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POST-OCCUPANCY PERFORMANCE OF OWNER-OCCUPIED RESIDENTIAL BUILDINGS IN KADUNA METROPOLIS: INFLUENCE OF STAKEHOLDER PARTICIPATION

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ABSTRACT

Post-Occupancy Evaluation (POE) provides a systematic approach for assessing the operational performance of residential buildings based on occupant use after completion. This study evaluates the post-occupancy performance of owner-occupied residential buildings in the Mando and Mahuta communities of Kaduna Metropolis, Nigeria, with emphasis on functional efficiency, space adequacy, building adaptability, and user satisfaction. A mixed-methods research design was adopted, combining structured household questionnaires with focus group discussions involving owner-occupiers of houses completed between 2004 and 2024. Quantitative data were analysed using descriptive statistics, while qualitative responses were used to support performance interpretation. The results indicate high levels of post-occupancy modification, reflecting the incremental nature of owner-occupied housing development. Over 96% of households reported adjustments related to internal space configuration, finishes, and service areas to improve usability. Buildings where owners were involved in design and construction decisions recorded higher functional performance and satisfaction levels (up to 78%) compared to buildings developed through unilateral decision-making (56%). Limited early-stage owner involvement was associated with increased post-occupancy alterations, indicating design–performance mismatch at the initial planning stage. Although the study is limited to two communities within Kaduna Metropolis, the findings provide practical insights applicable to similar urban residential contexts. Overall, the study demonstrates that post-occupancy performance of owner-occupied residential buildings is strongly influenced by technical and managerial decisions made during earlier housing delivery phases. The findings emphasize POE as a feedback mechanism for improving residential building design and long-term operational efficiency in urban Nigeria. Incorporating structured owner participation during early stages enhances functionality and sustainability.

Keywords: Owner-Occupied Housing, Building Engineering, Construction Technology, Post-Occupancy Evaluation, Housing Performancet, Owner Participation

INTRODUCTION

Post-occupancy evaluation (POE) provides a systematic framework for assessing the functional performance, adaptability, and user satisfaction of residential buildings by examining how design and construction decisions translate into operational outcomes after occupation. Within building engineering and housing performance research, POE is increasingly recognized as a structured feedback mechanism for evaluating how residential buildings perform in use and for informing improvements in space utilization, environmental quality, and long-term usability (Preiser *et al.*, 1988). POE enables the assessment of how technical decisions made during planning, design, and construction influence functional efficiency, spatial adequacy, and user satisfaction.

In the Nigerian context, empirical POE studies have demonstrated that occupant-based feedback provides valuable evidence of physical deficiencies affecting residential performance. For example, Ilesanmi (2010) showed that physical characteristics of public housing environments significantly influence occupant satisfaction, indicating that performance-based feedback can guide design improvements. Similarly, Jiboye (2012) reported that satisfaction indices derived from POE offer important insights into housing performance, particularly where spatial and service attributes fail to meet operational requirements. Evaluations of housing quality in Lagos estates (Nubi & Adegbemile, 2007) and studies linking satisfaction to post-occupancy modifications (Chukwuma-Uchegbu, 2025) further confirm that systematic POE can identify design–use mismatches and support improvements in residential building performance. Collectively, these studies establish POE as a performance-driven evaluation tool that links design and construction decisions to long-term usability and satisfaction in Nigerian housing.

In developing countries such as Nigeria, POE is particularly relevant because owner-occupied housing constitutes the dominant mode of residential development and is largely delivered through incremental and self-managed construction processes rather than formalized housing delivery systems. Studies on housing development in Nigeria indicate that owner-occupied dwellings evolve through successive stages of planning, construction, and occupation, during which owner decisions significantly influence spatial configuration, material selection, and overall building performance. Empirical evidence suggests that limited owner participation during early development stages often results in inefficient layouts, inadequate space provision, and functional mismatches that become evident only after occupation (Ilesanmi, 2010; Jiboye, 2012). From a building engineering perspective, such outcomes increase the need for post-occupancy modifications, thereby escalating construction costs, material consumption, and long-term maintenance demands.

