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Modelling the Predictive Relationship Between Architects' Knowledge and Adoption of Green Building Strategies in Lagos Nigeria

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Abstract: The continuous environmental impact of high-rise office construction in Lagos requires architects to adopt Green Building Design Strategies (GBDS). This study examines how architects' knowledge influences GBDS adoption using a mixed-methods approach, drawing on data from 344 architects and 12 expert interviews in Lagos. Analytical methods are descriptive statistics, the Relative Importance Index (RII), chi-square tests, correlation analysis, and Principal Component Analysis (PCA). Architects' knowledge was highest for sustainable materials (RII = 0.74), energy-efficient lighting (RII = 0.73), and passive cooling/ventilation (RII = 0.73), and lowest for smart building management systems (RII = 0.70). Adoption showed a similar pattern: sustainable materials ranked highest (92.73%), while advanced technological systems ranked lower. Chi-square analysis confirmed knowledge significantly impacted adoption ($\chi^2 = 358.703$, $p < 0.001$), while limited knowledge predicted low adoption ($\chi^2 = 247.308$, $p < 0.001$). There is a strong positive correlation ($r = 0.71$) between knowledge and adoption. PCA identified three components: passive/environmental control strategies, resource/waste management, and technological/renewable energy systems. The study concludes that knowledge is the main driver of GBDS adoption among Lagos architects, though its impact is moderated by cost, technology exposure, institutional support, and curriculum review.

Keywords: *Adoption; Architects; Green Building; Green Building Design Strategies; Knowledge; Lagos*.

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I. INTRODUCTION

The rapid increase in high-rise office construction in Lagos is driven by population growth, economic expansion, and continuous demand for space. These buildings consume excessive energy, produce excessive heat gain, emit CO_2 and increase water use which raise the need for environmentally conscious construction practices. Prior literature identifies high-rise buildings as major contributors to global greenhouse emissions [1] and emphasized the important role of design professionals in mitigating the environmental impact of climate change on the environment, economic and social life of the people through Green Building Design Strategies [2][3]

In the Nigerian context, Lagos accounts for over 60% of Nigeria's building construction ongoing [4], evidence suggests that green building practices remain unevenly applied, with passive strategies more common than advanced technological interventions [5][6]. According to the studies of [7],[8],[9], knowledge gaps, regulatory weaknesses, and perceived cost burdens are some of the factors influencing the adoption of Green Building Design Strategies (GBDS). However, [5][6] opined that empirical modelling of how architects' knowledge predicts adoption remains limited in Nigeria. This research aims to fill that gap using a strong statistical methodology to assess the licensed Lagos Architects.

A. Research Objectives

- Assess architects' knowledge of GBDS.
- Determine the extent of adoption.
- Model the predictive impact of knowledge on GBDS adoption.
- Inform strategies implications for practice and policy

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B. Contribution to Knowledge

- Enhance existing knowledge by providing precise, quantitative measurements of how architects' expertise affects the adoption of green building strategies in Lagos.
- Identify adoption clusters through PCA, reflecting Lagos' design realities.
- Reinforce [5][6] studies using statistical modelling rather than descriptive analysis
- Provide actionable evidence for policy review, professional training and architectural curriculum review.

II. RESEARCH METHODS

The study adopted a mixed-methods research design by combining quantitative and qualitative research approaches to obtain a comprehensive understanding of how architects' knowledge influences the adoption of Green Building Design Strategies (GBDS) in Lagos. This method approach was chosen to establish measurable patterns and contextual professional experiences, especially in a diverse and evolving design environment such as Lagos. The study datasets were extracted from [10] doctoral thesis titled "*Assessment of knowledge and adoption of green building design strategies in the design of high-rise office building in Lagos, Nigeria*".

A. Research Design and Approach

The quantitative approach adopted a structured questionnaire to Lagos ARCON/NIA registered architects while the qualitative approach consisted of semi-structured interviews with expert practitioners. This combined method helped achieve a more robust assessment of both the statistical relationships and the professional realities affecting GBDS adoption in Lagos.

