

Development of Housing Quality Assessment Tool for Public Housing: A Case of Nigerian Police Housing Scheme in North-Central Nigeria

Santali, B.N.

Department of Urban and Regional Planning,
Federal University of Technology, Minna

Sulyman, A.O.

Department of Urban and Regional Planning,
Federal University of Technology, Minna

Musa, H.D.

Department of Urban and Regional Planning,
Federal University of Technology, Minna

Kawu, A.M.

Department of Urban and Regional Planning,
Federal University of Technology, Minna

Abstract:

Ensuring adequate housing quality for public servants, particularly law enforcement personnel, is a critical responsibility for governments. This study aims to develop a comprehensive housing quality assessment tool tailored specifically for police barracks in the North-Central region of Nigeria. Utilizing a mixed-methods approach, the research employs the Delphi technique to identify and prioritize critical factors and criteria for assessing housing quality through an iterative process involving an expert panel. The identified factors are then empirically evaluated through a survey administered to police officers residing in the barracks. Partial Least Square (PLS) analysis is employed to examine the relationships between the factors and their impact on overall housing quality, ensuring the validity and reliability of the proposed assessment tool. By integrating expert consensus and empirical validation, the study contributes to the development of a context-specific and evidence-based housing quality assessment framework, addressing the unique needs and challenges of public housing provision for law enforcement personnel in the region. The findings have implications for policymakers, housing authorities, and stakeholders in improving the living conditions and well-being of police officers and their families.

Keywords: *Housing Quality, Public Housing, Delphi Technique, Partial Least Square analysis*

I. BACKGROUND

Public housing serves as a critical component of social welfare programs, aiming to provide affordable and adequate housing for populations in need. However, ensuring the quality of public housing remains a significant challenge in many developing countries, including Nigeria. Within this context, the Nigerian Police Housing scheme represents a vital aspect of

of public housing provision, specifically targeting police personnel across the country (Adedeji, 2023). The quality of residential areas serves as a reflection of a city's planning, development control, and ultimately, the residents' quality of life (Coker et al., 2008). Housing quality (HQ) is a multifaceted concept that evolves with time and context, necessitating periodic examination of existing indicators to ensure relevance amidst changing technical, social, and economic landscapes (Sinha et al., 2017).

Scholarly literature extensively explores housing quality indices globally, including within Nigeria. For instance, Fiadzo et al. (2001) established nine metrics encompassing various aspects such as water supply, proximity to essential services, and building materials. Ibem (2012) focused on indicators like resident safety, amenities availability, and social ties. Similarly, Sengupta and Tipple (2007) considered infrastructure, sanitation, neighbourhood characteristics, and commuting distance. Hassanain et al. (2023) elaborated on housing quality assessment indicators, distinguishing between external and internal components. The former encompasses spatial configuration and amenities like parking and playgrounds, while the latter includes aspects like layout, comfort, air quality, and furnishings. However, prior studies often assessed these indicators discretely, lacking a holistic evaluation approach.

Previous studies on housing quality in Nigeria have employed diverse methodologies and indicators, resulting in variations in assessment outcomes. This underscores the need to identify key indicators collaboratively, involving housing experts and stakeholders. Additionally, previous studies often utilized equal weighting assessment methods, which may not accurately reflect the relative importance of different quality parameters. This study addresses these gaps by employing DELPHI survey to identify key housing quality indicators. Moreover, it proposes the use of Partial Least Square (PLS) and Structural Equation Modeling (SEM) to develop a comprehensive Housing Quality Assessment Tool (HQAT) tailored for institutionalized public housing. By integrating expert opinions and advanced statistical techniques, this research aims to provide a region-specific indicators and metrics of housing quality in North Central Nigeria, particularly within Nigeria Police Barracks, contributing to improved living standards for police personnel and their communities.

STUDY SITE

The study area cuts across three state capital and the Federal Capital Territory (FCT). The states capitals include, Minna, Niger State, Lafia, Nasarawa State, Ilorin, Kwara State, and Abuja Municipal Area Council (AMAC). These four areas were randomly selected from the six states of the North central region and the FCT.