Post-occupancy studies conducted in Nigerian cities have consistently demonstrated strong relationships between

building attributes such as spatial layout, room sizes, circulation efficiency, adaptability, service integration and occupant satisfaction. Ilesanmi (2010) identified deficiencies in internal space organization and service areas as major contributors to dissatisfaction in public housing estates in Lagos. Similarly, Jiboye (2012) reported that residential satisfaction in urban Nigeria is more strongly associated with functional efficiency and spatial adequacy than with aesthetic considerations alone. These findings emphasize the need to evaluate residential buildings beyond construction completion, with greater attention to operational performance. Further evidence from POE research in Nigeria indicates that inadequate consideration of owner requirements during design and construction stages often leads to frequent post-occupancy alterations, including space reconfiguration and building extensions (Ibem *et al.,* 2013). Such modifications typically represent corrective responses to design–performance mismatches and attempts to improve operational efficiency. Waziri *et al.,* (2013) similarly observed that occupant dissatisfaction is closely linked to limited building adaptability and poor alignment between design assumptions and actual household activities. Despite the expanding body of POE research, many residential buildings in Nigerian cities continue to be developed with minimal structured owner participation during early technical decision-making stages. Consequently, post-occupancy performance challenges persist, highlighting a gap in performance-driven residential development, particularly in owner-occupied housing where owners function as both project initiators and end-users.

This study therefore evaluates the post-occupancy performance of owner-occupied residential buildings in Kaduna Metropolis, Nigeria, with specific emphasis on functional efficiency, space adequacy, building adaptability, and user satisfaction. It further examines how levels of owner participation during design and construction stages influence post-occupancy performance, with the aim of generating empirical evidence to support more efficient, adaptable, and performance-driven residential building practices in urban Nigeria.

MATERIALS AND METHODS

Study Area

The study was conducted in Mando and Mahuta communities of Kaduna Metropolis, Nigeria, which are characterized by incremental owner-occupied residential development. These areas were selected because they feature diverse household structures and exhibit active participation in housing construction and post-occupancy adaptation. The communities reflect typical urban residential patterns in Nigeria, providing a suitable context for evaluating the influence of stakeholder participation on building performance and post-occupancy outcomes.

