



Effects of Weak Integration of Weather-Climatic Conditions on Building Maintenance Costs: Evidence from Nigeria

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Abstract

The study examined the effects of Weak Integration of Weather-Climatic Conditions on Building Maintenance Costs: Evidence from Nigeria. The specific objectives were to examine the effect of Water Damage on Building Maintenance Costs: Evidence from Nigeria. Evaluate the effect of Structural Issues on Building Maintenance Costs: Evidence from Nigeria. A descriptive survey design was adopted for the study. Data was collected using questionnaires designed with a five-point Likert scale. The data were modified and coded using version 28. The data were then analyzed and described using descriptive statistics, and multiple regression analysis was used to evaluate hypotheses. The result revealed that water damage has a significant positive effect on Building Maintenance Costs with a p-value of (0.037 < 0.05): Evidence from Nigeria. Structural issues have a Significant Positive effect on Building Maintenance Costs with a p-value of (0.000 < 0.05): Evidence from Nigeria. The study concluded that weak integration of weather-climatic conditions has a significant positive effect on building maintenance costs: evidence from Nigeria. The study recommended that the government should implement a requirement that building approvals (especially for public and large private developments) include a clear climate-risk and durability statement, demonstrating how rainfall intensity, humidity, flooding, heat, and wind were considered in the design.

Keywords: *Building Maintenance Costs; Weather-Climatic Conditions; Water Damage; Structural Issues*

Introduction

Weak integration of weather climatic conditions into building planning, detailing, and maintenance strategy is increasingly recognized as a quiet but persistent driver of high building maintenance costs in Nigeria. In practical terms, “weak integration” describes situations where climate realities, rainfall intensity and wind-driven rain, high humidity, temperature swings, solar radiation, dust load, flooding potential, and the growing incidence of extreme weather are insufficiently reflected in site planning, material selection, building envelope design, drainage detailing, services design, and maintenance programming. When buildings are designed and constructed as if climate exposure were stable, mild, or generic, the result is accelerated deterioration, more frequent corrective repairs, premature component replacement, and avoidable lifecycle expenditure. This is particularly consequential in Nigeria, where climatic zones range from humid coastal and rainforest belts to the dry Sahel, and where climate change is amplifying heat stress, extreme rainfall, and flooding risks in many cities (IPCC, 2023; World Bank, 2024).

Nigeria’s building stock of public facilities, private residential buildings, schools, offices, markets, and healthcare infrastructure is subject to environmental loads that are often harsher than those assumed in standard “one-size-fits-all” designs. In the coastal south, persistent humidity, heavy rainfall, saline air in some locations, and biological growth create intense deterioration pressures on timber, painted surfaces, roofing systems, and metal components. In the Middle Belt and parts of the North, intense solar radiation, high daytime temperatures, dust, and seasonal storms degrade roof integrity, external finishes, and HVAC performance. Across the country, urban flooding driven by intense rainfall, blocked drainage, and expanding impervious surfaces adds intermittent but severe moisture exposure to foundations, floor slabs, wall bases, and external electrical systems. Where buildings lack robust moisture management (overhangs, flashing, continuous damp-proofing, well-graded sites, adequate drainage falls, ventilated cavities), the maintenance burden tends to shift from planned preventive works to repeated reactive interventions, typically the most expensive and disruptive form of maintenance (ISO, 2017; FEMA, 2021).

The conceptual link between weak climate integration and maintenance cost escalation can be explained through building physics and lifecycle thinking. Climate conditions govern the rate at which materials absorb moisture, expand and contract thermally, corrode, crack, delaminate, or support mould growth. Moisture is particularly central: persistent dampness and repeated wetting-drying cycles drive paint failure, plaster debonding, timber decay, corrosion of reinforcement and steelwork, and mould contamination, each of which requires recurring repairs and sometimes major remedial works. Heat and solar radiation accelerate the ageing of polymers, sealants, roofing membranes, and specific coatings, whereas thermal movement increases the likelihood of cracks at junctions, around openings, and at interfaces between materials. When these exposures are not accounted for in detailing and specifications, failure occurs earlier than expected, accelerating replacement cycles and increasing whole-life costs (ISO, 2017; IPCC, 2023).

