Adoption of Sustainable Design Strategies in Mid-Rise Office Buildings In Abuja: Awareness, Integration, Barriers and Drivers

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Abstract
The commercial building sector is a major contributor to global energy consumption and environmental degradation, particularly in rapidly urbanising tropical environments such as Abuja, Nigeria. Mid-rise office buildings of four to eight storeys are common in Abuja's Central Business District (CBD), yet many depend heavily on energy-intensive mechanical cooling and artificial lighting because their designs respond inadequately to local climatic conditions. This study examines professionals' awareness of sustainable design strategies, the extent to which these strategies are implemented, and the barriers and drivers that influence their adoption in mid-rise office buildings in Abuja. A mixed-methods research design was adopted; empirical data were collected from 55 built-environment professionals, architects, structural and services engineers, and facility managers, and supplemented with case-study assessment of regional office typologies. Descriptive analysis indicates that awareness is moderate for continuous building-envelope insulation, sustainable landscaping and geothermal heat-pump systems. In practice, however, implementation is uneven and concentrated on accessible measures such as landscaping (Mean = 3.69) and greywater recycling (Mean = 3.67), while more fundamental envelope and daylighting strategies, light shelves (Mean = 1.96) and daylight-harvesting (Mean = 2.00), remain poorly implemented. The principal barriers are concerns about reliability and maintenance (Mean = 4.53), limited technical expertise (Mean = 3.67) and resistance to change (Mean = 3.60), while Integrated Project Delivery (Mean = 3.93) and anticipated improvements in occupant health and productivity (Mean = 3.55) are identified as important drivers. The study concludes by proposing architectural and policy measures for translating the provisions of Nigeria's Energy Efficiency Building Code (EEBC) into effective practice in tropical office design.

Keywords: *sustainable architecture; energy efficiency; mid-rise office buildings; bioclimatic design; Abuja commercial real estate; passive cooling.*

1.0 Introduction
The global building sector accounts for a substantial proportion of primary energy consumption and greenhouse-gas emissions. Commercial buildings, particularly office complexes, require considerable electrical energy for indoor environmental quality, lighting and thermal comfort: the International Energy Agency (2020) estimates that buildings account for roughly 27% of global final energy consumption, while Kim et al. (2022) report that commercial facilities consume nearly 35% of electricity worldwide, and in Nigeria commercial buildings account for an estimated 20% of grid-generated electricity (Lawanson et al., 2022).

Rapid urbanisation in Abuja has encouraged the proliferation of mid-rise office buildings of four to eight storeys, particularly within the CBD. Many feature extensive glazed facades, sealed envelopes and a strong dependence on active mechanical, electrical and plumbing (MEP) systems, with limited consideration of the local climate (Oladipo & Fadairo, 2021). Abuja has a tropical savannah climate of high annual temperatures, frequently 30–35 °C, and intense solar radiation of approximately 5.5–6.0 kWh/m²/day. Where buildings fail to respond to solar orientation, shading and natural ventilation, cooling demand rises substantially, and grid instability forces owners and tenants to rely on costly, polluting diesel generators (Odunfa et al., 2015; Sholanke & Ganya, 2024). Although Nigeria introduced the Energy Efficiency Building Code (EEBC) in 2017 to set minimum performance requirements, enforcement remains limited and empirical evidence on local practice is scarce (Dos Santos & Lima, 2022; Akinlabi et al., 2023). Against this background, the study investigates the practical integration of sustainable design strategies in Abuja's mid-rise office sector, with objectives to (i) assess professionals' knowledge of energy-efficient strategies, (ii) evaluate the extent of their integration, (iii) identify the principal barriers to implementation, and (iv) determine the main factors influencing adoption.

