted in practice: Identification of measures taken in coastal projects in practice.

A five-point Likert scale was adopted to record the responses, with Strongly Disagree (1) being the lowest and Strongly Agree (5) being the highest response, for standardised responses. The survey was conducted in person and online.

The questionnaire's reliability was evaluated after an initial pilot survey, during which content with unclear constructs was modified and adjusted for clarity and alignment with the study's objectives.

Instrument reliability was assessed by calculating Cronbach's alpha for each construct, a commonly used method for assessing the internal consistency of Likert-scale items. The acceptable level of reliability was an alpha level of 0.70 or higher. Items with low item-total correlations were refined and analysed to enhance coherence. This led to the conclusion that all measurement constructs had Cronbach's alpha values exceeding 0.70.

The Statistical Package for the Social Sciences (SPSS) was used to analyse the data. The analysis was performed based on the level of awareness of resilience and the patterns of implementation across the project phases, using descriptive statistics (frequencies, percentages, and means). While chi-square cross-tabulation and analysis of variance (ANOVA) were used to determine whether a significant difference in resilient awareness exists among professional groups.

Results and Discussion

Respondents demography information

Table 1 presents respondents' professional roles. It shows that project managers were the largest group of professionals, with 25% of the total respondents. They were followed by engineers practising as either electrical, mechanical, or structural engineers, with 20%. Others are architects and builders (15%). Quantity surveyors and facility managers are the least represented professional category, at 12.5%. This distribution promotes a multidisciplinary viewpoint necessary for analysing the integration of resilience metrics into the management of buildings near lagoons.

Table 1: Respondents' Professional Roles in the Construction Industry

Role	Frequency (n)	Percentage (%)
Project Manager	50	25.0%
Engineer (Elec/Mech/Struct)	40	20.0%
Architect	30	15.0%
Builder	30	15.0%
Quantity Surveyor	25	12.5%
Facility Manager	25	12.5%
Total	**200**	**100%**

Table 2 shows the distribution of respondents' years of experience in the construction industry, indicating an even split between early-career professionals and experienced individuals. The largest category, accounting for 31.0 per cent of the sample, is in the 4 - 7 year range, suggesting that practitioners have had a good deal of experience beyond entry-level positions. Respondents with 0 - 3 years of experience represent 24.0% and may therefore reflect a significant share of respondents who are relatively new to the industry and bring new perspectives. Those with 8 -15 years' experience represent 27.5% and provide more mature professional insights, whereas the most experienced group of over 15 years in practice represents 17.5% and provides long-term knowledge and institutional experience. The distribution shows that the study was undertaken by a diverse pool of respondents with adequate knowledge of the study; therefore, it makes the study more reliable for measuring the integration of resilience in construction project management in the lagoon areas.

Table 2: Respondents' Years of Experience in the Construction Industry

Respondents' Years of Experience	Frequency	Percentage (%)
0-3 years	48	24.0
4-7 years	62	31.0
8-15 years	55	27.5
Over 15 years	35	17.5
Total	**200**	**100.0**

Table 3 summarises respondents' involvement in coastal building projects. 78.0% of the respondents were directly involved in coastal building projects. This validates that the majority of participants have relevant practical experience in coastal construction work and in the resilience of buildings around the Lagos lagoons. Also, 22.0% of the respondents have no prior experience with coastal construction projects; this suggests that, although they may have adequate practical knowledge, they have not been exposed to the challenges of coastal construction.

Table 3: Respondents' Involvement in Coastal Building Projects

Response	Frequency	Percentage (%)
Yes	156	78.0
No	44	22.0
Total	**200**	**100.0**

Threats of climate change to buildings close to the lagoon

Table 4 presents the respondents' responses regarding the threats of climate change that may affect buildings along Lagos State's shorelines. The results indicated that foundation instability or settlement is the most significant concern, with 89.0% of respondents expressing apprehension. Increased maintenance and repair costs at 75% came in a close second. Deterioration of materials came next at 60%, followed by overflow in the drainage and sewage systems at 50%. Fewer respondents reported that poor indoor air quality (25%), damage to electrical and mechanical systems (5%) and higher insurance costs (2.5%) were the main reasons. These findings point to the complex vulnerabilities of lagoon-side buildings: one is structural, another is financial, and the third is infrastructural.