B. Sample Size

A total of 344 valid out of 362 questionnaire responses (accounting for 95.03% response rate) out of the target population of 2501 architects were obtained for the quantitative analysis representing different levels of professional experience and organizational settings. In addition, 12 expert participants involved in high-rise commercial developments were purposively selected for qualitative interviews. All respondents were architects working in private consulting firms, real estate or corporate firms, governmental agencies, and academic institutions.

C. Research Instruments

➢ *Questionnaire Structure*

The questionnaire was structured into four sections using a five-point Likert scale to achieve RII values.

- *Section A:* Demographic and professional characteristics of the respondents in Lagos
- *Section B:* Knowledge of GBDS across key GBDS categories
- *Section C:* Extent of GBDS adoption in architectural practice
- *Section D*: Perceived barriers and enabling factors affecting adoption

➢ *Interview Guide*

Semi-structured interview questions explored practical realities affecting GBDS implementation and responses were transcribed for thematic analysis.

D. Data Collection Procedure

Questionnaires were electronically distributed through various practicing architects' platforms, and emails. The expert interviews were conducted at mutually agreed venues and virtual platforms. Ethical protocols were followed, ensuring confidentiality and voluntary participation.

E. Data Analysis Techniques

➢ *Relative Importance Index (RII)*

RII was used to analyze architects' knowledge and adoption levels which allowed clear ranking of the strategies based on importance and frequency. The formula applied was:

$$RII = (\sum w / A \times N) \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where w= weight assigned to respondents, A = highest weight (5), N = Total Number of Respondents

➢ *Adoption*

Adoption was recorded using a frequency scale: never, rarely, sometimes, often, always.

F. Modelling Procedures

➢ Chi-Square Tests

Chi-square tests determined the significant influence of knowledge on GBDS adoption, examine whether low knowledge was associated with lower adoption rates.

➢ *Correlation Analysis*

Pearson correlation coefficients were computed to measure the strength and direction of the relationship between knowledge and adoption.

➢ *Principal Component Analysis (PCA)*

PCA was conducted using the 15 GBDS variables to identify underlying dimensions of adoption. The extracted ccomponents were based on eigenvalues >1, and factor loadings.

➢ *Qualitative Analysis*

Interview transcripts were manually coded, and the common themes identified were used to reinforce quantitative findings and barriers limiting GBDS adoption.

III. RESULTS

The quantitative and qualitative analysis results presented below are organized according to the study objectives and supported by data extracted from the author's doctoral thesis followed subsections discussing the architects' knowledge, adoption levels, and the statistical relationships between knowledge and adoption of GBDS.

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A. Demographic and Professional Characteristics

Demographics and professional characteristics of the 344 respondents.

Table 1. Respondent Profile (N = 344)

Variable	Category	Frequency (%)
Gender	Male	77.74
	Female	22.26
Highest Qualification	B.Sc.	9.01
	M.Sc.	83.14
	PhD	7.85
Years of Experience	0-5	24.42
	6-10	31.10
	11-15	33.72
	16+	10.76

Source: Authors' field survey (2025)

Table 1 shows that the respondents were both academically advanced and professionally seasoned, ensuring that perspectives came from well-trained practitioners. This suggests that the respondents' demographic composition provided a strong foundation for reliable evaluations of Green Building Design Strategies (GBDS).

B. Sources of Knowledge of Green Building Design Strategies

Table 2. Knowledge Sources for GBDS

Source	Percentage (%)
Workshops	69.77
Online courses	64.53
On-the-job training	62.50
Tertiary education	61.34
Online research	3.19

Source: Authors' field survey (2025)

Table 2 shows that workshops and online courses are the most effective, underlining the need for ongoing professional development to meet current sustainability standards. This supports earlier research on learning through direct experience and informal sources [7][8].