2.0 Literature Review and Theoretical Framework

2.1 Theoretical Foundations

The study is grounded in Bioclimatic Design Theory and Sustainable Architecture Theory. First articulated by Victor Olgyay (1963), bioclimatic design proposes that buildings should respond to local environmental conditions, temperature, humidity, solar radiation and prevailing winds, to provide thermal comfort while minimising dependence on mechanical systems. In tropical savannah climates such as Abuja's, this means limiting direct solar heat gain through appropriate orientation and shading while using cross-ventilation and thermal mass to manage indoor temperatures (Erebor et al., 2021). Sustainable Architecture Theory complements this with a life-cycle perspective, emphasising resource efficiency, ecological responsibility, economic viability and occupant well-being across a building's planning, construction, operation and decommissioning (Dabija, 2020; Kibert, 2022). Together the frameworks support integrating passive solar design, energy-efficient envelopes, low-embodied-carbon materials and intelligent controls to reduce operational energy while maintaining high indoor environmental quality. Figure 1 expresses this integration in section.

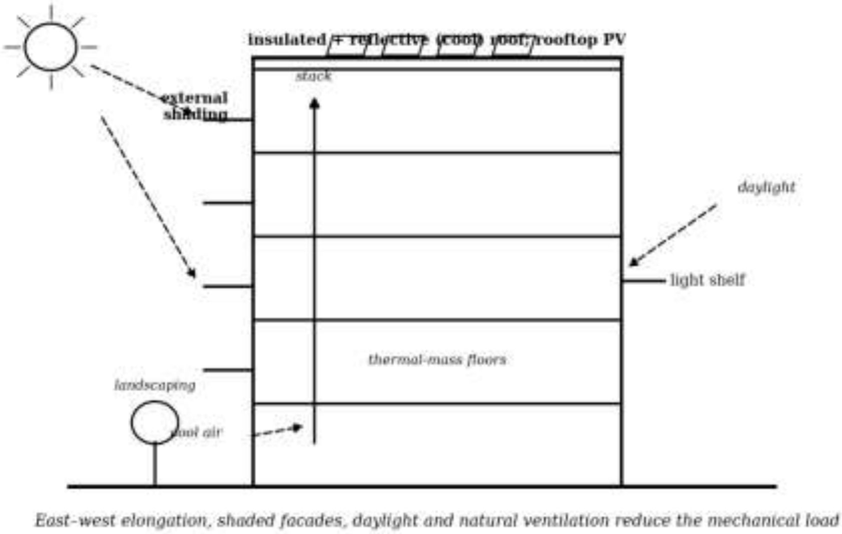

Figure 1: Bioclimatic section of a mid-rise office building for Abuja's climate, integrating east–west elongation, external shading, daylighting via light shelves, stack ventilation, thermal-mass floors, a reflective insulated roof with rooftop PV, and landscaping
Source: Authors' construction (2026).

2.2 Sustainable Design Strategies for Tropical Office Buildings

Sustainable interventions may be grouped into passive design, envelope optimisation, responsible material selection and the integration of active and renewable-energy technologies (Gangwar et al., 2020), as set out in Table 1 and Figure 2. Passive strategies use natural processes to maintain acceptable indoor conditions with little or no operational energy, compact or climate-responsive massing, elongated east–west orientation, external shading, courtyards, cross-ventilation and night-purge ventilation (Hegazi et al., 2021; Chung-Camargo, 2024). Envelope optimisation reduces unwanted heat transfer through double-skin facades, insulated assemblies, high-performance low-emissivity glazing and reflective roofing (Amirifard et al., 2019). Active technologies, Building Automation Systems, occupancy sensors, LED controls and rooftop photovoltaics, then complement passive measures by improving the monitoring and management of dynamic loads (Dambhare et al., 2021; Berawi et al., 2023). Although sustainable office projects can achieve energy savings of 40–50% (Kibert, 2022), their adoption in sub-Saharan Africa remains constrained by interrelated technical, social, financial and institutional challenges (Akinlabi et al., 2023). Table 2 and Table 3 present Abuja's climatic context and this classification respectively.

Table 1: Climatic characteristics of Abuja and their design implications

Climatic parameter	Characteristic in Abuja	Design implication
Climate type	Tropical savannah	Sustained cooling demand for most of the year
Air temperature	Frequently 30–35 °C	High sensible-heat load on office envelopes
Solar radiation	≈ 5.5–6.0 kWh/m²/day	Intense gain through unshaded glazing; shading essential

Climatic parameter	Characteristic in Abuja	Design implication
Grid supply	Unstable; reliance on diesel generators	Reducing cooling demand cuts cost and emissions
Policy	EEBC (2017), weakly enforced	A code framework exists but needs enforcement

Source: compiled by the authors from Oladipo & Fadairo (2021) and Sholanke & Ganya (2024).