Table 4: Perceived Threats of Climate Change to Buildings Close to the Lagoon

Threats	Frequency	Percentage
Foundation instability/settlement	178	89.0%
Material deterioration	120	60.0%
Poor indoor air quality	50	25.0%
Drainage and sewage system overload	100	50.0%
Increased maintenance and repair costs	150	75.0%
Damage to electrical and mechanical systems	10	5.0%
Increased Insurance	5	2.5%

Awareness of resilience attributes by construction professionals

This section examines professionals' awareness of specific attributes of building resilience in coastal areas. Table 5 shows the awareness scores of six resilience attributes: robustness, redundancy, flexibility, agility, recovery and adaptability.

Table 5: Awareness and Knowledge of Resilience Attributes Among Lagos Building Professionals

Metric	1	2	3	4	5	Mean	Rank
Recovery	12	22	32	62	72	3.8	1st
Flexibility	24	22	24	66	64	3.6	2nd
Adaptability	12	18	69	40	61	3.6	2nd
Robustness	10	18	75	58	39	3.5	4th
Redundancy	25	40	55	50	30	3.3	5th
Agility	19	29	79	38	35	3.2	6th

Recovery was ranked the highest with a mean of 3.80, indicating high recognition of the importance of restoring the functionality of buildings following climate-related disruption. Flexibility and adaptability were not far behind, with a mean of 3.60. This indicates that respondents realise how crucial it is to accommodate change and adjust systems in response to changing environmental conditions. Robustness also showed a relatively high mean score (M = 3.5) regarding the awareness of the need for structural strength and resistance. In contrast, redundancy (M = 3.3) and agility (M = 3.2) were rated the lowest in terms of mean scores and ranked 5th and 6th, respectively, and a significant number of the respondents rated their awareness at low levels (1-2). While recovery and robustness are well understood, attributes associated with backup capacity, quick response, and system flexibility are less well understood.

Integration of resilience across project phases

Table 6 addresses the stage of project development at which resilience measures are considered by building professionals in Lagos. The results show that resilience is most often observed at the planning stage (60.0%), followed by the design stage (50.0%), suggesting that the majority of the professionals recognise the importance of integrating resilience at the early stages of the project lifecycle. However, implementation declines significantly afterwards, with resilience during execution at 35.0%, in the post-construction stage at 25.0%, and at handover at 15.0%, suggesting that resilience considerations are not sustained throughout the entire project process.

Table 6: Integration of resilience across project phases

Stage	Frequency	Percentage
Planning	120	60.0%
Design	100	50.0%
Execution	70	35.0%
Handover	30	15.0%
Post-construction	50	25.0%
Not addressed	40	20.0%

Analysis of the Integration of resilience across project phases shows that 20.0% of respondents reported that resilience measures were not incorporated at all into their construction, raising concerns about gaps in industry practice. The results emphasise that although relatively strong integration at the early stage is provided, a consistent application of resilience measures across all stages of project management is needed to ensure long-term building sustainability and performance, especially for buildings close to the lagoon that are vulnerable to climate-related threats. This integration by phase validates an important concern raised in the literature: resilience is often addressed as an early-stage design consideration rather than a continuous project-wide commitment (Bosher and Dainty, 2011; United Nations Office for Disaster Risk Reduction, UNDRR, 2017). While attention to site selection and design is needed early in the process, the outcomes in terms of resiliency ultimately rest on the quality of construction, commissioning processes, and post-construction preparedness, areas where implementation appears weakest. The low level of consideration given to resilience at handover is also a particular cause for concern, as this is the stage at which resilience features are either documented, maintained and operationalised. Without clear standards for handovers, the resilience measures are prone to fail over time and to undermine long-term performance.