C. Knowledge of Green Building Design Strategies

The aarchitects' knowledge was measured in seven main GBDS categories. Table 3 below shows RII values from 0.70 to 0.74. The architects have strong knowledge of the GBDS listed, but their knowledge varied across categories. They demonstrated strongest knowledge in sustainable materials, energy-efficient lighting, and passive cooling and ventilation which align with Lagos climate-responsive design practices. However, architects demonstrated average knowledge for solar integration, rainwater harvesting, and green roofs, with the lowest smart building management system adoption.

The results in Table 3 below show that architect's knowledge is more focused in low-cost and climate-related strategies with limited knowledge of technological systems indicating potential training gap within the profession. This finding aligns with studies of [3] and [11] on the impact of lack of knowledge about smart building management systems technology and financial constraints as key barriers in the implementation of Green Building Design Strategies in the developing countries strategies. The results indicate stronger knowledge of passive and material-based strategies and lower knowledge of technologically intensive systems.

Table 3: Relative Importance Index (RII) of Architects' Knowledge of GBDS

GBDS Category	Expert	High Knowledge	Low Knowledge	Moderate Knowledge	No Knowledge	RII
Sustainable Materials	34	204	19	79	8	0.74
Energy-efficient Lighting	18	212	29	85	-	0.73
Passive Cooling & Ventilation	24	206	26	84	4	0.73
Solar Power Integration	24	183	21	112	4	0.72
Rainwater Harvesting	24	198	28	86	8	0.72
Green Roofs and Walls	24	191	17	100	12	0.72
Smart Building Management Systems	24	189	48	75	8	0.70

Source: Authors' statistical analysis (2025)

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D. Adoption of Green Building Design Strategies in Practice

Table 3 above and Table 4 below respectively presents GBDS categories adoption pattern. The results of these adoption patterns show similar pattern indicating that architects are more likely to implement strategies they understand better in practice. Furthermore, the adoption rates suggest that architects prioritize strategies that require lower cost implications, align with Lagos' climatic conditions, supported by readily available materials or skills and minimal specialized technology. The lowest adoption remains in smart energy management systems, consistent with the low knowledge values recorded earlier.

Table 4: Adoption of Green Building Design Strategies by Respondents

GBD strategies	Count	Percent
Energy Efficiency	309	89.83%
Sustainable Materials	291	84.59%
Indoor Environmental Quality	279	81.10%
Site Selection and Planning	276	80.23%
Water Conservation	264	76.74%
Waste Management and Recycling	259	75.29%
Increased Operational and Building Maintenance Practices	258	75.00%
Smart Building Technologies	207	60.17%
Grand Total	344	100.00%

Source: Authors' statistical analysis (2025)

Table 5. RII Values for Knowledge of GBDS

Strategy	RII
Sustainable materials	0.74
Energy-efficient lighting	0.73
Passive cooling and ventilation	0.73
Solar power integration	0.72
Rainwater harvesting	0.72
Green roofs and walls	0.72
Smart Building Management Systems	0.70

Source: Authors' statistical analysis (2025)

E. Chi-Square Analysis: Influence of Knowledge on Adoption

Table 6: Chi-Square Test for Knowledge and Adoption of GBDS

Relationship Tested	**Chi-Square Value (χ^2)**	**df**	**p-Value**	**Interpretation**
Knowledge → Adoption	358.703	4	$p < 0.001$	Significant
Lack of Knowledge → Low Adoption	247.308	4	$p < 0.001$	Significant

Source: Authors' statistical analysis (2025)

A chi-square test was conducted to determine whether architects' knowledge significantly influences the adoption of GBDS. The results indicate a strong and statistically significant relationship. This results in Table 6 imply that architects with higher knowledge are more likely to adopt GBD to those lacking knowledge who are less likely to apply these strategies in architectural practice. The research findings align with [5] study which stated that sustainable design outcomes in Lagos depend heavily on awareness, skills/competencies, education and continuous professional development programme

F. Correlation Analysis

The study used Pearson correlation coefficients to assess the strength of the relationship between architects' knowledge and their adoption scores.