Table 2: A classification of sustainable design strategies for tropical office buildings

Strategy family	Role in the low-energy office	Representative strategies assessed
Passive design	Maintain comfort with little operational energy	Climate-responsive massing; east–west orientation; external shading; courtyards / cross-ventilation; night-purge
Envelope optimisation	Reduce unwanted heat transfer through the skin	Continuous insulation; double-skin facades; low-E glazing; reflective roofing
Responsible materials	Lower embodied impact and resource use	Low-embodied-carbon and durable materials; water-efficient fixtures; greywater recycling
Active & renewable	Manage and offset dynamic loads efficiently	Building automation (BAS); occupancy sensors; LED controls; rooftop PV; geothermal heat pumps

Source: Authors' construction, after Gangwar et al. (2020).

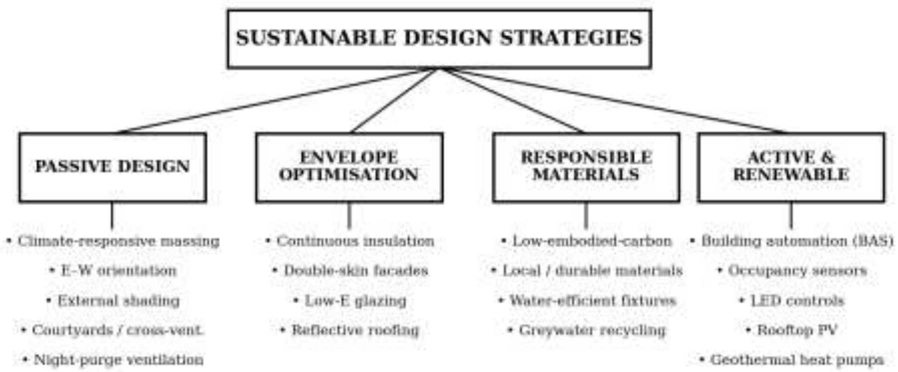

Figure 2: The four families of sustainable design strategy and their representative measures
Source: Authors' construction (2026).

3.0 Research Methodology

The study adopted a mixed-methods design combining quantitative survey analysis with qualitative observation, case-study assessment and a synthesis of the literature (Creswell & Creswell, 2021). The primary study area was Abuja's CBD, and the target population comprised built-environment professionals involved in the design, construction and management of mid-rise office buildings in Abuja and other major Nigerian commercial centres. Purposive sampling selected 55 qualified respondents; architects constituted 94.54% of the sample, civil or structural engineers 3.62% and mechanical or services engineers 1.81%, while 72.72% held a master's degree and 67.26% had more than six years of post-qualification experience, indicating substantial technical knowledge and practical experience. Data were collected using structured five-point Likert questionnaires, observation checklists and a review of the literature, and analysed in SPSS version 25 using frequency distributions, percentages, mean item scores and standard deviations. In interpreting the ratings, the scale mid-point of 3.0 is used as the reference for adequacy or agreement.

4.0 Results and Discussion

4.1 Professional Awareness of Sustainable Design Strategies

Table 3 and Figure 3 summarise awareness of the sustainable design strategies. Continuous building-envelope insulation achieved the highest mean (3.13, SD = 1.375), followed by landscaping and microclimate design (2.75) and geothermal heat pumps (2.65). By contrast, respondents reported limited knowledge of specialised facade-engineering strategies, with double-skin facades (1.75) and external shading devices (1.67) receiving the lowest ratings. Awareness is therefore only moderate even at the top of the list, and practitioners are more familiar with conventional insulation and landscaping than with advanced approaches to facade performance and solar control, a notable finding given how central shading is to a tropical office.

