



Investigate the Effect of Building Design Deficiencies on Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis

Chukwu Chinaechetam¹, Nnamani, Onyekachi Maximus² and Ononuju Favour I.³

^{1,2} Department of Architecture, Godfrey Okoye University, Nigeria

³ Department of Architecture, State University of Medical and Applied Sciences (SUMAS), Igbo-Eno

Citations - APA

Chinaechetam, C., Nnamani, O. M. & Ononuju, F. I. (2026). Investigate the Effect of Building Design Deficiencies on Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis. *International Journal of Engineering and Environmental Sciences*, 9(1), 15-27. DOI: <https://doi.org/10.5281/zenodo.18874106>

The study investigates the effect of Building Design Deficiencies on Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis. The specific objectives of this study were to examine the effect of inadequate structural support (ISS) on Post-Occupational Maintenance Costs in Public Buildings and assess the effect of low integration of owner-occupier needs-expectations on Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis. The study adopted a descriptive survey methodology. Data collection was facilitated using a structured questionnaire. The questionnaire included both yes-or-no questions and items measured on a 5-point Likert scale. The data were analyzed using SPSS 28.0. The result revealed that Inadequate structural support (ISS) has a significant positive effect on Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis. And Low integration of owner-occupier needs-expectation has a significant positive effect on Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis. The study concluded that reducing maintenance costs in Enugu's public buildings requires a deliberate shift toward design-stage prevention: ensuring robust structural adequacy and embedding owner-occupier requirements into design decisions through systematic stakeholder engagement. The study recommended that Development control and procuring agencies should require full compliance with applicable structural codes, loading standards, and detailing requirements, particularly for public-use buildings with high occupancy and heavy usage.

ABSTRACT



Keywords: Building Design Deficiencies; Post-Occupational Maintenance Costs; Public Buildings; Enugu Metropolis

Introduction

Public buildings are, in a practical sense, the everyday infrastructure through which government services are delivered, such as education, healthcare, administration, security, and community life. In Enugu Metropolis, where public facilities are heavily used and public budgets are persistently stretched, the condition of these buildings directly affects service quality, safety, and public confidence. Yet the rising cost of keeping many public buildings operational is often addressed mainly from the maintenance end, reactive repairs, emergency interventions, and periodic renovations, rather than from the point where many long-term problems begin: building design. A growing body of research argues that decisions made during design (materials, detailing, accessibility for servicing, environmental responsiveness, and service integration) strongly shape a building's maintainability and its life-cycle cost profile (Seeley, 1987; Flanagan & Jewell, 2005; ISO 15686-1, 2011). This study, therefore, introduces a targeted inquiry into how design deficiencies contribute to post-occupational maintenance costs in public buildings within Enugu Metropolis.

Building design deficiencies can be understood as design-related shortcomings—architectural, structural, and building services that reduce performance, durability, or ease of upkeep. Typical examples include poor roof detailing and drainage design leading to recurrent water ingress; inadequate damp-proofing; inappropriate specification of finishes and cladding; insufficient ventilation; undersized plumbing and stormwater systems; poorly coordinated mechanical/electrical service routes; and limited access for inspection and repairs. Such deficiencies do not always manifest immediately; rather, they often appear as recurring defects after occupation and normal use, raising the frequency and cost of maintenance interventions over time. In life-cycle terms, the operational phase accounts for a major proportion of total cost, and design choices that ignore maintainability can shift hidden burdens onto owners and facility managers for decades (Flanagan & Jewell, 2005; Kirkham, 2005; ISO 15686-5, 2017).

The issue is particularly consequential in the humid tropical conditions typical of Enugu, where prolonged rainy seasons and moisture-related stresses can accelerate building deterioration. Research in building pathology consistently highlights moisture intrusion as a dominant trigger of defects, mold growth, timber decay, corrosion of embedded reinforcement, paint failure, ceiling collapse, and premature deterioration of finishes, especially where detailing is weak or materials are poorly matched to environmental exposure (Douglas & Ransom, 2013; Watt, 2007). Once these defects become established, they often demand repeated corrective maintenance, component replacement, and service disruptions. For public buildings, the resulting costs extend beyond direct expenditure to include downtime, reduced functionality, user dissatisfaction, and heightened safety risks, outcomes that align with broader facility management concerns about sustaining performance and value-in-use (Al-Hammad, Assaf, & Al-Shihah, 1997; Shohet, 2006).