II. METHODOLOGY

The research methodology combined the Delphi technique and Partial Least Square (PLS) analysis to develop a housing quality assessment tool for police barracks in the North-Central region of Nigeria. The Delphi method involved an expert panel iteratively identifying and prioritizing critical factors and criteria through controlled feedback rounds (Linstone and Turoff, 1975; Okoli and Pawlowski, 2004).

The result from the first round of assessment by 28 out of 35 invited professionals, which comprise of eleven (11) academia and seventeen (17) practitioners is presented in Table 1 and 2 for academia and practitioners respectively.

The panel assessment of the nine (9) housing components were rated to determine the importance in assessing housing quality. The result of the panel assessment was statistically analysed to determine their consensus based on three (3) defined criteria of Mean score of ≥ 7 on Scale of 1 -10, inter-quartile range (IQR) of ≤ 1.5 , and Coefficient of Variation (CV) of ≤ 0.3 . Items is considered for consensus if the achieve the panellist assessment based on the set criteria.

Subsequently, a survey was conducted with police officers residing in the barracks to evaluate the identified factors quantitatively. The survey data was analysed using PLS, a structural equation modelling technique suitable for exploratory research (Hair et al., 2011). PLS examined the relationships between factors and their impact on overall housing quality, validating the proposed assessment tool's reliability and validity (Henseler et al., 2009). This mixed-methods approach ensured a comprehensive and context-specific development of the assessment tool, grounded in expert consensus and empirical data.

III. RESULTS

Indicators of Housing Quality in North-Central Nigeria

The components and indicators obtained from reviewed literatures were subjected to two round Delphi survey to appropriately validate the relevance to measure housing quality by panel of professionals from the academia and practitioners in the built environment. The experience panel of professionals considered for the study include Architects, Builders, Estate managers, Quantity Surveyors, structural engineer, and Town Planners with verse knowledge of sustainable housing design, construction, maintenance, and marketing. The panel of professionals were asked to rate the importance of housing components on the overall quality of the houses according to their experience. The assessment was conducted in two rounds in other to achieve consensus on the assessment by the experts from the various disciplines and sector.

Delphi First Round of HQ indicators assessment by dimensions

The Delphi result shows that consensus was reached on four (4) housing components. These components are, physical, infrastructure, functionality and safety components, the four components mutually met the three (3) criteria for the academia. However, panellist consensus was not achieved by the academic professionals on the importance of housing components for Outdoor (M = 6.42), Economic (IQR = 2.0), Indoor (IQR = 2.0), Sustainability (IQR = 2.5), and User Satisfaction (IQR = 3.5) which failed to have the combined scores at the end of the first round of assessment.

Similarly, result reveals that consensus was achieved by the panel of professional practitioners on six (6) housing components, but – Outdoor (M = 6.10; CV = 0.13, IQR = 2.0), Economic (M = 6.90; IQR = 2.0), and Safety failed to consensus (M = 6.70; IQR = 2.0). The variability in the opinion of both professionals (Academia and Practitioners) is also reflected in the gap in weight assigned to the housing components. The variability in experience and teaching maybe a major factor influencing the high degree of variability in the opinion of the experts from academia. Overall, only 'physical', 'infrastructure', and 'functionality' gained consensus in round 1.

Table 1: First Round of Housing Quality Indicators Dimensions Assessment by Academia

Components	Mini	Max	Mean	Stdev	CV	IQR
Physical	8	10	8	0.63	0.08	1.5
Infrastructure	7	10	8.18	0.63	0.08	1.5
Outdoor	5	9	6.42	0.76	0.12	1.5
Functionality	7	9	7.92	0.62	0.08	1.5
Economic	6	9	7.46	0.63	0.08	2
Indoor	6	8	7.57	0.63	0.08	2
Sustainability	6	9	7.64	0.62	0.08	2.5
User's Satisfaction	8	10	8.04	0.63	0.08	3.5
Safety	9	10	8.86	0.71	0.08	1.5

Note: M = Mean score on 7 -10 Scale; CV = Coefficient of Variation; IQR = Interquartile Range; Bold = No Consensus

Table 2: First Round of Housing Quality Indicators Dimensions Assessment by the Professionals in Practice