These issues matter more now because climate risks are no longer stationary. The latest synthesis of climate science indicates continuing increases in the frequency and intensity of extreme heat and heavy precipitation events in many regions, with cascading impacts on the built environment and infrastructure performance (IPCC, 2023). For Nigeria, this translates into higher probabilities of short-duration intense rainfall events that overwhelm roof drainage and site stormwater systems, and longer hot periods that increase cooling loads and stress building materials and services. Flooding is a precise mechanism by which weak climate integration increases maintenance costs. Post-flood repairs often involve multiple systems simultaneously, such as finishes, electrical installations, doors, furniture, and mould remediation, making the cost impact disproportionate to the duration of the event. International disaster guidance consistently shows that repeated small-to-moderate water incursions can accumulate maintenance liabilities comparable to (or exceeding) the cost of initial resilience upgrades, especially when buildings are not designed for drying and recovery (FEMA, 2021; World Bank, 2024).

In Nigeria, the cost consequences are amplified by socio-technical and market realities. First, maintenance is frequently underfunded in public buildings, leading to deferred maintenance and “failure-driven” repairs that are more costly than routine preventive actions. Second, variability in material and artistry quality, sometimes linked to procurement pressures and informal construction practices, reduces tolerance to climatic stressors, particularly moisture and heat. Third, replacement and repair costs are exposed to inflation, exchange-rate volatility, and supply constraints for certain building products, meaning that premature replacement due to climate-driven deterioration

is financially more damaging than it might be in more stable markets. The combined effect is that climate-related deterioration is not only a technical problem but also an economic one: it increases uncertainty in maintenance budgeting and can shorten the effective service life of buildings, undermining asset value and user comfort (World Bank, 2024; UN-Habitat, 2022).

Weak climate integration also has a design–maintenance feedback dimension. When climate-responsive features are absent or poorly executed, adequate roof pitch, robust gutters and downpipes, overflow scuppers, rainscreen principles, corrosion-resistant fixings, appropriately detailed window sills and drips, ventilated roof spaces, shading devices, correctly specified sealants, and maintenance teams are required to perform repetitive patchwork. Such repeated minor interventions (repainting, crack filling, leak repairs, ceiling replacements, mould cleaning) appear “manageable” in isolation but accumulate into high recurrent expenditures over time. Conversely, integrating climate conditions early through risk-informed design can shift costs from frequent corrective maintenance toward lower-frequency planned maintenance, improving cost predictability and reducing disruption (ISO, 2017; FEMA, 2021).

Statement of the Problem

In Nigeria, the integration of weather and climatic conditions into building maintenance strategies remains weak, resulting in significant financial burdens for property owners and managers. As the country grapples with diverse climatic zones, ranging from arid to tropical humid, inadequate consideration of these conditions in building maintenance planning often leads to accelerated deterioration and higher maintenance costs. Current maintenance practices frequently prioritize immediate repairs without considering the long-term effects of climatic factors, including rainfall, temperature fluctuations, humidity, and seasonal variations. This reactive approach not only neglects preventive measures tailored to specific weather conditions but also increases maintenance costs and reduces the overall lifespan of buildings. Additionally, a lack of comprehensive data on the correlation between climatic variables and building performance further complicates the issue, leading to inefficient resource allocation and increased vulnerability to weather-related damages. Thus, there is a pressing need to investigate the effects of weak integration of weather-climatic considerations on building maintenance costs in Nigeria.

Objective of the Study

The main objective of the study is to examine the effects of Weak Integration of Weather-Climatic Conditions on Building Maintenance Costs: Evidence from Nigeria. The specific objectives were to;

- i. Examine the effect of Water Damage on Building Maintenance Costs: Evidence from Nigeria.
- ii. Evaluate the effect of Structural Issues on Building Maintenance Costs: Evidence from Nigeria.

Hypotheses of the Study

- i. Water Damage has no significant effect on Building Maintenance Costs: Evidence from Nigeria.
- ii. Structural Issues have no significant effect on Building Maintenance Costs: Evidence from Nigeria.