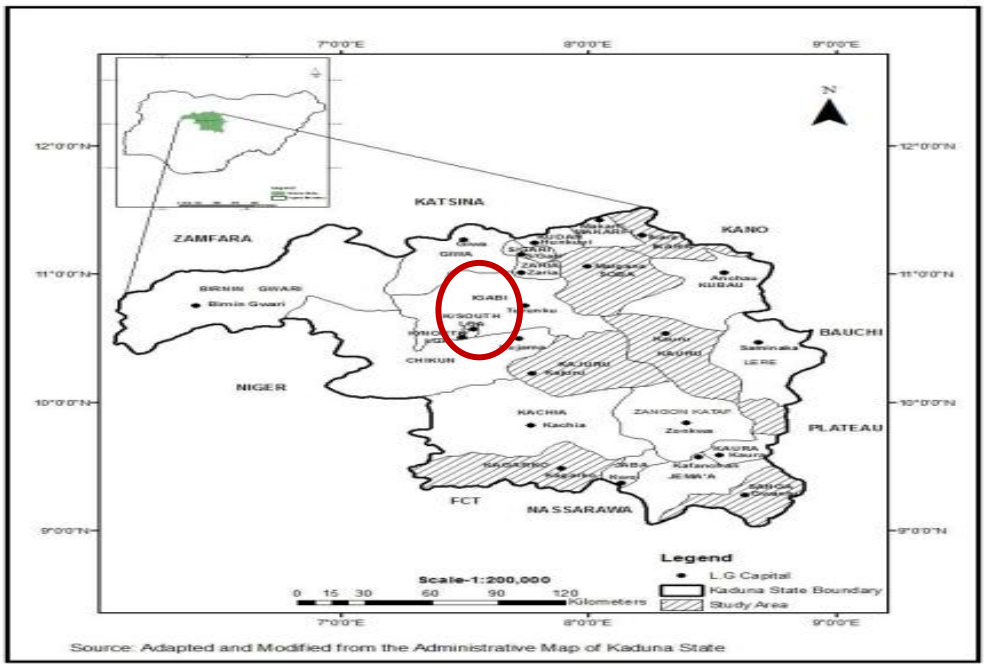

Figure 1: Position of North/ South Area of Kaduna Metropolis in Kaduna State, Nigeria

Research Design

A mixed-methods research design was employed to capture both quantitative and qualitative dimensions of post-occupancy performance. This approach allowed for the integration of objective housing performance indicators with subjective occupant experiences, enabling a comprehensive assessment of functional efficiency, space adequacy, building adaptability, and user satisfaction. The combination of survey data, focus group discussions, and observational verification ensured a thorough evaluation of post-occupancy outcomes.

Sampling Techniques

This study adopted a combination of stratified sampling and systematic probability sampling techniques in order to ensure adequate representation of the study communities and minimize selection bias. The combined approach enabled the researcher to capture variations between the communities while maintaining randomness in household selection.

Stratified Sampling Technique

The stratified sampling technique was employed to ensure balanced representation of the two study communities: Mahuta (Southern Kaduna Town) and Mando (Northern Kaduna Town). Stratification was based on geographical location, with each community treated as a distinct, non-overlapping stratum. This approach was considered appropriate because the communities differ in socio-cultural, economic, and spatial characteristics that are relevant to

occupants' participation in housing development. The study population comprised owner-occupied residential houses. Following the use of Google Maps satellite imagery and subsequent field verification (ground-trothing), 978 owner-occupied houses were identified in Mahuta and 1,000 in Mando, forming the final sampling frame.

Systematic Probability Sampling Technique

After stratification, systematic probability sampling was applied within each community to select the required households. A sampling frame was created by listing and tagging all confirmed owner-occupied houses according to their major and minor streets. A ballot method was used to randomly select the first sampling unit in each stratum, after which a sampling interval was calculated by dividing the total number of owner-occupied houses by the required sample size. Based on the calculated interval, every *nth* house was selected until the target sample size of 300 households per community was reached. During the first phase of data collection, 270 usable responses were obtained in Mahuta and 278 in Mando. However, to ensure that the predetermined sample size was fully achieved, follow-up visits were conducted and additional questionnaires were administered where necessary. This process enabled the sample to reach the required 300 respondents in each community. The analysis therefore reflects the completed sample size of 300 households per location, ensuring uniformity and ease of comparison across the study areas. Where selected respondents were unavailable or unwilling to participate, the next eligible owner-occupied house was selected in order to maintain the required sample size.

Sample Size Determination

The sample size for the study was determined using standard sample size estimation procedures based on a 95% confidence level, 5% margin of error, and a population proportion of 50%. Reference was made to established sample size determination tables and formulas, including those proposed by Krejcie & Morgan (1970). According to these guidelines, a minimum sample size of 270 households is recommended for a population of 978, while 278 households are recommended for a population of 1,000. However, to improve robustness, compensate for non-response, and enhance comparability between the two study communities, the sample size was increased to 300 households per community, resulting in a total sample size of 600 households.

Sample Size Calculation Formula by Krejcie & Morgan (1970)

$$n = \frac{x^2 * N * P(1-P)}{\left(ME^2 * (N-1)\right) + (x^2 * P(1-P))}$$

Where:

n = Sample Size

X^2 = Chi-square for the specified confidence level at 1 degree of freedom

N = Population Size

P = Population Proportion (0.5)

ME = Desired Margin of Error (expressed as a proportion)

Additionally, four focus group discussions were conducted, with 8 to 10 participants in each session, to obtain in-depth qualitative insights into household decision-making, adaptation practices, and satisfaction with housing performance.

