Sustainability and Innovative Technology Strategies in High-Rise Architecture: Architects' Awareness and Adoption in Lagos, Nigeria

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Abstract
Purpose: *This study investigates levels of awareness and adoption of sustainability and innovative technology strategies among architects practicing in high-rise building design in Lagos, Nigeria. The aim is to determine the way these experts integrate sustainable practices and technologies as a mitigation measure for the growing need for environmentally responsive urban development.*

Design/Methodology/Approach: *A mixed-method approach was used in the study. 87 responses were received from the semi-structured questionnaire shared with registered architects in Lagos. The Statistical Package for the Social Sciences version 23 was used to analyse the data, using both descriptive and inferential statistical methods. The interpretation of the quantitative results was also supported by thematic analysis of the qualitative observations obtained from the semi-structured responses.*

Findings: *There is high awareness among Lagos architects of both technological and sustainable initiatives, but uneven adoption. The most widely applied are daylighting and natural ventilation, while more sophisticated strategies such as BIM, modular construction, and green roofs have lower adoption. The findings show awareness-adoption imbalance, with a need for ways to balance it to align practice with global sustainability ambitions.*

Conclusion/Theoretical/Social/Practical Implications: *Inadequate policies, lack of technical skill, as well as high cost are some of the main gaps to the adoption of sustainability and innovative technology strategies. To close this gap, professional development and government interventions are needed to align sustainable design strategies with SDGs 11 and 13.*

Originality and value: *The empirical findings and interpretation offer a basis for comparative studies in other regions and specific frameworks to improve adoption.*

Keywords: Architects' Awareness, High-Rise Architecture, Lagos-Nigeria, Sustainability, Technological Innovation.

Introduction

Cities in Nigeria have changed in the last few decades. Only 10 per cent of people lived in cities in the 1950s. High birth rates and rural-urban migration have contributed to this number's rise (World Bank, 2023). More than 54% of Nigerians stayed in cities by the early 2020s. According to the United Nations (2023), this exceeds the base for majority urbanisation. Lagos is an example of this pattern. By 2010, it had grown into a megacity. Originally located around a lagoon, Lagos has become a massive metropolis (UN-Habitat, 2006). This comes with drawbacks. The rapid urbanisation seen in Lagos puts a strain on the city's infrastructure. This has led to a shortage of housing and encouraged the growth of informal settlements. (Koko and Bello, 2023; Aliyu and Amadu, 2017). Urbanisation changes places into sources of social, cultural and economic development (Oyalowo, 2022; Bibri, 2021).

This change has moved Lagos toward vertical urbanism. More is needed to address Lagos' issues than just increased space management (Akinyemi et al., 2020). Easy access to climate-resilient strategies and technological advancements has become important for sustainable urban development (Bichueti et al., 2025). Though the high-rise structures help overcome spatial constraints, they present new sustainable problems (Aduwo et al., 2024). They use a lot of energy and release greenhouse gases. This creates a need for sustainable solutions. Strategies like energy-efficient systems, smart technologies, rainwater harvesting and green facades are being used by architects to meet the sustainability needs (Chen et al., 2024). As these technologies are used, they offer ways to make Lagos' high-rises more sustainable.

Building high-rises sustainably reduces expenses while increasing resilience. However, the adoption of these strategies is delayed by inadequate policies, high costs, lack of expertise and client resistance (Aduwo et al., 2024). This suggests that there is a vacuum regarding architects' application of technology and sustainability in design (Mba et al., 2024). This study examines adoption rates among Lagos architects to enhance sustainable urban design. The purpose is to comprehend the architects' knowledge and application of sustainable practices and technology in high-rise buildings in Lagos. It looks at their understanding of these strategies and their application in real-world situations, as well as what promotes their use. The findings of the study contribute to discussions on the future of urban development in Nigeria. Its conclusions can influence regulatory and professional training frameworks by providing all stakeholders with relevant data.