Review of Related Literature

Conceptual Reviews

Weather-Climatic Conditions

Weak integration of weather and climate information occurs when such data are only partially, superficially, or inconsistently incorporated into planning, policymaking, research, and decision-making. Rather than being systematically integrated across all relevant stages and sectors, these efforts remain fragmented (VanBuskirk et al., 2023). The IPCC notes a failure to transform climate data into decision-relevant formats effectively and underscores the importance of climate services and boundary organizations in bridging science and practice. Without these connections, integration remains weak, leading to poorly informed decisions regarding climate risks (Jones et al., 2014). Singh et al. (2017) describe weak integration as the limited usefulness and adoption of weather and climate products across sectors, often due to mismatches in scale, lead time, format, or reliability relative to user needs.

Typically, weak integration prioritizes emergency response and post-disaster recovery over proactive adaptation and resilience, whereby climate risks are addressed only after they occur rather than prevented through systematic planning. It also occurs when weather and climate are treated as optional or secondary rather than as essential within development, risk management, and sustainability strategies. This pattern is characterized by poor coordination between meteorological and climate data and socio-economic planning, institutional processes, and sectoral policies, including agriculture, infrastructure, health, water management, disaster risk reduction, and urban development (Machingura et al., 2018). Furthermore, Machingura et al. (2018) and related commentaries point out that weak integration often neglects indigenous, cultural, and historical knowledge systems within formal climate information services. When climate data are not correctly integrated, policies and investments risk becoming maladaptive, increasing vulnerability, or missing opportunities to enhance productivity and reduce losses.

Water Damage

Water damage encompasses the physical, environmental, economic, and social harm caused by water's presence, movement, or accumulation in areas that disrupt normal operations, damage materials, or threaten safety and livelihoods (Mattsson et al., 2024). It involves various potential losses from water intrusion, leading to deterioration of materials or systems through processes such as wood rot, mold and bacterial growth, steel rusting, swelling of composite woods, damage to laminated materials such as plywood, and electrical short circuits (Wikipedia, 2025). Additionally, water damage affects property, materials, and building systems due to infiltration from sources such as plumbing leaks, appliance failures, or flooding. This can weaken materials, cause corrosion, and promote biological contamination (Grokikipedia, 2025). It occurs when water from flooding, heavy rains, storm surges, leaks, poor drainage, groundwater seepage, or coastal flooding exceeds the capacity of natural or engineered systems to manage it, resulting in damage that can be sudden, such as in flash floods, or gradual through ongoing dampness, erosion, or salinization (Sousa, 2024).

Water damage is among the most frequent and costly property issues. Various industry and policy reports indicate that non-weather-related water damage (burst pipes, appliance failures) and flood events result in high claim volumes and rising payouts. Water damage causes direct financial losses by destroying property, crops, and infrastructure, as well as indirect losses such as business interruption, reduced agricultural yields, and increased public spending on repairs and emergency responses (Fakunle et al., 2023). In many regions, water damage is exacerbated by the limited integration of weather and climate considerations into planning and infrastructure. When rainfall variability, flood frequency, and climate change projections are insufficiently accounted for, drainage systems, housing designs, and land-use plans are ill-prepared for extreme water events. Addressing water damage requires not only technical solutions but also better integration of weather and climate information into policy, infrastructure development, and risk management strategies (Mattsson et al., 2024).

Structural Issues

Structural issues are problems that weaken a building's foundation, framing, or other crucial structural components, such as cracks, bowing walls, or sagging floors, which could threaten safety and stability (Allen & Iano, 2019). These issues may also result from long-term neglect and material degradation, leading to structural deterioration through the gradual weakening of elements due to corrosion, moisture ingress, fatigue, and inadequate maintenance (Mehta & Monteiro, 2017). Furthermore, structural problems are defects, deficiencies, or failures in primary elements such as foundations, beams, and columns that jeopardize the building's stability, safety, or load-bearing capacity. Building surveys and inspection guidelines often identify structural issues through measurable signs such as crack width and pattern, vertical or horizontal displacements, differential settlement, beam deflection, and corrosion levels. These indicators are evaluated to determine severity thresholds that inform necessary actions (Bagdiya & Wadalkar, 2015).