Resilience awareness

To determine awareness levels by profession, a cross-tabulation was performed, assigning ordinal scores to the awareness categories (Low = 1, Moderate = 2, High = 3). Table 7 presents the results of the cross-tabulation of resilience awareness by professions. The distribution of resilience awareness across professional groups indicates a generally high level of familiarity with resilience concepts among built environment professionals. 56.5% of respondents reported high awareness, 39.5% moderate awareness, and only 4.0% low awareness of resilience. Analysis of the awareness across the professional groups shows that architects had the highest proportion of high awareness (60.0%), followed by project managers (58.0%), engineers (57.5%), and quantity surveyors (56.7%). On the other hand, facility managers and builders demonstrated a lower level of high resilience awareness than project managers, engineers, and architects (52.0%). A few per cent of the respondents reported a relatively low level of awareness, suggesting that the concepts of resilience have achieved significant familiarity among built environment professionals.

Table 7: Cross-tabulation of resilience awareness by profession

Profession	Low n (%)	Moderate (%)	High (%)	Row Total (%)
Project Managers	2 (4.0%)	19 (38.0%)	29 (58.0%)	50 (100%)
Engineers	2 (5.0%)	15 (37.5%)	23 (57.5%)	40 (100%)
Architects	1 (3.3%)	11 (36.7%)	18 (60.0%)	30 (100%)
Quantity Surveyors	2 (6.7%)	11 (36.7%)	17 (56.7%)	30 (100%)
Facilities Managers	1 (4.0%)	11 (44.0%)	13 (52.0%)	25 (100%)
Builders	0 (0.0%)	12 (48.0%)	13 (52.0%)	25 (100%)
Column Total	8 (4.0%)	79 (39.5%)	113 (56.5%)	200 (100%)

χ^2 (10) = 2.71, p = 0.882

The Chi-square test of independence was conducted to determine whether there is a significant difference in awareness levels across professions. The finding revealed that the level of resilience awareness is not statistically significantly associated with profession, $\chi^2(10, N = 200) = 2.71$, $p = 0.882$. This result indicates that the level of awareness of the concept of resilience is fairly similar across the professional groups included in the study. Though a few professions registered higher proportions of high awareness, these differences were not significant.

To further study possible variations in awareness level, a one-way analysis of variance (ANOVA) was conducted. Table 8 presents the results of the one-way ANOVA examining differences in resilience awareness across professional groups in the construction industry. These findings indicate that the difference in awareness scores among the six professional groups is not significant ($F = 0.079$, $p = 0.995$). The critical value ($p = 0.995$) is quite large compared to the traditional 0.05 threshold; hence, the null hypothesis that resilience awareness is the same across all professions is accepted. This implies that construction professionals, irrespective of their professional background, demonstrate the same degree of resilience attribute awareness.

Table 8: One-Way ANOVA for Differences in Resilience Awareness by Professions

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	0.133	5	0.027	0.079	0.995
Within Groups	65.742	194	0.339		
Total	65.875	199			

Resilience strategies implemented in coastal projects

The results of the resilience strategies adopted in the study are presented in Table 9. The outcome was that the construction of drainage systems, representing 60.0% of the respondents, is the most popular resilient method, given the priority placed on stormwater control and the reduction of the threat of flooding. The second practise was raised foundations, and 50.0% of the respondents selected this option; the third practice was the use of flood-resistant materials, of which 45.0% of the respondents selected the given option. Backup systems for power and water were reported by 40.0% and 35.0% of respondents, respectively, and reinforced roofing systems were reported by 35.0% as measures to withstand strong winds and heavy rainfall. Some of the less common practises are elevated platforms or stilts (20.0%), natural shoreline buffers (15.0%), and green infrastructure (10.0%), so ecological and nature-based practises are less frequently used. Other unspecified measures were used by a small percentage of the respondents (5.0). These results indicate that the existing practise is generally more inclined to embrace traditional structural and infrastructural solutions, and that sustainable and ecological solutions that would enable even greater resilience in coastal construction projects are not widely employed.