Post-occupational maintenance costs refer to the expenses incurred after a building is occupied to keep it in (or restore it to) an acceptable operational and safety standard. These costs typically include routine servicing, preventive maintenance, corrective repairs, replacement of worn-out elements, and periodic refurbishment, often influenced by the quality of initial design and construction, as well as the maintenance strategy adopted (Seeley, 1987; Kelly, Morledge, Wilkinson, & Hunter, 2015). In public-sector contexts where funding can be irregular and maintenance is frequently deferred, minor defects linked to design weaknesses may accumulate into major failures requiring expensive corrective work, thereby reinforcing a cycle of deterioration and escalating cost (Douglas & Ransom, 2013; Shohet, 2006).

While the link between “design quality” and “maintenance burden” is intuitive, it is not always systematically measured in ways that support policy and procurement decisions. Many public projects emphasize initial capital cost and delivery speed, sometimes at the expense of whole-life value and maintainability. Yet whole-life costing standards and guidance stress that early-stage design decisions serviceability, durability, access for replacement, material performance, and adaptability, are among the strongest levers for controlling long-run operational and maintenance expenditure (ISO 15686-5, 2017; Kirkham, 2005). Moreover, facility management scholarship emphasizes the need to integrate operations/maintenance knowledge into design development to prevent avoidable defects and reduce total cost of ownership (Kelly et al., 2015; Shohet, 2006). In the Nigerian context, studies have repeatedly noted persistent maintenance challenges in public buildings and the role of design, construction quality, and management systems in building performance outcomes (Olanrewaju, 2012; Iyagba, 2005).

Against this backdrop, investigating the relationship between building design deficiencies and post-occupational maintenance costs in public buildings in Enugu Metropolis becomes both timely and practically important. First, it supports more accountable asset management by identifying which design-related deficiencies most strongly predict recurrent maintenance spending. Second, it contributes evidence that can strengthen design review processes, specification standards, and the adoption of “design for maintainability” principles such as accessible service zones, robust envelope detailing, climate-responsive material selection, and coordinated MEP integration (Kelly et al., 2015; Douglas & Ransom, 2013). Third, it can inform government agencies and consultants in structuring procurement and project delivery to reward whole-life value rather than short-term savings that later reappear as maintenance liabilities (Kirkham, 2005; ISO 15686-5, 2017).

Enugu Metropolis provides a relevant setting for this investigation because it contains diverse public building types administrative offices, educational facilities, healthcare buildings, and civic centers, operating under high occupancy demands and varying building ages. These conditions make it possible to observe recurring defect patterns, relate them to specific design features (or omissions), and connect them empirically to maintenance histories and cost profiles. Ultimately, this research is positioned to move the conversation from general complaints about “poor maintenance” toward a clearer, evidence-based understanding of how design deficiencies shape post-occupational cost burdens and how better design decisions can improve performance, extend service life, and protect scarce public resources.

Statement of the Problem

In Enugu Metropolis, the increasing demand for public buildings, coupled with budget constraints, has led to a proliferation of structures often lacking optimal design and engineering practices. These design deficiencies can significantly impact the longevity and functionality of buildings. Preliminary observations suggest that these shortcomings may correlate with heightened post-occupational maintenance costs, creating financial burdens on local governments and impacting service delivery. This study aims to investigate the relationship between building design deficiencies and the corresponding post-occupational maintenance costs in public buildings in Enugu Metropolis. Specifically, it will assess how various design factors, such as inadequate structural integrity, poor space planning, and insufficient consideration for environmental factors, contribute to maintenance challenges.

By identifying key design flaws and quantifying their impact on maintenance expenditures, this research will provide policymakers, architects, and contractors with valuable insights. This work aims to promote more effective design practices in public infrastructure, thereby minimizing long-term costs and enhancing building sustainability, ultimately improving public service provision in the region.

Objective of the Study

The main objective of this study is to investigate the effect of Building Design Deficiencies on Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis. The specific objectives of this study were to;

- i. To examine the effect of inadequate structural support (ISS) on Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis.
- ii. To assess the effect of low integration of owner-occupier needs-expectations on Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis.