The leading causes of structural problems fall into several related categories: design and analysis errors; material and craftsmanship defects; faulty or degraded connections and detailing; foundation and ground failures; overloading or accidental impacts; and deterioration caused by environmental exposure, aging, or poor maintenance (Almarwae, 2017). Detecting and assessing structural issues relies on routine inspections and more detailed forensic and post-disaster evaluations. FEMA's guidelines provide tiered methods for rapid safety assessments after events to determine whether a building is safe, restricted, or requires further inspection, with clear definitions of

“substantial structural damage” and criteria for temporary shoring or demolition (FEMA, 2019). Structural issues pose immediate safety hazards, such as injury or collapse, and long-term concerns regarding usability and costs. The failure of a critical member or connector can cause local failure; more commonly, deterioration reduces redundancy and resilience, increasing vulnerability under extreme loads. Prevention and mitigation strategies involve three key approaches: improving design and detailing (including redundancy and robustness), enhancing materials and construction quality control, and implementing active monitoring and maintenance (Alam et al., 2025).

Building Maintenance Costs

Building maintenance involves ensuring a structure remains in good condition by allocating resources for repairs. It encompasses actions to repair or replace building components before or after demolition, prevent failures, or restore functionality (Fahruddin et al., 2020; Edward-Alikor, 2021). Maintenance costs encompass the total expenses necessary to preserve, repair, service, and restore a building and its components, ensuring safety, efficiency, and proper use throughout its lifecycle. These costs include both routine and non-routine activities aimed at preventing deterioration, fixing defects, and extending lifespan. Expenses tend to increase under adverse environmental conditions, such as moisture, temperature fluctuations, and extreme weather, particularly when climate-responsive design is absent (Seeley, 2018).

Typical costs include preventive measures (inspections, cleaning, servicing), corrective repairs, predictive maintenance (condition-based actions), and emergency repairs after events such as flooding or structural damage. They also cover labor, materials, equipment, energy, and management costs (Ashworth, Hogg, & Higgs, 2019). Factors affecting costs include design quality, construction standards, material durability, environmental and usage conditions, aging, and climate stresses. Poor initial design and deferred maintenance, particularly when they ignore weather and climatic factors, can significantly increase long-term costs, often exceeding initial savings. Thus, building maintenance costs are essential indicators of asset performance, sustainability, and resilience in the built environment (Izvekov & Rybakova, 2020). Overall, these costs generally comprise materials, labor, site overheads, equipment or plant, head office expenses, and profit.

Theoretical Reviews

Moisture Intrusion Theory

The Moisture Intrusion Theory has no single creator; it has developed through the building science literature, particularly through the research of Lstiburek and Straube, who examined moisture transport processes and their impact on building durability. It describes how unwanted water or vapor ingress into a building envelope gradually damages materials, structural integrity, and indoor air quality. This theory is often used to explain phenomena such as water damage, structural deterioration, and building failures, particularly in areas with high rainfall, high humidity, or poor drainage (Künzel & Dewsbury, 2022).

It is based on the concept that buildings are dynamic systems constantly exposed to moisture from external and internal sources (Janssen, Scheffler, & Plagge, 2016). When design, construction, or maintenance fail to control moisture movement effectively, water can infiltrate building components, causing damage. The theory emphasizes factors such as building envelope design, material selection, artistry, maintenance, and environmental conditions. It advocates a systematic mitigation approach that focuses on source control, disruption of moisture pathways, and enhancement of drying conditions (Sawadogo et al., 2023).

Structural Deterioration Theory

Structural Deterioration Theory describes the gradual decline in the strength, stability, and usability of buildings and infrastructure resulting from environmental exposure, aging materials, mechanical loads, and inadequate maintenance. Its development is closely associated with scholars like Mehta and Monteiro Neville. The theory assumes that all structural materials have limited durability and that their performance diminishes when subjected to sustained stressors beyond the original design assumptions (Neville, 2011). Over time, structural elements undergo physical, chemical, and biological degradation that gradually reduces their load-carrying capacity.