Components	Min	Max	Mean	Stdev	CV	IQR
Physical	4	10	7.5	0.63	0.08	1
Infrastructure	5	9	8.1	0.63	0.08	1.5
Outdoor	5	7	6.1	0.82	0.13	2
Functionality	7	9	8.1	0.63	0.08	1
Economic	6	9	6.9	0.68	0.1	2
Indoor	6	9	7.6	0.62	0.08	1
Sustainability	5	8	7.6	0.62	0.08	1
User's Satisfaction	8	9	8	0.63	0.08	1
Safety	8	10	6.7	0.71	0.11	2

Note: M = Mean score on 7 -10 Scale; CV = Coefficient of Variation; IQR = Interquartile Range; Bold = No Consensus

Table 3: Second Round of Housing Quality Indicators Dimension Assessment by the Academia

Components	Min	Max	Mean	Stdev	CV	IQR
Physical	8	10	9.1	0.75	0.08	0.8
Infrastructure	7	10	8.5	0.66	0.08	1
Outdoor Perf.	5	9	7.42	0.63	0.09	1
Functionality	7	9	8.3	0.64	0.08	1
Economic	4	7	6.2	0.8	0.13	0.8
Indoor Perf.	9	10	9.3	0.78	0.08	1
Sustainability	6	9	7.2	0.65	0.09	0.8
User's Satisfaction	8	10	8.6	0.7	0.1	1
Safety	5	7	6.8	0.7	0.1	0.8

In overall, seven (7) housing components – ‘Physical characteristic’, ‘Infrastructure’, ‘Outdoor performance’, ‘Functionality’, ‘Indoor performance’, ‘Sustainability’, and ‘User’s satisfaction’—were selected by both panellists to have significance to assess housing quality in police barracks in north central zone.

Table 4: Second Round of Housing Quality Indicators Dimension Assessment by Professionals in Practice

Components	Min	Max	Mean	Stdev	CV	IQR
Physical	4	10	8.3	0.64	0.08	1
Infrastructure	5	9	8.4	0.65	0.08	1
Outdoor Perf.	5	7	7.3	0.64	0.09	0.3
Functionality	7	9	8.3	0.64	0.08	1
Economic	6	9	6.5	0.74	0.11	1
Indoor Perf.	9	10	9	0.73	0.08	1
Sustainability	5	8	7.5	0.63	0.08	1
User's Satisfaction	8	9	8.5	0.66	0.08	1
Safety	5	7	6.1	0.82	0.13	0.5

Structural model: weighting of housing quality indicators

The seven housing components obtained from the Delphi survey is model to determine the effect of on housing quality. The inter-relationships between these variables were confined to a multivariate data analysis technique called structural equation modelling (SEM) using Partial Least Square. To determine the effect of the housing components on housing quality, the structural models was assessed. The path coefficients for the model are shown in Table 5. The result reveal that the ‘Physical quality’ component has the highest contributor to housing quality with path coefficient ($\beta = 1.066, p < 0.01$), ‘indoor performance ($\beta = 0.745, p < 0.01$), ‘Sustainability ($\beta = 0.661, p < 0.01$), ‘Outdoor performance ($\beta = 0.52, p < 0.01$), ‘User’s satisfaction ($\beta = 0.377, p = 0.1$), ‘Infrastructure/Utilities ($\beta=0.355, p < 0.01$), while ‘Functionality ($\beta = 0.400, p < 0.01$).

Delphi second round of housing quality indicators assessment by dimensions

Table 3 and 4 shows the Delphi result of the second round of assessment of housing quality assessment. The result shows that consensus was reached on seven (7) out of nine (9) housing components ‘Physical characteristic’, ‘Infrastructure’, ‘Outdoor performance’, ‘Functionality’, ‘Indoor performance’, ‘Sustainability’, and ‘User’s satisfaction’— that mutually attained the three (3) criteria for both panellists. However, panellist consensus was not achieved by both the academic professionals and practitioners on ‘Economic’ (M = 6.20) and (M = 6.50), and ‘Safety’ (M = 6.20) and (M = 6.50) respectively as an important housing component due to the mean score < 7.0 on a Likert scale of 1-10 rated.