Statement of Hypotheses

- i. Inadequate structural support (ISS) has no significant effect on Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis.
- ii. Low integration of owner-occupier needs-expectation has no significant effect on Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis.

Review of Related Literature

Conceptual Reviews

Inadequate Structural Support (ISS)

Building elements that offer the rigidity and strength required to endure internal forces like gravity, wind, and seismic activity, and safely transmit these forces to the ground are known as structural support. Flaws in a building's structural components that result from subpar design, construction, or materials are referred to as inadequate support (Bagdiya & Wadalkar, 2015). Notably, between 2009 and 2019, 41 out of 56 residential structures in Nigeria collapsed due to structural flaws (Odeyemi et al., 2019). Such deficiencies frequently occur during construction and pose significant hazards. Since structural components support the building, preventing faults is essential for the safety of occupants. This requires implementing thorough precautions throughout construction to avoid imperfections related to material quality. Typical structural elements include columns, earth-retaining walls, thick slabs, and beams (Tayeh et al., 2020).

Defects in these elements compromise the entire structure's stability, while over-stressing can cause faults and foundation instability, risking damage to other structural parts. Inadequate support also encompasses errors from poor design, materials, or construction. Ayodele et al. (2024) highlighted that design flaws, such as deviations from standards, weaken structural performance under loads. The construction sector recognizes inadequate support as a defect characterized by poorly designed elements like beams, columns, or foundations, which threaten stability and may lead to failure (Stryker, 2024). Alabi et al. (2024) further explain that such defects result from design or construction errors that prevent structural elements from safely carrying intended loads, with issues like weak foundations or undersized load-bearing components potentially causing collapse (Owl Griffin, 2024). According to Disu (2025), inadequate support also refers to weak bonding or insufficient layer support that may lead to failure under load.

Building Structural Addition Costs (SAC)

Fung et al. (2021) define building structural addition cost as the portion of direct costs related to structural elements like beams, columns, joints, and walls, which is proportional to the overall building cost estimate. This situates structural costs as a core subset of direct construction costs, distinguished from non-structural and other direct costs. Andrew (2023) describes Building Structural Addition Costs as the expenses directly linked to adding a structural component to a building. These include materials, labor, equipment, and other related costs tied to the physical construction process of the addition. Understanding these costs is essential for accurate budgeting, project planning, and successful completion. Building Structural Addition Costs (SAC) are the incremental expenses involved in adding or modifying load-bearing structural elements in an existing building, covering direct construction costs, professional fees, and overheads. SAC also encompasses costs incurred when new structural elements are added or when the original system is expanded or modified, including materials, labor, equipment, design revisions, supervision, and overheads needed to integrate the new components safely and in compliance with building codes.

Low Integration of Owner-Occupier Needs and Expectations (IONE)

In the context of housing, owner-occupier needs and expectations refer to the aspirations, practical necessities, aesthetic preferences, and comfort concerns that owners and inhabitants have before or during occupancy of a house. These include cultural and societal expectations of space, thermal and acoustic comfort, aesthetic pleasure, and spatial utility (Jiboye, 2012). Residents are more likely to express psychological well-being and residential satisfaction when their expectations align with the actual performance of their home; on the other hand, a mismatch usually results in dissatisfaction and demands for post-occupancy adaptation. According to Ogunbayo et al. (2018), it is a methodical assessment of user viewpoints on functional structures that include both indoor and outdoor areas. IONE is a useful technique for examining buildings after they have been constructed and occupied for an extended period, as it centers the evaluation process around the residents.

According to Ubani and Achi (2021), the owner-occupier needs and expectations in this context refer to the set of functional, psychological, cultural, and design requirements that homeowners take into account when assessing

their housing (e.g., comfort, spatial adequacy, aesthetic preferences, accessibility, sustainability, etc.), as stated by the occupants themselves or derived from behavioral and sociodemographic research. Owner-occupier needs and expectations encompass a range of functional, psychological, cultural, and environmental requirements that people hold before moving into their homes. These include layout preferences, ecological comfort, social and cultural values, and aspirations for lifestyle supports within the dwelling and neighborhood (Baker and Oppewal, 2023).