Mehta and Monteiro (2014) point out that structural failure typically occurs gradually rather than suddenly; warning signs such as cracking, spalling, corrosion stains, deflections, and deformations often precede failure but are frequently overlooked. This slow process of structural degradation accounts for the rise in building distress and collapses, particularly in areas with weak regulation. The theory stresses the need for lifecycle-based design, regular inspections, preventive maintenance, and climate-sensitive construction. It underscores that structural durability depends not only on initial strength but also on continued management during the structure's lifespan. Addressing environmental influences and enhancing maintenance are vital for improving structural performance and preventing failures (Bertolin et al, 2013).

Empirical Reviews

Ohazurike et al. (2020) conducted a study to identify the primary causes of structural cracks in the lecture theatre, evaluate current repair methods, and recommend preventive measures to reduce future structural defects. The study aims to examine the types and nature of cracks associated with buildings, the causes of these cracks, measures that could have been taken to prevent them, and reparative measures that could be employed to remedy them. The study utilized both observational and analytical techniques. The results revealed that the building's main structural cracks were caused by differential soil settlement, faulty design, and poor artistry. Some of these are still actively cracking and hence pose a real threat of future collapse.

Mattsson et al. (2024) conducted a study to compile and review the literature on water damage in buildings in Sweden. The study aims to examine water damage in buildings, with emphasis on incidents arising from building service systems, appliances, and wet rooms (kitchens/bathrooms), and the distribution, consequences, and prevention strategies for such damage. The study utilized a mixed-method literature review. The results revealed that much of the water-damage research is embedded within broader building-defect and building-pathology literatures rather than as tightly focused, room- or appliance-specific studies.

Ojedele (2024) conducted a study to investigate the effects of water seepage and dampness on the structural integrity of buildings in Ransom Kuti Hall of Residence, University of Ibadan, Nigeria. The study aims to determine the causes and effects of water seepage and dampness on buildings. The study employed site investigation, visual assessment, strength assessment, and interpretation of results. The results revealed that various factors, including rainfall and ponding, faults in the plumbing units within the buildings, and, at times, poor construction materials, caused dampness and water seepage, and these problems can be concluded to be serious causes of building defects.

Quadri et al. (2025) conducted a study to investigate the causes and effects of cracks in structural members of buildings and to identify possible repair strategies. The study aims to explore factors contributing to structural cracks, their implications for structural members and the building as a whole, and various repair methods reported in the literature. The study employed analysis, observation, including survey insights, and visual measurements. The results revealed a range of causes, from material deficiencies to environmental influences. Repair strategies are critical for addressing the underlying causes of cracking in structural members. This will involve efforts by architects, engineers, contractors, and occupants, through educational initiatives and awareness campaigns, to enhance collective understanding of the impending problems and of prevention measures to avoid recurring building collapses.

Methodology

Study Area

The study area for this research is the Federal Republic of Nigeria, a diverse and climatically varied country located in West Africa. Nigeria lies between latitudes 4° and 14° North of the Equator and longitudes 2° and 15° East of the Greenwich Meridian, covering an estimated land area of 923,768 square kilometers. It is the most populous country in Africa, with an estimated population exceeding 220 million people, and comprises 36 states and the Federal Capital Territory, Abuja.

Nigeria's geography exhibits marked climatic heterogeneity, which influences environmental exposure and building performance across regions. The country spans several major climatic zones, including the tropical rainforest climate in the south, characterized by heavy rainfall and high humidity; the savanna belt in the central regions, with distinct wet and dry seasons; and the semi-arid climate in the far north, marked by low rainfall, high temperatures, and