Table 7: Correlation Between Knowledge and Adoption

Variables	**Correlation (r)**	**p-Value**	**Interpretation**
Knowledge ↔ Adoption	0.71	$p < 0.05$	Strong positive relationship

Source: Authors' statistical analysis (2025)

Table 7 demonstrates that greater understanding is associated with greater adoption of GBDS. The evidence proves that knowledge directly influences behavior in a reliable, statistically significant way. This aligns with other research showing that expertise is the main factor in sustainable adoption [2][7].

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G. Principal Component Analysis (PCA)

PCA used GBDS variables for the study.

Table 8: PCA Component Loadings for GBDS Adoption

GBDS Variable	Component 1	Component 2	Component 3
Natural Ventilation	0.863	-	-
Orientation and Shading	0.891	-	-
Glazing Systems	0.843	-	-
Greywater Recycling	-	0.939	-
Construction Waste Reduction	-	0.900	-
Renewable/Low-Emission Materials	-	0.802	-
Smart Building Management Systems	-	-	0.744
Lighting Sensors	-	-	0.798
On-site Water Treatment	-	-	0.642

Source: PCA output from survey data (2025)

The Table 8 results identified three main elements that together explain most of the diversity in adoption patterns.

- *Component 1:* Passive and Environmental Control Strategies
  (Ventilation, shading, glazing)
- *Component 2:* Resource and Waste Management (Greywater recycling, waste reduction, renewable materials)
- *Component 3:* Technological and Renewable Systems (Smart BMS, sensors, water treatment)

These three elements show that architect's group GBDS by their knowledge, cost, and technological complexity. Lagos architects tend to use these strategies in groups rather than individually. Passive strategies are more common among those with greater knowledge, while technology-based techniques are less common due to lower familiarity. This pattern aligns with global trends, in which professionals start with basic, cost-effective solutions before moving to advanced systems [2].

H. Qualitative Insights

Interview responses emphasized:

- High cost of renewable systems
- Limited technical expertise
- Weak regulatory frameworks
- Client resistance to additional upfront cost

These themes make the research findings more important because they show common patterns in developing countries. The constraints mirror challenges reported in other African and developing contexts, where green technologies face market resistance due to cost, skill availability, and uncertain long-term performance [1][7].

IV. RESULTS

This study examined the predictive influence of architects' knowledge on the adoption of Green Building Design Strategies (GBDS) in high-rise office projects in Lagos. Using a robust dataset of 344 architects and multiple analytical techniques-including RII, chi-square tests, correlation, and PCA-the findings offer clear empirical evidence that knowledge is a decisive factor in determining the extent of GBDS adoption among Lagos architects.

A. Knowledge as the Central Determinant of GBDS Adoption

The chi-square modelling ($\chi^2 = 358.703$, $p < 0.001$) provides strong evidence of a close relationship between architects' knowledge and their likelihood of adopting Green Building Design Strategies (GBDS). A similarly strong association was found between lack of knowledge and low adoption, indicating that insufficient knowledge remains a major barrier to green design implementation ($\chi^2 = 247.308$, $p < 0.001$). These findings support long-standing arguments that knowledge is one of the most potent drivers of green design adoption in developing contexts where technological readiness and policy structures are still emerging [7][8]. The correlation analysis ($r = 0.71$) further reinforces this relationship, revealing a consistent positive link between knowledge and implementation across strategy groups. This aligns with [5], who observed that Lagos-based architects with stronger sustainability knowledge are more inclined to apply green design principles in high-rise office projects.