Building Design and Re-Design Cost by Owner-Occupier (RDC)

When an owner or occupier modifies a previously established architectural design or after a project's design or construction phase, RDC often refers to the extra costs, planning modifications, and resource implications that result. These expenses are closely linked to variations, lifespan cost management, and owner satisfaction and may result from design changes, change orders, retrofit interventions, or post-occupancy modifications. (Abou 2019). In the architecture, engineering, and construction (AEC) sector, building design and redesign a dynamic and expensive processes. When building owners, especially owner-occupiers, choose to change the design during or after construction, there are frequently substantial financial ramifications. The combination of technical, engineering, and architectural methods for planning, conceiving, and documenting structures is known as building design. To guarantee safety, functionality, and adherence to codes and client requirements, building design usually necessitates expert collaboration across disciplines, particularly in big or complicated projects (Ayooobi et al., 2024). Modifying an existing design plan, scope, or specification during design development, construction, or after completion is referred to as "building redesign." The relationship between building design and redesign costs, which are typically thought of as Owner-Occupier Redesign Cost. Due to owner choices and outside influences, owner redesign frequently includes upgrades, such as structural modifications or increases in energy efficiency (Balasbaneh et al., 2025).

Theoretical Review

The Marxist Housing Theory

Karl Marx and Friedrich Engels first formulated the Marxist Housing Theory in the middle of the 19th century with the intention of giving the proletariat more control over their life (Silvija et al., 2018). Examining elements including land use, rental housing, and housing conditions, this theory, which mostly concentrates on the economic aspects of human existence, has also been used in the study of housing satisfaction. Fundamentally, Marxism maintains that all people, regardless of their financial situation, should have access to good housing and works to reduce the gap between the affluent and the poor to accomplish this (Silvija et al., 2018). Marx and Engels stated that there should be less economic inequality between the various social classes, since this would reduce the discrepancies in housing comfort. This viewpoint is predicated on the idea that Marxism aims to refute and alter capitalist perspectives on housing satisfaction (Silvija et al., 2018). This capitalist housing theory was backed by academics like S. E. Barton, A. Skarburskis, and M. Moos, who claimed that in a capitalist system, the proletariat would acknowledge their disadvantage and act as change agents in society. This perspective holds that advancement is only possible when the starting conditions are less developed (Silvija et al., 2018).

Empirical Reviews

Saidu et al (2015) conducted a study on the Effect of Plan Shapes on the Cost of Institutional Buildings in Nigeria. The study aimed to assess the impact of plan shapes on the cost of multistorey institutional buildings in Nigeria. In order to determine the plan shape with the most effect, a descriptive method of analysis (bar chart) was used. The findings indicate that clients should consider the cost-effectiveness of plan shapes to avoid adverse cost consequences on their projects.

Yap and Skitmore (2017) conducted a study on design changes in Malaysian building projects. The study aimed to identify the specific causes of design changes and their implications for the cost performance of Malaysia-based building projects. A questionnaire survey of 338 clients, consultants, and contractors was then analyzed to infer and rank the identified causes and their overall effect. The research reveals that building projects in Malaysia encounter time–cost overruns of 5–20% due to design changes.

Baker and Oppewal (2023) conducted a study on the effects of floor plan representations, preferences for layout attributes differ when floor plans versus text descriptions are used to measure preferences for build-to-rent

apartments. The study employed an experimental approach. The results revealed that floor plan representations of apartments are rated higher overall than text representations; however, they also suggest that the effects of the two focal attributes on apartment preferences are larger for text than floor plan formats.

Yildiz and Turkmen (2023) conducted a study on User Satisfaction with the Configuration of Housing Interior Spaces. The study aimed to address the housing features and quality as factors affecting satisfaction with the housing unit, and to analyze and present satisfaction levels of users of housing interior spaces as per the variables of the housing ownership structure. A face-to-face survey was conducted by reaching 134 households from the Pendik district, which was selected as the study area. The results revealed that the variable of the housing ownership structure did not affect the satisfaction of the housing interior space user.

Methodology

Study Area

The study area for this research is Enugu Metropolis, the capital and principal urban center of Enugu State, located in southeastern Nigeria. Established as a major administrative and commercial center since colonial times, Enugu Metropolis comprises several contiguous urban districts, including Enugu Urban, Indigenous Layout, Independence Layout, Achara Layout, GRA, and New Haven, among others. Enugu lies approximately between latitudes 6° 25' and 6° 30' North and longitudes 7° 25' and 7° 30' East, occupying a strategic position within the southeastern highlands of Nigeria.