Data Collection Instruments, Validation, Reliability

Data were collected using three complementary instruments: a structured household questionnaire, focus group discussions, and an observation checklist. The questionnaire generated quantitative data on functional efficiency, space adequacy, building adaptability, user satisfaction, and post-occupancy modifications. Focus group discussions provided qualitative insights into stakeholder participation in housing development, adaptation practices, and satisfaction with completed dwellings, while the observation checklist was used to verify spatial layouts, physical modifications, and overall building conditions.

All instruments were pilot-tested and refined for clarity and reliability. Instrument reliability was assessed using Cronbach's alpha and a test-retest approach, with analyses conducted in SPSS. The results yielded alpha coefficients of 0.864 and 0.890, exceeding the recommended threshold of 0.70 ($\alpha > 0.86$), thereby confirming a high level of internal consistency in owners' responses.

Performance Indicators

Post-occupancy performance was evaluated using five key indicators. Functional efficiency assessed the extent to which building spaces supported household activities without operational constraints. Space adequacy considered the sufficiency of room sizes and circulation areas in relation to household needs. Building adaptability examined the capacity of dwellings to accommodate modifications without major structural interventions. User satisfaction captured occupant perceptions of usability, comfort, and overall contentment with their dwelling. Post-occupancy modifications recorded physical adjustments implemented by occupants to address functional or spatial deficiencies. These indicators collectively provided a comprehensive framework for assessing building performance.

Data Analysis

Quantitative data were analyzed using SPSS software, employing descriptive statistics and Analysis of Variance (ANOVA) to examine differences in housing performance and user satisfaction between the two communities. Qualitative data from focus group discussions were analysed thematically, with particular attention to patterns of stakeholder participation, adaptation practices, and satisfaction outcomes. Triangulation of quantitative and qualitative findings ensured a robust and reliable evaluation of building performance and the influence of household participation.

Cross-Community Comparison of Residential Performance

A comparative analysis of Mahuta and Mando communities indicates both shared and location-specific patterns in post-occupancy residential performance. In both communities, owner participation during housing development was associated with improved functional efficiency and overall satisfaction. However, Mando recorded relatively higher satisfaction with spatial functionality and building services, while Mahuta exhibited a higher incidence of post-occupancy alterations, particularly in service spaces and circulation areas. These variations suggest that differences in construction practices, household size, and resource allocation may influence post-occupancy outcomes across the two communities. Despite these differences, the consistent relationship observed between owner participation and housing performance across both locations supports the reliability of the findings and demonstrates that participatory input is a critical factor influencing residential building performance within Kaduna Metropolis.

Civil Engineering Implications

The results of this study have direct implications for civil engineering practice in residential building delivery, particularly in the areas of planning, detailing, and construction management. The frequency of post-occupancy modifications observed in both communities indicates shortcomings in initial functional planning and service integration. Civil engineers involved in residential projects should therefore emphasize adequate space planning, efficient service layout, and structural provisions for future adaptability at the design stage.

The findings also highlight the need for flexible structural systems and modular service designs that can accommodate household changes without compromising structural integrity or increasing maintenance costs. Improved coordination between civil engineers, architects, and end users during the pre-construction phase can reduce avoidable alterations, enhance ability to construct, and improve life cycle performance of residential buildings.

Furthermore, the similarity of performance trends across the two communities suggests that incorporating participatory considerations into standard residential design and construction guidelines can improve building functionality and durability in comparable urban settings.