This study supports international initiatives to encourage sustainable urban growth. It promotes the development of resilient and sustainable cities. This aligns with SDG 11. By showing how Lagos' architectural practice applies sustainable and technological strategies, it provides insights that can be applied to other growing cities in the Global South. These would promote international best practices in sustainable development while using technology to address the problems caused by rapid and ongoing urban growth.

Literature Review

Global Trends in Sustainable and Technological Strategies for High-Rise Architecture

Global interest in sustainable urban development has increased due to rapid urbanisation (Angel, 2023). Building high-rises is essential to meet this growth. The creation of resilient and livable environments is enhanced by the application of sustainable strategies (Shakir et al., 2021; Aduwo et al., 2024). The main idea is to get a balance between social, economic, and environmental priorities. To achieve this goal, building practices must incorporate sustainability and technological innovations (Ali et al., 2023).

While offering financial and societal advantages, these environmental strategies contribute to the reduction of greenhouse gas emissions (Teklie, & Yağmur, 2024). Hence, sustainable high-rise design is now regarded as an environmental need to produce long-term value. The application of passive solar systems, green roofs, energy-efficient façades or smart building technologies by architects is important. These strategies connect environmental responsiveness to innovation (Ali et al., 2023; Lam et al., 2024).

Architects as Agents of Sustainable Urban Transformation

The future of sustainable urbanisation needs architects to play a vital role (Yan et al., 2024). Their design decisions impact many aspects. Resource management, energy efficiency, circular economy and occupant well-being over the course of a building's lifecycle, are affected by these decisions (Mba et al., 2024; Aduwo et al., 2024; Rimamtanung & Charles, 2018). Architects must incorporate sustainable practices in fast-growing cities like Lagos, where vertical growth is the main solution to land scarcity. Given the increasing environmental and infrastructure pressures brought on by rapid urbanisation, it is essential to evaluate their awareness and adoptions of these strategies.

Levels of Awareness and Adoption: Prior Research Findings

According to recent studies, Nigerian architects know of sustainable practices but find them difficult to put into practice. Opoko et al. (2022), reported that even though Lagos architects know about solar technologies, they applied daylighting solutions more. Umar et al. (2021) revealed a lack of knowledge regarding sustainable materials. Mba et al. (2024) found a similar relationship of moderate awareness and weak adoption due to inadequate professional training. However, according to Adewale et al. (2024), there are financial and technological issues with the use of passive design, green materials, and water conservation. Lack of institutional support and training was also noted by Adeogun (2022) as a major barrier. Collectively, these studies demonstrate a continuous disconnect between awareness and adoption caused by various challenges.

Connection to the Sustainable Development Goals

The global sustainability agenda, including SDG 11: Sustainable Cities and Communities and SDG 13: Climate Action, addresses the increasing urban challenges and climate risks in Lagos (Allan, Rajabifard & Foliente, 2024). The achievement of the agenda calls for sustainable design approaches that integrate experience with the potential for universal application (Agboola et al., 2023).

Approaches that consider practical experiences and broader adoption patterns are necessary to understand and solve the challenges.

Research Methods

A mixed-methods approach was used. This helped to measure current practices and investigate underlying views. This design uses quantitative data to identify generalisable patterns and qualitative insights to clarify contextual factors driving adoption (Dawadi *et. al.*, 2021). After a thorough evaluation of pertinent literature, the main research tool was created, guaranteeing that its content was reliable and compliant with accepted norms. However, due to the exploratory nature of the study, hypotheses were not formulated. The research was intended to identify patterns, associations, and fundamental aspects of awareness and adoption. Purposive sampling method was used to target architects with professional exposure to sustainable and digital construction practices. This ensured that data was collected from participants who had the ability to provide informed responses to the study topic. Although the method is not generalisable, it is more valid and relevant to the data collected.