frequent dust-laden Harmattan winds. Annual rainfall varies widely from over 2,500 mm in the coastal south to less than 500 mm in the northern Sahelian fringe, while temperatures typically range from 24°C to above 38°C depending on season and location. These climatic variations significantly impact the built environment. In the southern and coastal regions, persistent moisture and high humidity accelerate material degradation, corrosion of structural elements, fungal growth, and decay of finishes. In the central savanna zones, intense solar radiation and pronounced seasonal swings between wet and dry conditions contribute to thermal stresses, cracking of concrete and masonry, and deterioration of roofing and cladding materials. Meanwhile, in the northern semi-arid areas, extreme heat, ultraviolet radiation, and wind-borne sand abrasively affect external surfaces and mechanical components of buildings. Despite this wide climatic diversity, the weak integration of weather-climatic considerations into building design, construction, and maintenance planning remains a pervasive challenge in Nigeria. Integration here refers to the systematic incorporation of localized climatic data, weather-responsive design strategies, and adaptive construction practices aimed at enhancing durability and reducing life-cycle costs. In many cases, building standards and practices have not kept pace with the environmental demands of the different climatic regions, leading to premature material deterioration, structural distress, and elevated demand for maintenance interventions.

This phenomenon has important cost implications for building owners, facility managers, and policy makers. Maintenance costs escalate when buildings are not properly designed or retrofitted to accommodate prevailing weather patterns, for example, inadequate roofing systems in high-rainfall zones, poor thermal design in extreme heat areas, or insufficient protective detailing in dusty environments. These conditions result in recurrent repair cycles, shortened maintenance intervals, and higher cumulative expenditure over a building's life span. Nigeria, a country with significant climatic contrasts and a building sector grappling with integration challenges, this study aims to provide empirical evidence on how inadequate consideration of weather-climatic conditions influences building maintenance costs. The research draws on data and case studies representative of key climatic zones, offering insights that are locally grounded while bearing relevance for other regions facing similar environmental and infrastructure challenges.

Method

Creating a framework for data collection, analysis, and interpretation is the main goal of a research design. The data and features of the target population will be detailed in this study using a descriptive survey design. This method aims to gather accurate, factual, and well-structured data while providing insights into the topics being studied. Considering the size of the population that the data comes from, it is especially beneficial. The study was carried out in a few integrity-driven private sectors in the southeast of Nigeria. The effect of Weak Integration of Weather-Climatic Conditions on Building Maintenance Costs: Evidence from Nigeria. was investigated in this study using a survey research design. Appropriate instruments were used for data collection, particularly questionnaires with a five-point Likert scale. In order to collect the primary data required to examine the correlations between variables, the survey was essential. After being coded, the gathered data were loaded into SPSS for examination. The data were modified and coded to guarantee the correct recording of pertinent characteristics. The data were then analyzed and described using descriptive statistics, and multiple regression analysis was used to evaluate hypotheses. Regression statistical measurements were deemed acceptable and significant if they were below the $\alpha = 0.05$ significance level.

Data Presentation and Analysis

Data Presentation

There were 236 people in the study's population. A total of 180 surveys were completed and returned, yielding an acceptable return rate of 76.3%. To assess the data, descriptive and correlational techniques were used. Cronbach's alpha for a pilot test of 36 surveys was 0.775, indicating a reasonable degree of reliability. The tables below display the findings.

Results

Gender of Respondents

The table below illustrates that there were more females than males in the research population.

Table 1: Gender Distribution of Respondents

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|--------|-----------|---------|---------------|--------------------|
| Valid | Male | 107 | 59.4 | 59.4 | 59.4 |
| | Female | 73 | 40.6 | 40.6 | 100.0 |
| | Total | 180 | 100.0 | 100.0 | |

Table 2: Age Distribution of Respondents

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|----------------|-----------|---------|---------------|--------------------|
| Valid | Under 21 years | 8 | 4.4 | 4.4 | 4.4 |
| | 21-30 years | 109 | 60.6 | 60.6 | 65.0 |
| | 31-40 years | 49 | 27.2 | 27.2 | 92.2 |
| | Above 40 years | 14 | 7.8 | 7.8 | 100.0 |
| | Total | 180 | 100.0 | 100.0 | |

Table 3: Distribution of Respondents' Location

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---------|--------|-----------|---------|---------------|--------------------|
| Valid | Urban | 117 | 65.0 | 65.4 | 65.4 |
| | Local | 62 | 34.4 | 34.6 | 100.0 |
| | Total | 179 | 99.4 | 100.0 | |
| Missing | System | 1 | .6 | | |
| Total | | 180 | 100.0 | | |