Study Limitations and Applicability

This study was limited to two owner-occupied residential communities within Kaduna Metropolis, and the findings may not be directly applicable to other regions with differing socio-economic or regulatory conditions. In addition, some data were based on occupants' perceptions, which may be subject to response bias. However, the use of multiple data collection instruments and cross-community comparison mitigated these limitations. Despite these constraints, the findings remain applicable to civil engineering-led residential developments in similar urban contexts, particularly where owner involvement and incremental housing delivery are prevalent. The study therefore provides useful empirical evidence to inform residential planning, construction practice, and post-occupancy performance evaluation in Nigeria.

Ethical Considerations

The study observed ethical standards for social and engineering research involving human subjects. Informed consent was obtained from all participants, and confidentiality and anonymity were strictly maintained throughout the research process. Participants were assured that the information they provided would be used solely for academic purposes and that their identities would remain protected.

RESULTS AND DISCUSSION

Post-occupancy assessment indicates variation in functional efficiency across the studied dwellings. Buildings where occupants participated in design and construction decisions demonstrated more efficient spatial organization, particularly in living areas, kitchens, and circulation spaces. Approximately 78% of respondents in this category reported that internal layouts adequately supported daily household activities. In contrast, only 56% of occupants in buildings developed through unilateral decision-making rated their layouts as functionally efficient. Inefficiencies were commonly associated with poor room interconnections and inadequate service-space planning, resulting in operational constraints during use.

Results show that space adequacy was closely related to household size and initial planning assumptions. In Mando, 42% of respondents reported insufficient space in core functional areas, compared to 31% in Mahuta. Reported deficiencies were most pronounced in bedrooms and kitchen areas. Dwellings that were developed with limited early-stage occupant input exhibited higher levels of perceived overcrowding and spatial inadequacy (Plate 1), necessitating post-occupancy alterations such as room extensions and internal reconfiguration.

Plate 1: Spatial Inadequacy (Extension of Living Space) Reflected in Make-Shift Outdoor Cooking by Respondent in Mando, North Metropolis. Source: Author Survey (2023)

Building adaptability emerged as a key performance attribute in owner-occupied housing. Over 96% of households reported undertaking post-occupancy modifications, reflecting the incremental nature of residential development in the study area. Common adaptations included internal partition adjustments, extension of living spaces, and changes to finishes. Buildings with flexible layouts and non-load-bearing internal walls facilitated easier modification, while rigid structural configurations constrained adaptability and increased modification costs. Statistical analysis indicated variations in satisfaction levels across development stages. Dwellings developed through collaborative participation recorded higher satisfaction ratings (up to 78%) than those developed without occupant input (56%). Dissatisfaction was linked to recurring functional issues, spatial inadequacy, and the need for repeated modifications. This indicates that satisfaction operates as a composite performance indicator reflecting multiple operational attributes.

A one-way ANOVA was conducted to examine variations in occupant satisfaction across the stages of owner-occupied house development (Table 1). The analysis yielded an F-statistic of 92.849 with a corresponding p-value of 0.000, indicating a statistically significant difference in satisfaction levels at the 5% significance level.

Table 1: One-way Analysis of Variance (One-way ANOVA)

Source of Variation	Sum of Squares	Degrees of Freedom	Mean Square	*F* Ratio
Between the means (explained by factor A)	$SSA = r\sum(\overline{X_J} - \overline{\overline{X}})^2$	$c-1$	$MSA = \frac{SSA}{c-1}$	$\frac{MSA}{MSE}$
Within the samples (error or unexplained)	$\sum\sum(\bar{X}_{LJ} - \overline{\overline{X_J}})^2$	$r-1$	$MSE = \frac{SSE}{(r-1)c}$	—
Total	$\sum\sum(\bar{X}_{LJ} - \overline{\overline{X}})^2$	$rc-1$	—	—

This finding warranted a post-hoc analysis to identify which specific stages contributed to the observed differences in satisfaction. The post-hoc results revealed that occupants who reported being "not satisfied" had the highest harmonic mean (1.82), followed by those who were "moderately satisfied" (1.55), while the lowest harmonic mean was observed among occupants who were "satisfied" (1.12) (Figure 2).