Professional architects employed in Lagos, Nigeria, were the focus population. Lagos was chosen because more than 60% of construction projects are completed there (Adeogun, 2022). Furthermore, according to Koko and Bello (2023), the city has the greatest number of registered architects in Nigeria. A deliberate sampling of architects with experience in high-rise projects was used to obtain the needed expertise. Cochran's technique for determining sample size states that approximately 80 responses would be sufficient at a 95% confidence level with a 5% margin of error (1977, as cited in Bartlett *et. al.*, 2001). 87 valid responses, or 72.5% of the total, came back from 120 architects contacted through online channels. This exceeded the bare minimum of statistical requirements and gave a solid foundation for analysis. Given that average response rates in organisational research are typically less than 40%, the study's 72.5% response rate is impressive and indicates high engagement (Baruch and Holtom, 2008).

Data was collected using a semi-structured questionnaire. It consists of five sections, with a combination of closed and open-ended questions. Although the closed-ended questions facilitated accurate measurement and comparison of the respondents' awareness, adoption, and perception, the open-ended questions were semi-structured, directing the respondents to consider specific experiences, issues, and suggestions. Section A collected demographic information, including age, years of work experience, and membership in the Architects Registration Council of Nigeria (ARCON). Section B concentrated on experience working on high-rise projects. Section C evaluated the understanding and application of sustainability practices such as passive design, natural ventilation, rainwater harvesting, and green roofs/walls. Section D asked about issues like cost implications, as well as awareness and usage of cutting-edge technologies like Building Information Modelling (BIM). For most closed-ended items, awareness, usage frequency, and adoption levels were measured using a five-point Likert scale. Section E's open-ended questions prompted participants to reflect on prior experiences and provide strategies for improving sustainable design practice.

To ensure wide distribution and reach busy professionals, the surveys were shared electronically. The responses were coded and analysed using the Statistical Package for the Social Sciences (SPSS) version 23. Descriptive statistics, such as standard deviations and frequencies/percentages, were used to deduce awareness levels, adoption trends and motivational factors. Significant relationships were found by comparing responses across different variables using inferential statistical tests like factor and correlation analysis. All constructs got values above the 0.70, indicating internal consistency, when the instrument's reliability was tested using Cronbach's alpha. Open-ended responses were analysed using thematic analysis, which improved the quantitative findings by extracting reform recommendations.

Findings and Discussions

This section presents the findings from the online survey. The presentations are supported by statistical analysis; hence, the observations are trustworthy and understandable. The findings are arranged in accordance with the study's three objectives: (1) assessing the degree of awareness of sustainability and technology strategies, (2) investigating the level of adoption in practice, and (3) determining the primary barriers to awareness and adoption. Descriptive statistics like frequencies, mean scores, and percentage distributions are used in response summaries.

Respondents' Demographic Profile

The information collected in this section included age, gender, years of professional practice, academic background, and professional registration status.

TABLE 1. Demographic Information of Respondents (N=87)

Variable	Category	Frequency (n)	Percentage (%)
Age	21–30 years	24	27.6
	31–40 years	32	36.8
	41–50 years	19	21.8
	51 years and above	12	13.8
Gender	Male	50	57.5
	Female	37	42.5
Academic Qualification	B.Sc./B.Tech	13	14.9
	M.Sc./M.Tech	64	73.6
	PhD	10	11.5
Years of Practice	1–5 years	7	8
	6–10 years	24	27.6
	11–15 years	41	47.1
	16 years and above	15	17.2
ARCON/NIA Member	Yes	52	59.8
	No	35	40.2

Table 1 presents the demographic profile of the architects. The majority, 59%, were between the ages of 31 and 50. The men slightly outnumbered women, making up 57.5% of the population. Most, 73.6%, had a master's degree. With 11 to 15 years of work experience, 47.1% demonstrated a high level of expertise. ARCON/NIA registered nearly 60% of them, indicating good professional representation. Generally, the sample is made up of knowledgeable and experienced individuals. This offers a strong basis for assessing awareness and the uptake of sustainable and technological strategies.