Enugu Metropolis experiences a tropical wet and dry climate characterized by distinct rainy (approximately April–October) and dry (November–March) seasons, with average annual rainfall exceeding 1,500 mm and mean temperatures ranging from about 23°C to 31°C. These weather conditions, notably intense rainfall episodes and humidity, interact with built environment factors, influencing material performance, structural durability, and maintenance regimes. The metropolis has a dense network of public buildings, including government offices, educational institutions, healthcare facilities, courts, and transportation terminals, which constitute significant capital investments and serve critical socio-economic functions.

Public buildings in Enugu Metropolis vary widely in age, form, function, and design quality. Many structures date from post-independence expansion phases and lack contemporary design adaptations that respond to local environmental conditions, user needs, and evolving functional requirements. Additionally, some newer public buildings have exhibited design inefficiencies, including inadequate spatial planning, poor detailing, suboptimal material selection, insufficient provision for serviceability, and non-compliance with relevant design standards. While public buildings are often planned to meet immediate functional needs, design deficiencies may not become evident until after occupation, when they manifest as operational challenges and recurring maintenance demands.

The implications of such design shortcomings are particularly pronounced in Enugu Metropolis, where constrained maintenance budgets, bureaucratic procurement processes, and competing public expenditure priorities limit the capacity for proactive building upkeep. Consequently, post-occupational maintenance costs frequently escalate, as corrective and remedial works are necessitated to address defects related to design inadequacies rather than routine wear and tear. Examples include persistent leaks due to poor roof design, frequent failure of building services stemming from inappropriate specifications, and structural distress resulting from insufficient consideration of load paths and material performance.

This study situates its investigation within the context of Enugu Metropolis's public building stock, recognizing the metropolis as a representative locus where design, environmental, institutional, and economic factors converge to influence maintenance outcomes. urban setting with its rich population of public facilities and well-documented maintenance challenges, the research aims to generate empirical evidence on how building design deficiencies affect post-occupational maintenance costs, offering insights that can inform policy, practice, and future design frameworks in Nigeria and similar developing urban environments.

Method

To investigate the Relationship Between Building Design Deficiencies and Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis, this study adopted a descriptive survey methodology. Eighteen firms were selected based on their expertise and track record in entrepreneurship, ensuring the sample included organizations with significant experience in Building Design firm. From each firm, 14 specialists were randomly chosen, encompassing a broad range of employees with relevant insights into the subject matter. This provided a total population size of 252 participants, forming the basis for sample size determination.

Using Yamane's formula, $n = \frac{N+}{1+N(e)^2}$, where $N = 252$ (population size) and $e = 0.05$ (margin of error), The calculated sample size is approximately 157. To ensure representativeness and mitigate selection bias, a simple random sampling technique was employed. This approach allowed each specialist an equal opportunity to participate, enhancing the reliability of the findings.

Data collection was facilitated using a structured questionnaire. The questionnaire included both yes-or-no questions and items measured on a 5-point Likert scale, with responses ranging from Strongly Agree (SA=5) to Strongly Disagree (D=1). This design provided a comprehensive means of capturing respondents' opinions and perspectives on the Relationship Between Building Design Deficiencies and Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis.

The data for this study were collected through questionnaires administered to a sample of 18 firms in Nigeria. Out of 252 questionnaires distributed, 217 were returned, yielding a response rate of 86.1%. The returned questionnaires were deemed valid and were used for the analysis. The study aims to meet its objectives through a comprehensive examination of the gathered data.

To provide a thorough understanding of the research, the study employs both statistical and economic analysis techniques. The statistical methods include exploratory data analysis to assess the demographic characteristics of the respondents and Chi-square tests to examine relationships between variables. These tools offer a foundation for understanding the data and its patterns.

In addition to statistical analysis, econometric methods are applied to perform empirical analysis, estimate coefficients, and test the study's hypotheses. While the demographic statistics provide insights into the respondents' profiles, econometric analysis builds upon this foundation to validate the hypotheses. All data analysis was conducted using SPSS 28.0, ensuring a robust and reliable evaluation of the research questions.