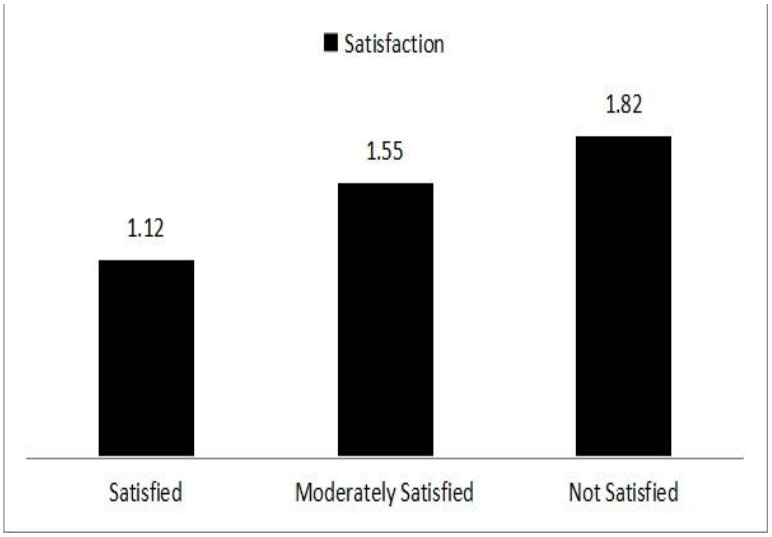

Figure 2: Mean Plots of Spouses Satisfaction Index. Source: IBM SPSS (2020)

This pattern suggests that dissatisfaction was more prevalent across the stages of architectural development, whereas full satisfaction was limited to a smaller proportion of participants. The mean plots of the satisfaction index further illustrate this trend, showing a clear hierarchy from highest to lowest participation in terms of perceived satisfaction. These results highlight critical stages in the housing development process where user needs and expectations were not fully addressed, emphasizing the importance of enhanced participatory engagement during pre-design, design, and construction phases to improve post-occupancy outcomes and overall user satisfaction.

CONCLUSION

Post-occupancy modifications provide direct evidence of the relationship between design intent, construction execution, and actual building use. In this study, a high frequency of modifications reflected mismatches between initial design provisions and household requirements, particularly in space configuration and service areas. Conversely, buildings developed with early household participation exhibited relatively lower levels of corrective alterations, confirming the role of stakeholder input in improving post-occupancy performance.

From a building engineering perspective, these findings demonstrate that early-stage participatory input directly influences operational efficiency. Efficient space utilization reduces the need for structural alterations, minimizes material waste, and enhances building usability over time. Functional efficiency, space adequacy, and adaptability were found to be closely linked to engineering design decisions such as layout planning, service-core placement, and structural flexibility.

Dwellings that incorporated flexible layouts and non-load-bearing partitions allowed easier post-occupancy adjustments with minimal structural intervention, supporting established principles of design-for-adaptability and life-cycle performance optimization.

The results further highlight the value of Post-Occupancy Evaluation (POE) as a systematic feedback mechanism for residential building delivery. Recurrent post-occupancy alterations signal the need to revisit layout standards, room sizing, and service integration based on real user requirements. For civil and building engineers, incorporating POE findings into future projects enables evidence-based improvements in design standards, material selection, and construction practices, thereby reducing long-term operational inefficiencies.

Overall, the study demonstrates that post-occupancy performance in owner-occupied housing is strongly shaped by decisions made during the pre-design, design, and construction stages rather than at completion alone. Buildings developed with active stakeholder participation exhibited higher levels of functional efficiency, adaptability, and user satisfaction, while limited early involvement was associated with inefficient layouts and frequent post-occupancy modifications. Although the study was limited to two communities within Kaduna Metropolis, the consistent patterns observed across both locations underscore the broader relevance of participatory and performance-driven residential development approaches.

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