Table 4: Distribution of Respondents' Educational Level

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|-------|----------------------|-----------|---------|---------------|--------------------|
| Valid | Below High School | 6 | 3.3 | 3.3 | 3.3 |
| | High School Graduate | 31 | 17.2 | 17.2 | 20.6 |
| | University Degree | 131 | 72.8 | 72.8 | 93.3 |
| | Master's or Higher | 12 | 6.7 | 6.7 | 100.0 |
| | Total | 180 | 100.0 | 100.0 | |

The respondents' demographic information, such as gender, age, location, and educational background, is shown in Table 2-5. According to the data, the majority of respondents roughly 107 people, or 59% are men. With about 109 responders (61%), the greatest age group is between 21 and 30 years old. Geographically speaking, 117 people (65%) of the sample come from metropolitan locations, making up the majority of participants. Finally, in terms of educational background, 131 respondents (72.8%) had a university degree, which is a significant percentage.

Multiple Regression Analysis

Table 5: Multiple Regression Table

| Model 1 | Beta | Std. Error | t-Statistic | P-value |
|--------------------|---------|------------|-------------|---------|
| Water Damage | 0.71145 | 0.41319 | 1.72184 | 0.031 |
| Structural Issues | 0.22714 | 0.03241 | 7.00833 | 0.000 |
| Constant | 2.90181 | 0.11028 | 26.3131 | 0.000 |
| Adj R ² | 0.698 | | | |

Source: SPSS version 28.0

The outcomes of the multiple regression analysis for hypotheses one and two are shown in Table 4.3 above. This analysis, which was carried out at a 5% significance level, shows that every predictor variable has a substantial impact on the outcome variables. The following hypothesis has more information.

Hypotheses of the Study

Hypothesis One

- i. **H₀₁: Water Damage has no significant effect on Building Maintenance Costs: Evidence from Nigeria.**

Regression Model of Hypothesis 1

Below is the equation for a model for Hypothesis 1

$$\text{BMC} = \beta_0 + \beta_1 \text{WD} + \varepsilon_i \quad (1)$$

BMC= Building Maintenance Costs

WD = Water Damage

Table 6: Regression Coefficient for Model 1

| Model 1 | Beta | Std. Error | t-Statistic | P-value |
|--------------------|---------|------------|-------------|---------|
| Water Damage | 0.71199 | 0.41319 | 1.72315 | 0.037 |
| Constant | 2.90181 | 0.11028 | 26.3131 | 0.000 |
| Adj R ² | 0.698 | | | |

Source: SPSS version 28.0

The modified R Square, unstandardized beta coefficient, standard error, t value, and P value are displayed in Table 6. The modified R-squared value is 0.698, which indicates that Water Damage (WD) accounts for 69.8% of the variation in Building Maintenance Costs (BMC), with the remaining variation in EG being unaccounted for by variables not included in this model. Additionally, the unstandardized beta coefficient is 0.71199, meaning that for every unit rise in Water Damage (WD), Building Maintenance Costs (BMC) will also increase by 0.71199 units. With a 95% confidence interval of less than 0.05 and a p-value of =0.037, this effect is statistically significant. Thus, it can be concluded that Water Damage (WD) has a major impact on Building Maintenance Costs (BMC) in Nigeria and that the null hypothesis is rejected.

Hypothesis Two

- ii. **H₀₁: Structural Issues have no significant effect on Building Maintenance Costs: Evidence from Nigeria.**

Regression Model of Hypothesis 2

Below is the equation for a model for Hypothesis 2

$$\text{BMC} = \beta_0 + \beta_1 \text{SI} + \varepsilon_i \quad (2)$$

BMC= Building Maintenance Costs

SI = Structural Issues

Table 7: Regression Coefficient for Model 2

| Model 1 | Beta | Std. Error | t-Statistic | P-value |
|------------------------|---------|------------|-------------|---------|
| Structural Issues (SI) | 0.22714 | 0.03241 | 7.00833 | 0.000 |
| Constant | 2.90181 | 0.11028 | 26.3131 | 0.000 |
| Adj R ² | 0.698 | | | |