Table 3: Professional awareness of sustainable design strategies (N = 55)

S/N	Sustainable design strategy	Mean	SD	Rank
1	Continuous building-envelope insulation	**3.13**	1.375	1st
2	Landscaping and microclimate design	**2.75**	1.142	2nd
3	Geothermal heat pumps	**2.65**	1.481	3rd
4	Predictive energy analytics	**2.40**	1.369	4th
5	Demand-controlled ventilation	**2.29**	1.181	5th
6	Operable windows and night-purge ventilation	**2.27**	1.326	6th
7	Solar photovoltaic systems	**2.24**	1.276	7th
8	Building Automation Systems (BAS)	**2.22**	1.329	8th
9	Double-skin facades	**1.75**	1.022	19th
10	External shading devices	**1.67**	0.944	20th

Table shows the leading and lowest-ranked strategies from the full instrument (intermediate ranks not tabulated). Source: Authors' analysis, SPSS v25 (2026).

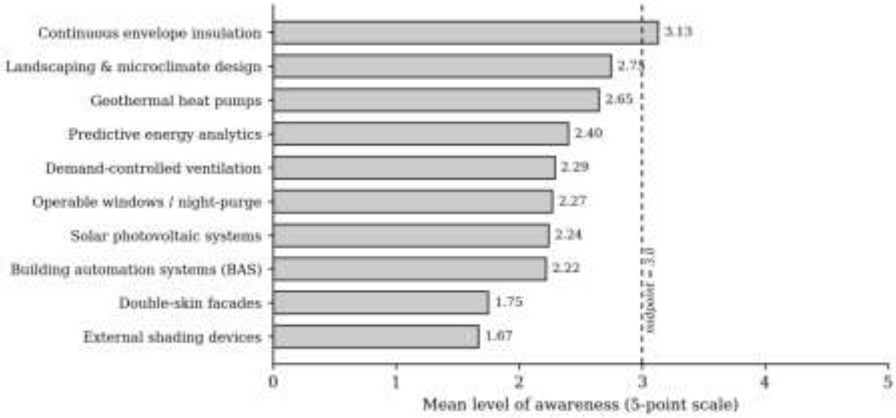

Figure 3: Mean level of awareness of the reported strategies (dashed line = 3.0 mid-point)
Source: Authors' analysis (2026).

4.2 Extent of Integration in Practice

Table 4 and Figure 4 reveal a substantial gap between awareness and application. Landscaping received the highest implementation rating (3.69), followed by greywater-recycling systems (3.67) and predictive energy analytics (3.51). In contrast, passive solar and daylight-responsive strategies were among the least implemented, building massing and solar orientation (2.00), daylight-harvesting systems (2.00) and light shelves (1.96). Two patterns stand out. First, several measures are implemented more than they are nominally "known" (landscaping, greywater, predictive analytics), suggesting they are adopted as visible, site-based or client-driven features rather than as consciously "sustainable" design. Second, and more concerning, the fundamental passive strategies of solar geometry and natural lighting are both poorly understood and poorly applied, precisely the measures that would most reduce cooling and lighting energy in Abuja's climate.

Table 4: Extent of sustainable design strategy integration (N = 55)

S/N	Sustainable design strategy	Mean	SD	Rank
1	Landscaping integration	**3.69**	1.923	1st
2	Greywater-recycling systems	**3.67**	1.991	2nd
3	Predictive energy analytics	**3.51**	1.514	3rd
4	Water-efficient fixtures	**3.11**	1.641	4th
5	Demand-controlled ventilation	**2.85**	1.193	5th
6	Occupancy and vacancy sensors	**2.58**	1.397	6th
7	Building massing and solar orientation	**2.00**	1.427	15th
8	Daylight-harvesting systems	**2.00**	1.401	15th
9	Light shelves	**1.96**	1.276	16th

Table shows the leading and lowest-ranked strategies from the full instrument (intermediate ranks not tabulated). Source: Authors' analysis, SPSS v25 (2026).