Table 5: Loadings of Dimensions of Housing Quality Indicators

Dimensions of HQ indicators	Standardized factor Loading	R ²	R ² - Adjusted
Functionality -> Housing Quality	0.400***		
Indoor Performance -> Housing Quality	0.745***		
Infrastructure/Utilities -> Housing Quality	0.355***		
Outdoor Performance -> Housing Quality	0.52***		
Physical Quality -> Housing Quality	1.066 ***		
Sustainability -> Housing Quality	0.661***		
User's Satisfaction -> Housing Quality	0.377***		
Overall		0.69	0.68

Table 6: The Effect Size of Housing Quality Indicators Dimension

Indicators	Loadings	Weight	Mean Ranking
Functionality	0.400	0.10	5 th
Indoor Performance	0.745	0.18	2 nd
Infrastructure/Utilities	0.355	0.09	6 th
Outdoor Performance	0.52	0.13	4 th
Physical Quality	1.066	0.26	1 st
Sustainability	0.661	0.16	3 rd
User's Satisfaction	0.377	0.09	6 th

In overall, the result shows that the seven (7) housing components contributed 69% ($R^2 = 0.69$) to explain the amount of variation in housing quality. The determination coefficient (R^2) is the estimate of the proportion of the dependent variable's variance over its mean that is explained by the independent variable(s). The value ($R^2 = 0.69$) indicated that a 'substantial' (> 0.67) defined by Gefen and Straub (2000) contribution was made by the housing component to achieve housing quality. The determination coefficient is a predictive Model accuracy assessment (Sheko and Braimllari, 2018). Thus, higher R^2 value describes the structural model's (Figure 2) ability to improve predictability (Muslim *et al.* 2020).

The weighting of housing components based on the weight of each component from the panellist ratings is presented in Table 6. The result shows that 'physical components', ranked 1st with 0.26; 'indoor performance (0.18)' ranked 2nd; 'Sustainability (0.16)' ranked 3rd; 'Outdoor performance (0.13)' ranked 4th; 'Functionality (0.10)' ranked 5th; while 'user's satisfaction (0.09)' and 'infrastructure/utilities (0.09)', ranked 6th respectively. To determine housing quality, the weighted housing quality indicators were aggregated in a linear combination. The mathematical model of the linear combination for housing quality indicators is therefore presented in equation 4.1.

$$HQI = (0.26 * \sum_1^{nth} PC) + (0.18 * \sum_1^{nth} IP) + (0.16 * \sum_1^{nth} SU) + (0.13 * \sum_1^{nth} OP) + (0.10 * \sum_1^{nth} FU) + (0.09 * \sum_1^{nth} IU) + (0.09 * \sum_1^{nth} US) \text{ equation 1}$$

Where HQI= Housing Quality Index; PC= Physical components; IU= Infrastructure/Utility; OP= Outdoor

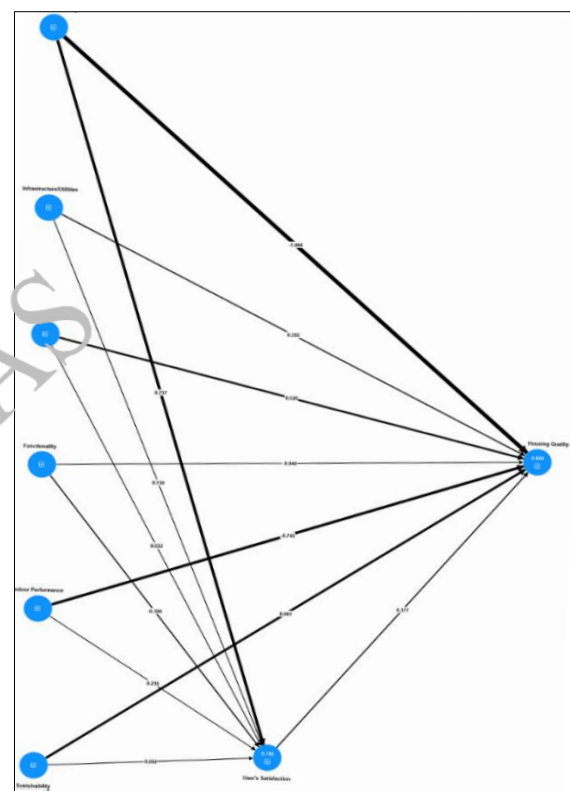


Figure 2: Structural Relationship between Indicators and Housing Quality

Aggregate housing quality of police barracks in North-Central, Nigeria

Table 7 presents the aggregate quality of housing in the police barracks. The table provides various indicators and their corresponding Housing Quality Index (HQI) along with remarks. The indicators include Physical Characteristics, Infrastructure/Utilities, Outdoor Performance, Functionality, Indoor Performance, Sustainability, and User's Satisfaction. The HQI values range from 0.52 to 0.73, and the aggregate HQI is 0.60, with corresponding remarks ranging from Fair to Good. For instance, studies on housing quality often emphasize the importance of physical characteristics, such as structural integrity, safety, and aesthetics, in influencing residents' well-being and satisfaction (Garcia *et al.*, 2019).