Demographic Data on the Respondents

The demographic data are shown below along with their gender, marital status, age, level of education, and career category.

Table 1: Demographic Profile of the Respondents (n = 217)

Characteristics	Frequency	Percentage
Gender		
Male	139	64%
Female	78	36%
Marital Status		
Single	98	45%
Married	119	55%
Age (Years)		
20 -29 years old	47	22%
30-39 years old	71	33%
40-49 years old	39	18%
50-59 years old	27	12%
60 years and above	33	15%
Educational Qualification		
B.sc/HND	89	41%
Masters	53	24%
PhD	29	13%
Others	46	21%
Career category		
Managers	22	10%
Senior staff	33	15%
Contract Staff	87	40%
Junior staff	75	35%

As shown in Table 1, the demographic profile of the respondents (n=217) reveals a diverse group in terms of gender, marital status, age, educational qualification, and career category. In terms of gender, the majority of respondents are male, accounting for 64% (139), while females make up 36% (78) of the sample. This distribution indicates a higher male representation among respondents. For marital status, a slightly larger proportion of respondents are married, constituting 55% (119), compared to 45% (98) who are single.

The age distribution shows that the largest group of respondents falls within the 30–39 age bracket, comprising 33% (71) of the sample. This is followed by 22% (47) aged 20–29, 18% (39) aged 40–49, 15% (33) aged 60 years and above, and 12% (27) aged 50–59. This indicates a relatively younger population with significant representation across other age groups.

In terms of educational qualification, the majority of respondents hold a B.Sc./HND, representing 41% (89) of the sample. Those with Master's degrees make up 24% (53), while 13% (29) possess a Ph.D., and 21% (46) fall under other categories of educational qualifications. The career category highlights that the largest group is contract staff, comprising 40% (87) of respondents, followed by junior staff at 35% (75), senior staff at 15% (33), and managers at 10% (22). This distribution suggests a workforce with a significant proportion in non-permanent or junior roles.

Research Question 1:

- i. How does the inadequate structural support (ISS) affect Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis?

Table 2: Response Rate for Research Hypothesis 1

Option	Frequency	Percentage
Yes	182	84%
No	35	16%
Total	217	100%

The above table shows that 84% of the total respondents think that inadequate structural support affects the post-occupational maintenance costs in Public Buildings in Enugu Metropolis, while 16% of the total respondents said that inadequate structural support does not affect the post-occupational maintenance costs in Public Buildings in Enugu Metropolis.

Research Question 2:

- ii. Does the low integration of owner-occupier needs-expectation affect Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis?

Table 3: Response Rate for Research Hypothesis 2

Option	Frequency	Percentage
Yes	168	77%
No	49	23%
Total	217	100%

The above table shows that 737% of the total respondents think that owner-occupier needs-expectation affects the Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis, while 23% of the total respondents said that the owner-occupier needs-expectation does not affect the Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis.

Testing of Hypotheses

At this point tests the hypothesis formed is either accept or reject it, and determine the extent of its reliability. In order to achieve this, we shall use the chi-square method, which is the chi-square (χ^2) test.

Hypothesis One

H₀₁: Inadequate structural support (ISS) has no significant effect on Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis.

Test Statistic

χ^2 = Chi-square

Formula = $\chi^2 = \sum (O - E)^2 / E$

O = observed frequency

E = expected frequency

Assumption:

The level of significance used is 5%, that is, 0.05.

Degree of Freedom

The degree of freedom is given as: $DF = (M-1) (N-1)$

Where:

M = rows, N = columns

$DF = (2-1) (2-1) = 1$

Table 4: Chi-Square table for hypothesis 1

Chi-Square Tests								
	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)			
Pearson Chi-Square	35.147 ^a	1	.000					
Continuity Correction	32.304	1	.000					
Likelihood Ratio	39.409	1	.000					
Fisher's Exact Test				.000		.000		
Linear-by-Linear Association	32.513	1	.000					
N of Valid Cases	217							

The value of 1 at a 0.05 significance level is = 3.45. Using the chi-square table.

Thus, the critical value is given as $\chi^2 = 3.45$.

Since the calculated value of χ^2 (35.147) is greater than the critical value (3.45), we reject the null hypothesis and accept the alternative hypothesis. We therefore conclude that inadequate structural support (ISS) has a significant effect on the Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis.