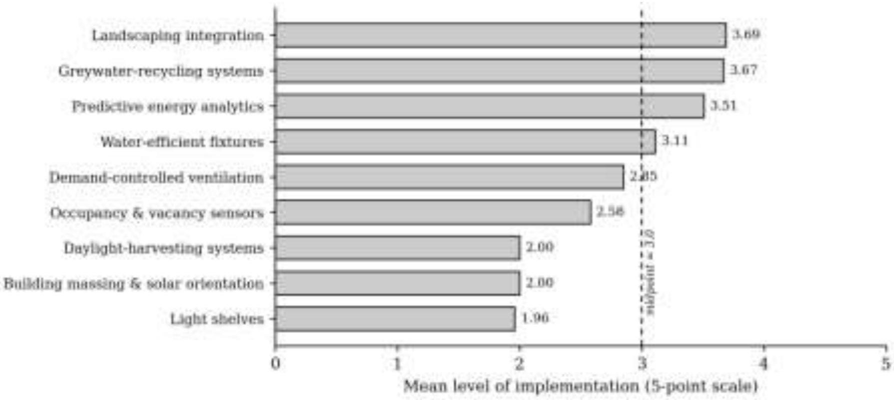

Figure 4: Mean level of implementation of the reported strategies (dashed line = 3.0 mid-point)
Source: Authors' analysis (2026).

4.3 Barriers to Sustainable Design Integration

Table 5 and Figure 5 report the barriers. Concern about reliability and maintenance was rated the most significant constraint (4.53, SD = 1.884), reflecting widespread uncertainty about local capacity to operate, maintain and repair specialised green-building technologies over their service lives. A lack of professional awareness and expertise ranked second (3.67) and resistance to change and cultural inertia third (3.60). Financial and regulatory conditions also feature, high initial capital costs (3.36), insufficient policy incentives (3.25) and appraiser and lender hesitancy (3.18), consistent with Menna et al. (2022) and Akinlabi et al. (2023) on upfront costs and weak policy enforcement as constraints on green-building adoption in developing economies.

Table 5: Barriers to sustainable design integration (N = 55)

S/N	Barrier	Mean	SD	Rank
1	Concerns about reliability and maintenance	**4.53**	1.884	1st
2	Lack of professional awareness and expertise	**3.67**	1.504	2nd
3	Resistance to change and cultural inertia	**3.60**	1.523	3rd
4	High initial capital costs	**3.36**	2.049	4th
5	Lack of strong policy incentives	**3.25**	1.691	5th
6	Perceived comfort or aesthetic trade-offs	**3.25**	1.590	5th
7	Appraiser and lender hesitancy	**3.18**	1.588	7th
8	Inconsistent or outdated building codes	**2.84**	1.619	13th

Table shows the leading and lowest-ranked barriers from the eighteen assessed (intermediate ranks not tabulated). Source: Authors' analysis, SPSS v25 (2026).

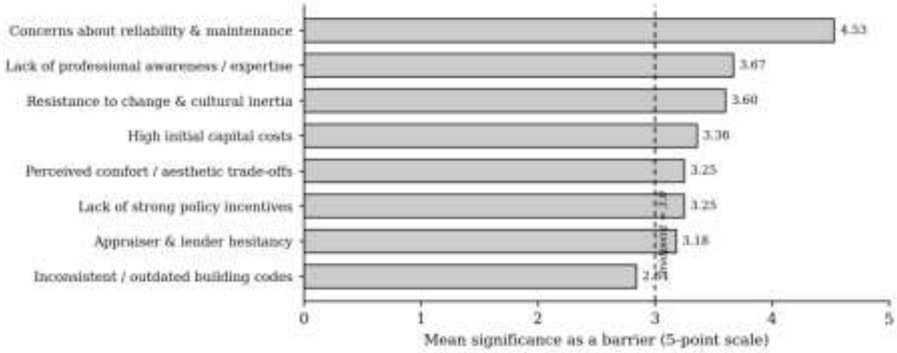

Figure 5: Mean significance of the reported barriers (dashed line = 3.0 mid-point)
Source: Authors' analysis (2026).