The HQI value of 0.57 for Physical Characteristics being rated as "Fair" suggests that there may be room for improvement in these aspects of the housing facilities.

Table 7: Aggregate Quality of Housing in the Police Barracks

Indicators	HQI	Remark
Physical charact	0.57	Fair
Infrastructure/Utilities	0.52	Fair
Outdoor perform	0.73	Good
Functionality	0.63	Good
Indoor Perform	0.59	Fair
Sustainability	0.55	Fair
User's Satisfaction	0.64	Good
Aggregate	0.60	Good

Moreover, Outdoor Performance and Functionality are important dimensions of housing quality that contribute to residents' overall satisfaction and well-being. Studies by Johnson (2020) and Lee *et al.* (2017) emphasize the impact of outdoor amenities and functional design on residents' quality of life. The HQI values of 0.73 and 0.63 for Outdoor Performance and Functionality being rated as "Good" corroborate the positive aspects of the housing facilities in these domains.

Indoor Performance and Sustainability are also critical considerations in assessing housing quality. Research by Chen and Wu (2019) underscores the significance of indoor environmental quality and sustainable features in promoting healthy and sustainable living environments. The HQI values of 0.59 and 0.55 for Indoor Performance and Sustainability being rated as "Fair" suggest areas that may require attention to enhance the overall quality of the housing facilities.

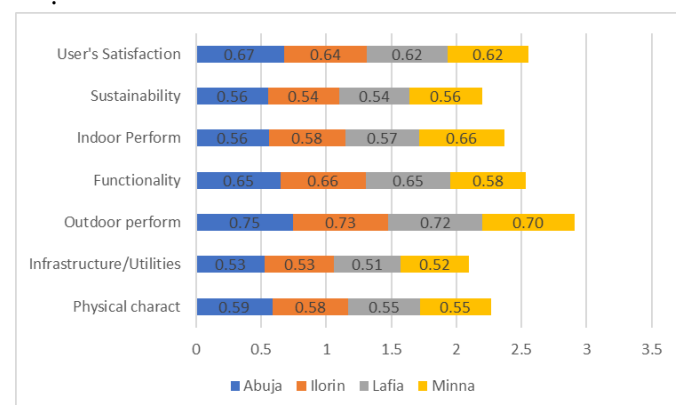


Figure 1: Housing Quality Index of the Police Barracks

IV. CONCLUSION

In this study, a housing quality assessment model was developed to evaluate the public housing, especially the police housing scheme in selected barracks in the north central Nigeria. The following conclusions were drawn from the research findings. First, among the housing components examined, 'physical quality' contributed the most to housing quality, followed by 'interior performance', 'Sustainability', 'Outdoor performance', 'User satisfaction', 'Infrastructure/Utilities', and 'Functionality'. The findings of this study underscore the importance of a holistic approach to modeling housing quality, recognizing the interplay between physical attributes and other factors. By employing advanced modeling techniques (DELPHI and PLS-SEM), the study was able to identify key determinants of housing quality and their relative impacts on housing quality. This knowledge not only enhances our theoretical understanding but also has practical implications for policymakers, urban planners, and housing developers seeking to improve housing conditions for diverse populations.

Furthermore, the methodology developed in this thesis offers a robust foundation for future research in the field of housing quality assessment. As the housing landscape evolves and new challenges emerge, the model can be adapted and expanded to address emerging trends and incorporate additional variables. In summary, the mathematical model presented in this thesis contributes to the advancement of knowledge in housing quality assessment, offering a nuanced understanding of the factors that influence the overall quality of housing. It is our hope that the insights gained from this research will inform strategies and policies aimed at promoting better housing conditions, ultimately contributing to the well-being and quality of life for individuals and communities.

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