Table 9: Resilience strategies implemented in coastal projects

Strategy	Frequency	Percentage (%)
Drainage systems	120	60.00%
Raised foundations	100	50.00%
Flood-resistant materials	90	45.00%
Backup systems (power, water)	80	40.00%
Reinforced roofing system	70	35.00%
Elevated platforms/stilts	40	20.00%
Natural shoreline buffers	30	15.00%
Green infrastructure	20	10.00%
Others	10	5.00%

Discussion of Findings

The findings present factual evidence that the relevant stakeholders engaged in coastal construction in Lagos State are aware of the physical dangers posed by climate change. The main areas of concern will be geotechnical instability, material deterioration, drainage mechanisms, and the mounting maintenance requirements. These perceptions align with the research by Akpodiogaga and Odjugo (2010) and Ayolabi *et al*. (2013), who identified geotechnical instability, saline intrusion, and persistent flooding as the defining risks in the urban low-lying environment. The emphasis on ongoing maintenance and deterioration of materials suggests that climate change is not only reinvented as a cause of extreme events, but also as a chronic stressor eroding building performance. It is consistent with studies on building resilience that view climate risk as a long-term, cumulative process rather than a series of discrete shocks (Ellingwood *et al*., 2018). Such conceptualisation is a developing awareness of lifecycle cost, particularly relevant for lagoon-side developments, which are subject to a constant moisture and salinity regime and fluctuating groundwater levels.

Moreover, the results indicate that construction professionals have fragmented and uneven knowledge of resilience attributes. This implies awareness of the adaptive capacity in response to changing climatic conditions. This aligns with the concept of resilience, aiming to survive hazards and restore functionality after failure. Such a perspective is common, as some professionals tend to confuse resilience with robustness and post-event repair rather than with anticipatory and systemic capacity (Ayyub, 2014; Garmestani *et al.*, 2019). While these attributes are vital, resilience theory argues that long-term system performance is equally dependent on redundancy, agility and the ability to respond expeditiously to unforeseen disturbances (Meerow *et al*., 2016). This fragmented awareness provides further support to concerns raised in preceding studies that knowledge of resilience among construction professionals is partial and discipline-specific rather than holistic and systems-oriented (Bosher and Dainty, 2011). As a result, the concept of resilience can be recognised in principle, but is not sufficiently translated into integrated decision-making in projects.

The findings on the application of resilience strategies across project phases show that resilience is most evident in the preliminary stages, such as planning and design, but is significantly less evident in execution, handover, and post-construction phases. This pattern provides strong support for earlier critiques that resilience is often addressed as a front-end design issue rather than as a continuous management of the project responsibility (Bosher and Dainty, 2011; UNDRR, 2017). While site selection and design configuration are impossible without early-stage integration, the resilience achievements ultimately depend on the quality of construction, commissioning processes, documentation, and long-term maintenance. Insufficient integration during execution increases the risk that resilience features specified at the design stage will be compromised or left out of the project due to cost or time pressures, or a lack of supervision. Likewise, insufficient attention to handover limits how resilience is operationalised, as there is a risk that building occupants and facility managers will lack the knowledge or resources to sustain adaptive features in the longer term. These results point to a gap between knowledge and practice. While professionals have a basic understanding of resilience, no consistent resilience implementation plan was evident in the project delivery frameworks across all phases. This divide, as referred to by Zarghami and Zwikael (2022), reflects more complex systemic issues, such as the neglect of professional duties, short-term performance targets, and the lack of enforcement of regulations in rapidly urbanising coastal areas.

The analysis of the cross-tabulation of resilience awareness among construction professionals indicates that resilience awareness is relatively widespread and uniformly distributed across professional groups in the construction industry. Consequently, the issue of resilience adoption into the practise of construction might not always be related to the variations in the level of awareness among professionals but can be connected to other issues, including institutional constraints, policy implications, or barriers to implementation. However, the fact that resilience measures have not been endorsed across all project lifecycle phases suggests an awareness-implementation gap: the awareness of resilience concepts does not always translate into practice.

The outcomes of the strategic resilience actions undertaken by respondents in projects along the coasts of the city of Lagos are characterised by conventional engineering measures such as drainage system improvements, structural elevation and reinforcement, and backup facilities. The strategies to reduce flooding and storm damage are similar to those used by project engineers to manage coastal hazard risk. While essential, the utilisation of these strategies is overdone, and the emphasis is on short-term physical safety rather than long-term flexibility. The same practise has been found in other world constructions in coastal regions; nevertheless, intensive engineering solutions are implemented due to the presumption that they are more secure.