4.4 Drivers and Influencing Factors

Table 6 and Figure 6 report the drivers. Integrated Project Delivery (IPD) was rated the most influential (3.93, SD = 1.538): by enabling clients, architects, MEP engineers, contractors and other consultants to collaborate from the earliest design stages, IPD can resolve interdisciplinary conflicts before construction begins. Anticipated improvements in employee health and productivity ranked second (3.55), indicating growing recognition of the organisational value of high-quality indoor environments, while corporate leadership and brand value (3.05) and lower vacancy and stronger tenant attraction (3.04) were relevant market-based drivers. Table 7 draws the four objectives together.

Table 6: Drivers of sustainable design adoption (N = 55)

S/N	Driver or influencing factor	Mean	SD	Rank
1	Integrated Project Delivery (IPD)	**3.93**	1.538	1st
2	Improved employee health and productivity	**3.55**	1.331	2nd
3	Corporate leadership and brand value	**3.05**	1.458	3rd
4	Lower vacancy rates and greater tenant attraction	**3.04**	1.122	4th
5	Green financing, bonds and concessional loans	**2.93**	1.687	5th
6	Life-cycle costing and total cost of ownership	**2.71**	1.524	6th

Source: Authors' analysis, SPSS v25 (2026).

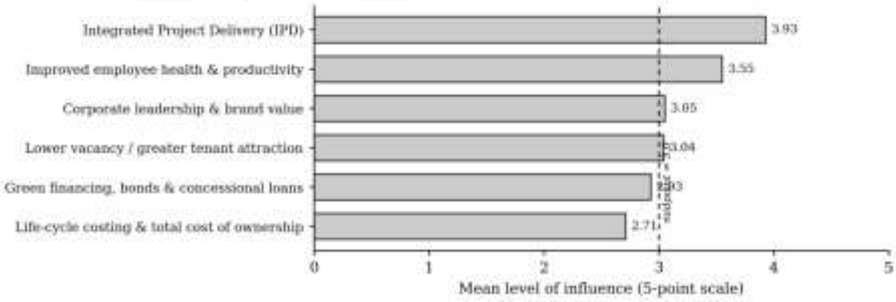

Figure 6: Mean level of influence of the drivers (dashed line = 3.0 mid-point)
Source: Authors' analysis (2026).

Table 7: Summary of the leading finding for each research objective

Research objective	Leading item	Mean	Key inference
Awareness of strategies	Continuous envelope insulation	3.13	Awareness is only moderate, even at the top
Extent of integration	Landscaping integration	3.69	Practice favours visible, site-based measures
Barriers to integration	Reliability and maintenance concerns	4.53	Doubts about local upkeep capacity dominate
Drivers of adoption	Integrated Project Delivery (IPD)	3.93	Early collaboration is the strongest lever

Source: Authors' analysis (2026).

5.0 Conclusion and Policy Recommendations

This study assessed the adoption, barriers and drivers of sustainable design strategies in mid-rise office buildings in Abuja. Although local professionals recognise several fundamental sustainability principles, practical implementation remains concentrated on landscaping and water-efficiency measures, while important passive strategies involving solar orientation, natural ventilation and daylight utilisation are substantially underused. Concerns about system reliability and maintenance, deficiencies in professional expertise, and high initial costs are the most significant barriers, whereas Integrated Project Delivery and the anticipated benefits of healthier, more productive workplaces offer promising pathways for change. On this basis the following measures are recommended:

1. Enforce building energy codes. The Federal Capital Development Authority and relevant planning agencies should require demonstrable compliance with the Energy Efficiency Building Code (EEBC, 2017) as part of development-control approval for commercial office projects in Abuja;
2. Strengthen institutional capacity. ARCON and the NIA should provide continuing professional-development modules on bioclimatic design and facade engineering;
3. Promote Integrated Project Delivery. Clients and project managers should engage MEP engineers, sustainability specialists and other key consultants during the earliest stages of site planning, massing and schematic design; and
4. Introduce financial incentives and green tax credits. Government authorities and financial institutions should establish concessional green loans, reduced property taxes and accelerated approvals for developments that achieve independently verified reductions in energy consumption.

By addressing the reliability, expertise and cost barriers directly while building on collaborative delivery and the demonstrable value of healthy workplaces, Abuja's mid-rise office sector can translate the provisions of the EEBC into measurable improvements in energy performance and occupant well-being.

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