Awareness of Sustainability and Innovative Technology Strategies in High-Rise Architecture

The levels of awareness of sustainable and technological strategies were first examined using descriptive statistics. As shown in Table 2, descriptive statistics ranged from moderate to high. Natural Ventilation had the highest mean score (M = 4.02, SD = 1.13). Followed by energy-efficient HVAC systems (M = 3.59, SD = 1.24), daylighting (M = 3.67, SD = 1.28), and prefabricated/modular construction (M = 3.62, SD = 1.28). A moderate level of awareness was found for smart and digital technologies, such as solar PV integration (M = 3.58, SD = 1.34), smart controls (M = 3.58, SD = 1.25), smart lighting (M = 3.54, SD = 1.33), and Building Information Modelling (BIM) (M = 3.51, SD = 1.34). While recycled/eco-friendly materials scored lowest (M = 3.00, SD = 1.36; Median = 2.00). However, the greater standard deviation shows that respondents' awareness of this problem differs considerably. Although the standard deviations (1.13-1.36) indicate substantial variability, the median scores of 4.00 for most of the items indicate that the respondents considered themselves to be "aware" of this issue.

TABLE 2. Descriptive Statistics of Awareness of Sustainable and Digital Technologies Design Strategies (N = 87)

Variable	N	Mean (M)	SD	Rank
Natural ventilation	87	4.02	1.13	1
Daylighting strategies	87	3.67	1.28	2
Prefabricated/modular components	87	3.62	1.28	3
Energy-efficient HVAC	87	3.59	1.24	4
Rainwater harvesting	87	3.58	1.33	5
Smart controls/sensors	87	3.58	1.25	5
Solar PV integration	87	3.58	1.34	5
Smart lighting systems	87	3.54	1.33	8
Building Information Modelling (BIM)	87	3.51	1.34	9
Passive solar design	87	3.45	1.31	10
Green roofs/walls	87	3.45	1.27	10
Recycled/eco-friendly materials	87	3.00	1.36	12

Scale: 1 = Very unaware, 5 = Very aware

The level of respondents' awareness of sustainable and technological design methods was measured using a five-point Likert scale, where 1 stood for very unaware and 5 for very aware.

Factor Analysis of Awareness of Sustainable and Smart Building Strategies Sampling Adequacy

Weak sampling adequacy was shown by the Kaiser-Meyer-Olkin (KMO) measures, which were 0.522 for passive sustainable design strategies and 0.510 for smart building technologies, both below the recommended threshold of 0.60.

Bartlett's test of sphericity was not significant for passive strategies ($\chi^2 = 9.788$, df = 15, p = 0.833), suggesting weak inter-item correlations. In contrast, it was significant for smart technologies ($\chi^2 = 47.754$, df = 15, $p < 0.001$), supporting the factorability of that dataset.

Due to the exploratory nature of the study and the theoretical coherence of the items, factor analysis was conducted with caution.

Total Variance Explained

Principal Component Analysis (PCA) with Varimax rotation was performed on the 12 awareness items. Table 3 shows a rotated solution with five interpretable factors, representing 59.81% of the total variance. It means that five main themes can be used to represent awareness of these strategies.

TABLE 3. Total Variance Explained (Extraction Method: PCA)

Component	Initial Eigenvalues	% Variance	Cumulative %
1	1.641	27.35	27.35
2	1.407	23.44	50.80
3	1.029	17.15	67.95
4	0.941	15.68	83.63
5	0.846	14.10	97.73

Rotated Component Matrix and Interpretation

The Varimax-rotated solution generated five interpretable factors across the 12 items, as shown in Table 4. Readings above 0.5 are considered strong and used to define factor interpretations. This reveals key themes of awareness among architects.