Source: SPSS version 28.0

The modified R-squared, unstandardized beta coefficient, standard error, t value, and P value are displayed in Table 7. The corrected R-squared value is 0.698, which indicates that Structural Issues (SI) accounts for 69.8% of the variation in Building Maintenance Costs (BMC), with the remaining variation in BMC being unaccounted for by factors not included in this model. Furthermore, the unstandardized beta coefficient is 0.22714, meaning that for every unit rise in Structural Issues (SI), Building Maintenance Costs (BMC) will also grow by 0.22714 units. Given that the p-value is less than 0.000, or less than 0.05 at a 95% confidence range, this effect is statistically significant. Thus, it can be concluded that Structural Issues (SI) have a major impact on Building Maintenance Costs (BMC) in Nigeria and that the null hypothesis is rejected.

Discussion of Findings

The study examined the effect of Weak Integration of Weather-Climatic Conditions on Building Maintenance Costs: Evidence from Nigeria. According to Table 4.1, the Cronbach's alpha for these particular items was 0.775. This outcome shows that the items were accurate in measuring the factors we chose. According to the multiple linear regression results in Tables 4.4.1 and 4.4.2, Water Damage has a statistically significant effect on Building Maintenance Costs in Nigeria, at a 5% level of significance for hypothesis one. In contrast, the Structural Issues have a statistically significant impact on Building Maintenance Costs at the 5% level of significance, according to hypothesis two. Their individual p-values, which fall below the < 0.05 cutoff, provide the basis for this conclusion.

Conclusion

In conclusion, the evidence from Nigeria underscores that weak integration of weather-climatic conditions into building design, construction decisions, and facility management planning is not a minor oversight; it is a direct cost driver for building owners and managers. Where climatic realities such as intense rainfall, prolonged humidity, flooding events, and temperature fluctuations are treated as secondary considerations, buildings are left exposed to premature deterioration and more frequent corrective interventions. The outcome is a maintenance cycle that is largely reactive, expensive, and difficult to stabilize over time.

The findings further show that water damage has a significant positive effect on building maintenance costs. In practical terms, this means that moisture-related problems, such as roof leakages, rising damp, plumbing seepage, mold growth, material swelling, and corrosion, consistently translate into higher spending on repairs, replacements, and remedial works. In many Nigerian contexts, where heavy rains and humidity are common, inadequate weatherproofing, poor drainage detailing, and limited moisture control measures amplify the rate at which water damage accumulates, thereby escalating costs.

Likewise, structural issues also demonstrate a significant positive effect on building maintenance costs. Structural cracking, settlement, weakened foundations, and compromised load-bearing elements often require specialized inspection, skilled labour, and costly materials to rectify. Importantly, these structural problems are frequently intensified by climate stressors, such as water infiltration, erosion, and thermal expansion, especially when initial designs fail to anticipate local weather extremes or when preventive maintenance is not timed around seasonal patterns. Overall, the study points to a clear implication: reducing maintenance costs in Nigeria is not only about doing repairs more efficiently, but about embedding climate responsiveness into the full building lifecycle from design and material selection to inspection schedules and long-term maintenance planning. Prioritizing climate-informed standards, effective moisture control, and proactive structural monitoring can curb the frequency and severity of defects, ultimately shifting maintenance from crisis spending to planned, predictable investment. The study concluded that weak integration of weather-climatic conditions has a significant positive effect on building maintenance costs: evidence from Nigeria.

Recommendations

Based on the evidence that weak integration of weather–climatic conditions significantly escalates building maintenance costs in Nigeria, particularly through water damage and structural issues, the following recommendations are proposed to reduce recurring defects, curb reactive spending, and improve lifecycle performance of buildings:

- i. The government should implement a requirement that building approvals (especially for public and large private developments) include a clear climate-risk and durability statement, demonstrating how rainfall intensity, humidity, flooding, heat, and wind were considered in the design.
- ii. Since water damage shows a significant positive effect on maintenance costs, prevention should be treated as a cost-control strategy, not an aesthetic upgrade.

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