Hypothesis Two

H₀₂: Low integration of owner-occupier needs-expectation has no significant effect on Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis.

Test Statistic

$\chi^2 =$ Chi-square

Formula = $\chi^2 = \sum (O - E)^2 / E$

O = observed frequency

E = expected frequency

The level of significance used is 5%, that is, 0.05.

Degree of Freedom

The degree of freedom is given as thus: $DF = (M-1) (N-1)$

Were

M = rows N = columns

$DF = (2-1) (2-1) = 1$

Table 5: Chi-Square Table for Hypothesis 2

Chi-Square Tests								
	Value	Df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)			
Pearson Chi-Square	33.912 ^a	1	.000					
Continuity Correction ^b	24.319	1	.000					
Likelihood Ratio	36.164	1	.000					
Fisher's Exact Test				.000		.000		
Linear-by-Linear Association	23.931	1	.000					

N of Valid Cases

217

The value of 1 at a 0.05 significance level is = 3.45. Using the chi-square table. Thus, the critical value is given as $X^2 = 3.45$.

Since the calculated value of X^2 (33.912) is less than the critical value (3.45), we reject the null hypothesis and accept the alternative hypothesis. We therefore conclude that low integration of owner-occupier needs-expectation has a significant effect on the Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis.

Discussion of Results

This study investigates the effects of Building Design Deficiencies on Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis, with data analyzed using chi-square tests. The demographic analysis provides insights into the respondents' profiles, which include a sample of 217 individuals. The demographic breakdown indicates that 64% (139) of the respondents are male, and 36% (78) are female. In terms of marital status, 55% (119) are married, and 45% (98) are single. The respondents span a wide range of ages, with the majority falling between 30–39 years (33%, 71). Educationally, 41% (89) hold a B.Sc./HND, while career-wise, 40% (87) are contract staff, followed by 35% (75) in junior roles. These demographic characteristics suggest that the study draws from a balanced and diverse workforce.

For **Hypothesis One**, the analysis examined the effect of inadequate structural support (ISS) on Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis. Using a significance level of 0.05, the critical chi-square value is 3.45. The calculated chi-square value of 35.147 is significantly higher than the critical value, leading to the rejection of the null hypothesis. This result confirms that inadequate structural support has a significant impact on the Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis.

For **Hypothesis Two**, the analysis assessed the effect of the Low integration of owner-occupier needs-expectation on Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis. Similarly, at a 0.05 significance level, the critical chi-square value is 3.45. The calculated chi-square value of 33.912 exceeds the critical value, leading to the rejection of the null hypothesis. This outcome demonstrates that low integration of owner-occupier needs-expectation significantly affects Post-Occupational Maintenance Costs in Public Buildings in Enugu Metropolis.

Conclusion

In conclusion, the findings show that building design deficiencies are not merely aesthetic or procedural issues, but direct cost drivers of post-occupational maintenance in public buildings within Enugu Metropolis. The significant positive effect of inadequate structural support (ISS) on post-occupational maintenance costs indicates that weaknesses in structural framing, load distribution, detailing, and overall support strategy translate into frequent defects, accelerated deterioration, and recurrent corrective interventions after occupation. In practical terms, structural inadequacies increase the likelihood of cracks, deflections, failures around joints and service points, and other building distress signs that demand continuous repairs and, in some cases, costly remedial strengthening, thereby inflating maintenance expenditure over time.

Similarly, the significant positive effect of low integration of owner-occupier needs and expectations confirms that when public buildings are designed with limited input from end-users and facility managers, the resulting mismatch between design provisions and real operational demands leads to avoidable maintenance burdens. Poor alignment with occupant needs often manifests as inappropriate space planning, inefficient service layouts, inadequate durability choices for high-use areas, and operational “workarounds” that overstress building components. These issues trigger premature wear, repeated alterations, higher replacement rates, and persistent servicing requirements that cumulatively raise post-occupational maintenance costs.

The study concluded that reducing maintenance costs in Enugu’s public buildings requires a deliberate shift toward design-stage prevention: ensuring robust structural adequacy and embedding owner-occupier requirements into design decisions through systematic stakeholder engagement.