TABLE 4. Rotated Component Matrix (Varimax Rotation, PCA)

Awareness Strategy	**Factor 1** (Smart/Prefabricated)	**Factor 2** (Design-Integrated)	**Factor 3** (Energy/Intelligent)	**Factor 4** (Resource Efficiency)	**Factor 5** (Water-Light)
Passive solar design	-	0.687	-	-	-
Natural ventilation	-	-	0.674	-	-
Green roofs/walls	-	0.636	-	-	-
Recycled/eco-friendly materials	-	-	-	0.594	-
Rainwater harvesting	-	-	-	-	0.781
Daylighting strategies	-	-	-	-	0.640
Smart lighting systems	-	-	0.756	-	-
Building Information Modelling (BIM)	-	0.540	-	-	-
Energy-efficient HVAC	-	-	-	0.725	-
Smart controls/sensors	0.890	-	-	-	-

Awareness Strategy	Factor 1 (Smart/Prefabricated)	Factor 2 (Design-Integrated)	Factor 3 (Energy/Intelligent)	Factor 4 (Resource Efficiency)	Factor 5 (Water-Light)
Prefabricated/modular components	0.828	-	-	-	-
Solar PV integration	-	-	0.505	-	-

Factor Interpretation

The five-factor solution revealed by Table 4 showed the following conceptual groupings:

- Factor 1 Smart/Prefabricated Systems (25.97%): Awareness of smart systems and prefabricated methods (sensors, modular components).

- Factor 2 (Design-Integrated, 23.45%): Awareness integrated in design, including passive solar, green roofs, and BIM.

- Factor 3 (Energy/Intelligent, 18.53%): Awareness of advanced technologies such as smart lighting, natural ventilation, and solar PV.

- Factor 4 (Resource Efficiency, 11.16%): Awareness of recycled materials and efficient HVAC.

- Factor 5 (Water-Light, 10.57%): Awareness of water and daylight strategies, including rainwater harvesting and daylighting.

The five factors provide a clear conceptual structure for understanding awareness among architects.

Adoption of Sustainable and Technological Design Strategies

Adoption was measured dichotomously (0 = Not applied; 1 = Applied). Implementation patterns mixed considerably across strategies. Table 5 presents the findings.

TABLE 5. Descriptive Statistics and Frequencies of Adoption of Sustainable and Technological Design Strategies

Strategy	Not Applied (0)	Applied (1)	Mean	SD	Rank
Daylighting	30 (34.5%)	57 (65.5%)	0.655	0.478	1
Energy-efficient HVAC	46 (53.5%)	40 (46.5%)	0.465	0.501	2
Passive solar design	48 (55.2%)	39 (44.8%)	0.448	0.500	3
Natural ventilation	48 (55.2%)	39 (44.8%)	0.448	0.500	3
Solar energy systems	49 (56.3%)	38 (43.7%)	0.437	0.499	5
Smart lighting	50 (57.5%)	37 (42.5%)	0.425	0.497	6
Smart controls/sensors	57 (65.5%)	30 (34.5%)	0.345	0.478	7
BIM	63 (72.4%)	24 (27.6%)	0.276	0.450	8
Local/recycled materials	64 (73.6%)	23 (26.4%)	0.264	0.444	9
Rainwater harvesting	64 (74.4%)	22 (25.6%)	0.256	0.439	10

Strategy	Not Applied (0)	Applied (1)	Mean	SD	Rank
Modular/prefabricated components	68 (79.1%)	18 (20.9%)	0.209	0.409	11
Green roofs/walls	71 (81.6%)	16 (18.4%)	0.184	0.390	12
None (technology)	72 (82.8%)	15 (17.2%)	0.172	0.380	13
None (sustainability)	82 (94.3%)	5 (5.7%)	0.057	0.234	14

The highest adoption level was daylighting (65.5%). This showed a partiality for passive design strategies. Followed by energy-efficient HVAC systems (46.5%), passive solar design (44.8%) and natural ventilation (44.8%). The lowest levels were green roofs/walls (18.4%) and modular/ prefabricated components (20.9%). Rainwater harvesting (25.6%) and local/recycled materials (26.4%) showed moderate use. These findings imply that architects lean towards passive strategies and economic approaches.

Factor Analysis of Technological Adoption Strategies

Varimax rotation was used in a principal component analysis (PCA) to determine the important aspects of the adoption of sustainable and technological strategies. The data were appropriate for factor analysis based on the KMO value of 0.510, and Bartlett's Test of Sphericity was statistically significant ($\chi^2 = 47.754$, df = 15, $p < 0.001$), confirming sufficient correlations for factor extraction.