The low utilisation of ecological and nature-based strategies, for instance, green infrastructure and shoreline buffers, reveals lost opportunities for multifunctional resilience benefits. Past studies show that nature-based solutions can help reduce the risk of flooding, increase thermal comfort, improve environmental quality and contribute to long-term sustainability when used with engineered measures (Cheong *et al*., 2013; UNDRR, 2017). Their poor adoption points to a lack of technical knowledge, regulatory incentives and interdisciplinary work in construction practice.

Conclusion and Recommendation

Conclusion

This research examined the application of climate resilience strategies for construction projects around the lagoon in Lagos, Nigeria. The study's findings show that construction professionals have a high level of awareness of the physical risks of climate change, particularly flooding, geotechnical instability, and material degradation. Nonetheless, this awareness does not translate into coherent, persistent resilience strategies in the lifecycle of the construction project. Resilience is mostly covered by conventional engineering, with most attention given to this in the earlier stages of a project and less in the execution, handover, and post-construction stages. The lack of an in-depth knowledge of resilience is linked with the fragmentation of implementation and the gap between knowledge and action in the management of coastal construction projects. As a result, resilience measures are often applied as makeshifts, based on individual professional judgement rather than coordinated, life-cycle-oriented project management processes.

These findings therefore support the broader argument that improving resilience in coastal construction requires institutional and project-level mechanisms that facilitate implementation, rather than focusing solely on raising professional awareness. Such mechanisms may include clearer regulatory frameworks, stronger integration of resilience requirements in project documentation, and enhanced interdisciplinary collaboration among built environment professionals.

The outcome demonstrates the necessity of shifting from short-term, reactive protection strategies to more comprehensive, adaptive strategies that protect buildings over the long term across different weather conditions. Such results have great implications for both practice and policy.

i. To practitioners, the paper indicates that it is time to go beyond design-stage resilience checklists and embrace lifecycle-centred project management models that explicitly introduce resilience concerns at all levels. The findings for policymakers highlight the need for regulatory frameworks that require resilience integration at all stages of the project, not just at the design and planning stages. The phase-specific resilience guidelines should be formulated in collaboration with professional bodies such as the Council for the Regulation of Engineering in Nigeria (COREN) and the Architects Registration Council of Nigeria (ARCON), and should specifically address coastal construction.
ii. This study is relevant for the overall climate resilience narrative because it offers empirical data of a fast-urbanising city in the Global South, where the overlap between climate risk, weak regulatory application, and high-speed development is especially vulnerable. The awareness-practice gap identified in the current study is not peculiar to Lagos but rather

indicates challenges in the system across other coastal cities in Africa and Asia, suggesting that the results can be applied to similar settings.

Recommendations

Based on the findings, the following recommendations are hereby made to enhance the resilience and adaptability of construction near lagoons to climate change. To start with, resilience must be established as part of the management structures of construction projects, as stipulated in the lifecycle requirements, rather than being considered during the design phase, particularly for projects along the coast. To ensure the implementation of resilience assessment at the project execution, handover, and post-construction phases, the Lagos State Urban and Regional Planning Law should be amended by the Lagos State Ministry of Physical Planning and Urban Development to include clear sanctions for non-compliance. Guidelines and checklists are to be used to address resilience issues in an orderly manner during project execution and handover, as well as in the post-construction stages.

Second, professional training and continuing development programmes should look beyond the conceptual focus on robustness and recovery, to include redundancy, agility and anticipatory capacity. Professional bodies operating in Nigeria, including COREN, ARCON, the Quantity Surveyors Registration Board of Nigeria (QSRBN), and the Nigerian Institute of Building (NIOB), should incorporate climate resilience modules into their mandatory continuing professional development (CPD) programmes, with specific emphasis on lifecycle integration and nature-based solutions. Strengthening systems-based thinking among construction professionals to allow for more comprehensive risk management in climate-exposed environments.

Third, regulatory authorities and professional bodies should provide incentives to promote integrated approaches to resilience, including green infrastructure solutions alongside traditional engineered solutions. The Lagos State Environmental Protection Agency (LASEPA) and the Lagos State Building Control Agency (LASBCA) should develop a Resilience Certification Scheme that rewards developers and contractors who demonstrate exemplary integration of nature-based solutions in coastal projects. Further research should examine additional coastal cities and project typologies, as well as the institutional, contractual, and governance mechanisms that may facilitate or impede the integration of resilience.

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