Recommendations

Based on the evidence that inadequate structural support (ISS) and low integration of owner-occupier needs/expectations both have a significant positive effect on post-occupational maintenance costs in public buildings in Enugu Metropolis, the following recommendations are proposed to reduce recurrent failures, curb unplanned repairs, and improve whole-life building performance:

- i. Development control and procuring agencies should require full compliance with applicable structural codes, loading standards, and detailing requirements, particularly for public-use buildings with high occupancy and heavy usage.
- ii. Material selection (reinforcement protection, concrete grade, corrosion resistance, roofing support systems) should prioritize durability in Enugu's climatic conditions, thereby lowering maintenance frequency and cost.

References

- Aladi, M., Aminuddin, F. A., Misnan, M. S., & Mustafa, N. E. (2024). Construction defects and their classifications in the construction phase of building projects: A review. *International Journal of Research and Innovation in Social Science*, 8(2).
- Ayodele, S. A., Cyril, A. A., Timothy, T. O., & Oluwafemi, T. A. (2024). Post-occupancy evaluation of students' halls of residence in Obafemi Awolowo University, Ile-Ife, Nigeria. *Academia.edu*, 39(2), 163–179.
- Ayoobi, A. W., Inceoğlu, M., & Inceoğlu, G. (2024). A next-generation holistic building design framework: A focus on integrating sustainable and vernacular design principles. *Smart Construction and Sustainable Cities*, 2, 18.
- Bagdiya, N. V., & Wadalkar, S. (2015). Review paper on construction defects. *IOSR Journal of Mechanical and Civil Engineering*, 12(2), 88–91.
- Baker, J., & Oppewal, H. (2023). The effects of floor plan representations on preferences for apartments. *Journal of Housing and the Built Environment*, 38, 727–752.
- Disu, O. (2025). Experimental study on the buildability of 3D-printed cement. *Construction and Building Materials*.
- Fung, J. F., Siamak, S., David, T. B., & Steven, L. M. (2021). The total costs of seismic retrofits: State of the art. *Earthquake Spectra*, 37(4).
- Jiboye, A. D. (2012). Post-occupancy evaluation of residential satisfaction in Lagos, Nigeria: Feedback for residential improvement. *Frontiers of Architectural Research*, 1, 236–243.
- Odeyemi, O. S., Giwa, Z. T., & Abdulwahab, R. (2019). Building collapse in Nigeria (2009–2019), causes and remedies: A review. *Journal of Science and Engineering Production*, 1(1), 122–135.
- Ogunbayo, B., Ogunbayo, I., & Oyedele, L. (2018). Post-occupancy evaluation of residential satisfaction in Lagos megacity: The case of Lekki Peninsula Scheme I. *Journal of Building Engineering*, 18, 395–406.
- Owl Griffin. (2024). *Pukkelpop tragedy: Stage collapse analysis*. Retrieved from <https://owlgriffin.com>
- Saidu, I., Alumbugu, P. O., Abdul, A. A., & Wasiu, A. O. (2015). Assessment of the effect of plan shapes on cost of institutional buildings in Nigeria. *International Journal of Science and Engineering*, 4(3), 39–50.
- Silvija, B., Kauko, V., & Jurgita, S. (2018). The concept of housing satisfaction and its measurement indicators: A systematic literature review. *International Journal of Strategic Property Management*, 22(3), 173–188.

Stryker Slev. (2024). *What are common construction defects?* Retrieved from <https://www.strykerslev.com>

Tayeh, B. A., Maqsoom, A., Aisheh, Y. I. B., Almanassra, M., Salahuddin, H., & Qureshi, M. I. (2020). Factors affecting defects occurrence in the construction stage of residential buildings in the Gaza Strip. *SN Applied Sciences*, 2, 167.

Ubani, O. J., & Achi, B. (2021). Residents' post-occupancy housing satisfaction among various dwellings. *Journal of Humanities and Social Policy*, 7(1).

Yap, J. B. H., & Skitmore, M. (2017). Investigating design changes in Malaysian building projects. *Architectural Engineering and Design Management*, 14(3), 1–21.

Yıldız, N., & Türkmen, A. (2023). A study on user satisfaction with the configuration of housing interior spaces. *Gazi University Journal of Science, Part B*, 11(1), 121–137.