Total Variance Explained

Principal Component Analysis (PCA) extracted three factors with eigenvalues greater than 1, accounting for 67.95% of the total variance. Table 6 shows the variance explained by each factor, along with the rotated solution.

TABLE 6. Total Variance Explained (Extraction Method: PCA)

Component	Initial Eigenvalues	% of Variance	Cumulative %	Rotation Sums of Squared Loadings	% of Variance	Cumulative %
1	1.641	27.35	27.35	1.558	25.97	25.97
2	1.407	23.44	50.80	1.407	23.45	49.42
3	1.029	17.15	67.95	1.112	18.53	67.95

Factor Structure

- Factor 1 Smart Building Systems (25.97%): Smart controls/sensors and prefabricated/modular construction.
- Factor 2 Energy and Renewable Technologies (23.45%): Smart lighting and solar PV systems.
- Factor 3 Digital-Energy Integration (18.53%): BIM and energy-efficient HVAC systems.

The grouping of adoption strategies is done by the three extracted factors, as seen in Table 6. This helps in understanding how adoption is impacted

Rotated Component Matrix and Interpretation

The Varimax-rotated component matrix in Table 7 reveals the loading of each technological strategy on the three factors. Readings above 0.5 are considered strong and used to define factor interpretations.

TABLE 7. Rotated Component Matrix (Varimax Rotation, PCA)

Strategy	Factor 1	Factor 2	Factor 3
Smart lighting systems	-	0.806	-
BIM	-	-	0.892
Energy-efficient HVAC	-	-	0.512
Smart building controls/sensors	0.870	-	-
Prefabricated/modular components	0.839	-	-
Solar PV integration	-	0.807	-

The three factors suggest that technological adoption clusters around smart systems, energy-focused innovations, and integrated digital/energy strategies, providing insights into architects' technological preferences in high-rise sustainable design.

Comparison of Awareness and Adoption of Sustainable and Innovative Technology Strategies in High-Rise Architecture

A comparative analysis was carried out to study the connection between awareness and adoption of sustainable and innovative strategies. Adoption shows how certain strategies are applied in practice. While awareness implies familiarity with them. Table 8 shows that from the PCA for awareness (five factors, 59.8% cumulative variance) and adoption (three factors, 67.95% cumulative variance) gaps, where adoption is not always a result of awareness.

TABLE 8. Comparison of Awareness and Adoption Factors of Sustainable and Innovative Strategies

Dimension	Awareness Factors (PCA, 59.8% variance)	Adoption Factors (PCA, 67.95% variance)	Key Insights
Smart/Intelligent Systems	Factor 1 (Smart/Prefabricated): Smart controls/sensors, prefabricated/modular components	Factor 1 (Smart Building Systems): Smart controls/sensors, prefabricated/modular components	High awareness corresponds with adoption of digital and modular strategies, reflecting a clear technological adoption trend.

Dimension	Awareness Factors (PCA, 59.8% variance)	Adoption Factors (PCA, 67.95% variance)	Key Insights
Design-Integrated Sustainability	Factor 2 (Design-Integrated): Passive solar design, green roofs/walls, BIM	Factor 4 (Passive Environmental Strategies): Passive solar design, recycled/local materials	Awareness of design-integrated strategies is higher than adoption, particularly for green roofs/walls and BIM, indicating practical uptake lags familiarity.
Energy Efficiency	Factor 3 (Energy/Intelligent): Smart lighting, natural ventilation, solar PV	Factor 2 (Energy & Renewable Technologies): Solar energy systems, energy-efficient HVAC, smart lighting	Awareness focuses on renewable and intelligent technologies, whereas adoption emphasises energy-efficient systems, showing a partial mismatch between knowledge and practice.
Resource Efficiency	Factor 4 (Resource Efficiency): Recycled/eco-friendly materials, energy-efficient HVAC	Factor 3 (Modular/Adaptive Construction): Prefabricated/modular components	Adoption favors modular construction methods over material-based strategies, revealing a gap between material efficiency awareness and practical implementation.
Water-Light Strategies	Factor 5 (Water-Light): Rainwater harvesting, daylighting	Factor 6 (Water & Ventilation Strategies): Rainwater harvesting, natural ventilation	Both awareness and adoption capture environmental resource management, but adoption prioritises water and ventilation interventions.
Commitment Dimension	Not directly observed	Factor 5 (Sustainability Commitment): “None applied” vs. commitment	Adoption factors reveal an attitude/commitment dimension absent from awareness measures, highlighting behavioural influences on implementation.