B. Why Sustainable Material and Passive Strategies Dominate

The highest knowledge and adoption levels were recorded for strategies such as sustainable materials (RII = 0.74), rainwater harvesting, passive cooling and ventilation, daylighting, and solar shading. These strategies have long formed the foundation of tropical architectural practice and align closely with Lagos' climatic conditions. Their dominance can be attributed to their minimal technological requirements and comparatively lower costs when measured against advanced mechanical or digital systems. As noted by [3], passive environmental strategies remain central to sustainable architecture in contexts where affordability and climatic responsiveness are critical. Lagos architects' preference for these methods therefore reflects both design heritage and practical considerations, as building owners are more willing to invest in strategies that reduce immediate costs (Adeogun, 2024).

C. Limited Adoption of Technological and Renewable Systems

In contrast, technologically intensive strategies recorded consistently lower knowledge and adoption levels. These include smart building management systems (RII = 0.70), solar photovoltaic integration, and automated environmental controls. Qualitative interviews revealed several reasons for this trend, including high initial costs, limited local expertise,

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weak enforcement of sustainability policies, low client demand, and maintenance challenges in high-density urban environments. These constraints mirror challenges identified in other African and developing contexts, where green technologies face resistance due to cost, skills gaps, and uncertainty regarding long-term performance [1][7].

D. PCA Evidence of Adoption Clusters

The Principal Component Analysis (PCA) extracted three distinct components: passive and environmental control strategies, resource and waste management strategies, and technological and renewable systems. These components indicate that architects in Lagos tend to adopt GBDS in clusters rather than individually. The strong representation of passive strategies aligns with their higher knowledge and adoption levels, while the weaker loadings of technological systems reflect lower familiarity and confidence. This pattern is consistent with global evidence showing that practitioners typically adopt low-cost and low-complexity strategies before progressing to more advanced systems [2].

E. Influence of Knowledge Sources on Adoption

Workshops (69.77%), online courses (64.53%), and on-the-job learning (62.50%) emerged as the dominant sources of GBDS knowledge, indicating that most architects rely on post-education, practice-based learning pathways to build sustainability competence. The relatively lower contribution of tertiary education (61.34%) confirms earlier findings that sustainability content within Nigerian architectural curricula remains limited or inconsistently integrated [5]. This highlights the need for stronger curricular alignment with global sustainability competencies and professional practice demands.

F. Implications for Practice and Policy

The findings highlight several practice and policy implications:

- *Professional Training:*

Professional bodies should initiate a more engaging structured professional development programs targeting technological and renewable systems would directly enhance sustainable design outcomes.

- *Regulatory Strengthening:*

Enact enforceable green building policies or codes that aligned with Lagos' climatic and economic context with incentives to encourage stakeholders.

- *Client Awareness*

From interview, many architects indicated that low client demand affects adoption. Therefore, awareness campaigns and demonstration projects could help shift perceptions and increase acceptance of green innovations.

- *Curriculum Reform*

Architecture programs should integrate sustainability more comprehensively into design studios, construction courses, and environmental control course.

V. CONCLUSION

This study findings demonstrate that architects possess moderate to high knowledge of major GBDS categories, particularly those related to sustainable materials, and energy-efficient lighting and passive cooling. Statistical analysis confirmed that knowledge plays a critical role in predicting adoption which is a strong and significant relationship between knowledge and adoption as supported by chi-square test, while the correlation analysis further reinforced this by showing a strong positive linear association between the two variables.

The PCA results provided a structured understanding of how adoption behaviour is grouped, giving a clearer picture of the hierarchy of strategies within Lagos' design culture However, the study demonstrated that architect knowledge alone does not fully explain adoption as barriers such as cost, limited training, regulatory gaps, and client perceptions all influence the extent to which GBDS are adopted in practice.

The study therefore concludes that improving knowledge must be complemented by institutional support, stronger policy frameworks, client awareness, curriculum reform and targeted professional development programmes. By providing empirical evidence from a large sample of Lagos architects, this study contributes meaningfully to sustainable design literature in Nigeria and offers practical insights for policymakers, educators, and practitioners who seek to enhance the adoption of GBDS in high-rise office developments.

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