Table 8 demonstrates that awareness does not automatically translate into adoption, particularly for innovative technologies. It presents findings that give a different perspective on architects' use of these strategies. The use of solar energy systems, passive solar design, and natural ventilation was comparatively higher than BIM, modular construction, and green walls /roofs. These differences are measured by the adoption index (0-1 coding), where percentages and frequencies show the percentage of respondents using each strategy. This revealed that innovative technologies are adopted slowly, possibly because of regulatory, technological, cost or knowledge barriers, whereas traditional passive methods are more widely adopted.

Open-Ended Insights: Barriers and Adoption Drivers

Project Experience and Professional Roles: The respondents' views on adoption were shaped by their involvement in sustainable projects. Approximately 28% of respondents reported working on a single project type, while 31% reported working on all project types. Projects of the hotel and retail types were less common. A majority have worked on several residential, commercial, healthcare and educational projects. There is an obvious gap between awareness and adoption, as about one-third reported never having been on a sustainability project. This is in line with the inferential findings discussed in Section 4.2. This distribution implies that the role and project involvement focus has a significant influence on the awareness and adoption of the strategies

Barriers: The primary barriers were found to be high cost (37%), ignorance (30%), client resistance (28%), insufficient skill (27%), inadequate policy framework (24%), material scarcity (21%) and energy-related issues (21%). These align with the statistical findings in Table 5, which showed that the non-adoption of solar PV and rainwater harvesting was due to a lack of technical expertise and regulatory restrictions. Furthermore, the findings support those of Amuda-Yusuf et al. (2020). The merging of the results from open-ended and quantitative research supported the findings.

Adoption Drivers: The most frequently mentioned adoption motivators were awareness and education (55%), followed by policy incentives (41%), design standards, technical capacity and cost incentives (approximately 25% each). To increase adoption levels, these views highlight the necessity of systemic interventions like capacity-building, policies, financial incentives and innovative design.

The findings support and strengthen the quantitative results. They are further enhanced by the open-ended section of the research instrument that resembles interview questions. In combining the descriptive, inferential and qualitative results, the multi-view triangulation presents multiple perspectives on the challenges and drivers of adoption.

Discussion

The findings show how qualified Lagos architects are in sustainability and technological strategies. These include Natural Ventilation, energy-efficient HVAC systems and daylighting with the highest mean. The findings present a professional commitment to sustainable design in Nigeria and support the first research objective. These are consistent with studies by Mba et al. (2024) and Aduwo et al. (2024). The five-factor structure reveals high adoption around smart/prefabricated systems and design-integrated strategies, while material efficiency and water management remain less adopted. Similar results regarding the growth of sustainability awareness throughout the Global South are also reported by Rimamtanung and Charles (2023) and Sowmya et al. (2025).

The second research objective is addressed by the uneven levels of adoption in practice despite encouraging levels of awareness. Despite substantial awareness, adoption patterns present selective application: passive strategies (daylighting 65.5%, passive solar 44.8%, natural ventilation 44.8%) are more widely used than technologies (BIM 27.6%, modular/prefabricated 20.9%, green roofs 18.4%). This is because they are not expensive and are simple to integrate. This supports the findings of Adeogun (2022) and Mogaji et al. (2025), which showed that awareness does not always translate to adoption. Additionally, adoption varies among demographic groups Compared to their older counterparts, younger architects are substantially more likely to use BIM ($\chi^2(3, N = 87) = 8.62, p =.035$) and architects with more than ten years of experience are more likely to use passive solar design ($\chi^2 (2, N = 87) = 6.74, p =.034$). These results imply that professional experience and generational disparities affect the choice and implementation of strategies. Like Darko et al. (2017), they emphasise the importance of training and exposure in closing the awareness-adoption gap, especially for technological solutions. Therefore, even though Lagos architects use both sustainable and innovative strategies, institutional gaps and practical limitations shape their implementation in practice.

The most significant factors were found to be high costs (85%), a lack of technical expertise (72.5%) and insufficient regulations (60%). Earlier studies by Chan et al. (2018), Mba et al. (2024), and Adeogun (2022) also reveal these obstacles. According to their research, in comparable cases, professional motivation is overshadowed by systemic barriers. Economic, technical, client-related, and policy barriers limit the uptake of advanced strategies. Statistical associations confirm that regulatory frameworks, technical capacity, and costs significantly constrain adoption. This trend is supported by quantitative findings. Adoption and BIM awareness had a moderately positive correlation ($\rho =.41, p <.001$) while passive solar design had a positive correlation ($\rho =.32, p =.004$). Suggesting that although technical expertise can promote adoption, factors like expenses, customer demand, and viability also play a significant role.

Motivating factors were found in the open-ended responses. These consist of more robust policy frameworks, financial incentives, education and awareness campaigns. These are consistent with findings from other countries, such as Singapore's achievement of raising adoption levels through incentives by the government (Hwang & Tan, 2012). Africa's institutional reforms are needed as revealed by Aduwo, Sholanke, and Eleagu, (2024). The findings collectively highlight how contextual limitations and enabling factors influence adoption, requiring approaches that incorporate incentives, training and regulatory enforcement.

Knowledge is not a factor of implementation, particularly in technologically new tactics, according to the comparison of awareness and adoption. The most popular tactics are passive ones because they are practical, economical, and well-known to the client; in contrast, obstacles prevent the widespread use of digital and high-tech techniques. Lagos architects' perceptions of creative and sustainable high-rise design approaches are richly and multidimensionally revealed by the combination of descriptive, inferential, and qualitative data.

5.0 Conclusion and Recommendations

This study examined how architects in Lagos, Nigeria, understood and applied sustainable and innovative strategies for high rise design. The results show that while awareness of strategies like daylighting, passive solar design and BIM is high, adoption varies. Adoption is delayed by challenges such as high costs, a lack of technical expertise, client resistance and inadequate policies. The study demonstrates that awareness alone is not sufficient for measurable adoption; supportive frameworks and professional interests must be balanced.

The findings highlight the need for teamwork that goes beyond personal awareness. Improving skills requires providing workshops and expert training on locally applicable sustainable technologies. To shift attitudes and increase demand for sustainable design, client focused campaigns are also important. Strong enforcement of policies and compliance monitoring are required. Financial barriers may be reduced with things like tax breaks, grants, incentives and subsidised access to environmentally friendly materials. Including sustainability and technological innovation in core curricula is another way to improve architectural education.

By considering adoption as a process with three interconnected stages, awareness, willingness and adoption capacity, the study promotes sustainability theory. This social-technical perspective shows how institutional frameworks, professional culture, economic viability and contextual factors all affect architectural practices. This model provides a useful approach for determining where adoption is low.

Implemented adoption strategies should be the subject of future research. The regional differences in adoption patterns and barriers may be studied by comparative studies conducted in other Nigerian and sub-Saharan African cities. It is also advisable to carry out long-term research to track evolving sustainability trends and regulatory frameworks.

Overall, the study presents both local and general insights. Lagos and other urban areas can enhance their implementation of sustainable and innovative strategies in high-rise design by improving each stage of the adoption process, particularly those aligned with SDGs 11 (Sustainable Cities and Communities) and 13 (Climate Action).

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