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Public Housing Project Delivery in Nigeria: Quality versus Quantity

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ABSTRACT

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The outbreak of COVID-19 and its consequences have altered people's perceptions of the availability of high-quality housing. Nigeria, the most populous country in sub-Saharan Africa, has taken many initiatives to address its growing population's housing demands. However, considerable focus has been placed only on housing quantity at the expense of housing quality. This study aims to investigate the interplay of factors affecting the provision of high-quality public housing projects in Nigeria. The objective is to identify the factors that significantly influence project success and failure in the delivery of quality public housing projects. A descriptive survey design with 351 randomly selected households and built environment experts (BEPs) was used. A self-developed structured questionnaire was used to collect data from households, buildings, and professionals over the course of three months. The findings indicate that in several buildings, the indoor air temperature and relative humidity extend acceptable limits (for example, 28 °C and 70% RH), which can have an effect on indoor air quality. Meanwhile, responses from the BEPs revealed that in order to develop high-quality housing, adequate project financing, evaluation of suitable building materials, and project management expertise were required. The study's conclusion emphasises that considering only the number of houses required to accommodate Nigeria's growing urban population is insufficient; rather, other factors such as appropriate design for improved air quality, high-quality and appropriate building materials, adequate project financing, and project management expertise would result in the quality delivery of livable public housing in Nigeria.

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Highlights:	Contribution to the field statement:
- Nigeria's housing efforts are more focused on quantity over quality, leading to poor living conditions despite government initiatives. -Rapid urbanization in Nigeria intensifies the housing deficit, with a current need for 20 million units and N21 trillion for financing. - The quality of housing projects delivered is influenced by various factors, with project management expertise, construction materials, and project money being the most significant. - In housing project management, flexibility and financial sufficiency should be given top priority since they can support the effective completion of housing projects.	The originality of this article resides in its use of a multidimensional approach to analysing housing provision in Nigeria. It examined Nigeria's housing shortage in a way that went beyond the traditional methodology used by other researchers. It imparts to those involved in the housing industry a fresh and precise comprehension of the essential distinction between quantity and quality housing. The authors also emphasise that more research may widen the focus on the supply of high-quality housing, which has not gotten much attention in the current studies.

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1. Introduction

In accordance with Habitat (2015), a billion new houses will be needed worldwide by 2025 to accommodate growing urban populations, and it is also anticipated that the meagre resources will be pushed and squeezed by housing needs. As stated by Addo (2016), the majority of available housing is located in overcrowded regions with inadequate infrastructure, poor building quality, and insufficient environmental facilities. This highlights significant talks at national and global summits such as the 1992 Rio-de-Janeiro Summit on Environment and Development, the 1996 Istanbul Habitat Summit, the 2002 World Summit in Johannesburg, and the 2002 La Havana Summit. Meanwhile, Jacobs *et al.,* (2002) stated that decent housing is an important aspect in determining and maintaining a dynamic community.

In the world, Africa is now the continent with the least urban population, accounting for 11.3% of the global urban population. Sub-Saharan Africa is the continent's poorest region. Cities in the region are rapidly growing, with Africa's urban population predicted to reach 1.2 billion by 2050, representing a 58% urbanisation rate (Laros and Jones, 2014). African urbanisation is linked to a rise in demand for affordable housing and other ancillary urban services, which most countries cannot provide (Habitat, 2012). As a result, housing professionals have highlighted the need to reduce the rate of housing scarcity and poverty in developing cities (Riley *et al.,* 2001). Nigeria, one of the fastest-urbanizing nations in the world is currently dealing with the biggest issue brought on by urbanisation: a shortage of housing as a result of a high rate of rural-to-urban migration, which raises social, economic, environmental, and political issues.

In the view of Mbazor (2018) new research on the housing situation in Nigeria, there are currently 23 houses for every 1000 people, while there is an estimated housing shortfall of 16–17 million dwellings. The housing gap has to be filled with $140 billion, or an average of $7,551.24 per unit which is approximately ten times the proposed 2016 Nigerian budget. Access to inexpensive housing, which has largely remained an unfulfilled dream for the vast majority of people, especially the middle and lower classes, is made worse by this circumstance. Owning the huge millions of houses to house the Nigerian populace, the government has made several efforts, put up policies, regulations, and established organisations to address the huge housing deficits. However, it appears that they have just scratched the surface, especially given that the country's population has been rising at an exponential rate. Despite the efforts put in place by the Nigerian government since independence in 1960, there is still a huge housing shortage which is further exacerbated by huge low-quality housing in existence. This is due to much emphasis being placed on housing quantity at the detriment of housing quality.

The above-stated problem is brought to the fore by the introduction of COVID-19 and its consequences which have also altered people's perceptions of the availability of high-quality housing. Thus, owning to the limited quality housing provision for the Nigerian populace, Nigeria's housing shortage has gotten worse over time, despite the efforts of successive governments battling it since the country's independence (Mbazor, 2018). Hence, Habitat (2001) stated right to appropriate housing (i.e., safe, secure, healthy, accessible, and affordable) completely codified in the Habitat Agenda, with the goal of ensuring adequate shelter for all is yet to be fully accomplished in Nigeria. In order to address Nigeria's needs for quality housing and not just the quantity required, this study aims to investigate the interplay of factors affecting the completion of high-quality public housing projects in Nigeria. The objectives are to (i) identify the key variables responsible for poor public housing project delivery and (ii) evaluate how the factors significantly influence project success and failure in the delivery of quality public housing projects.

2. Literature review

One of the Sustainable Development Goals of the UN involves housing. The broader 2030 Agenda for Sustainable Development includes the 17 Sustainable Development Goals (SDGs) set forth by the United Nations. By 2030, enabling access for all to suitable, safe, and affordable housing and basic services, and upgrading slums is one of the ten objectives of Goal 11 Sustainable Cities and

Communities (Ofem and Ufot-Akpabio, 2020). Indicators of housing quality for nations that are members of the Organisation for Economic Co-operation and Development (OECD) ought to assess both the external characteristics of the home and the neighbourhood's overall environmental factors. Important elements are the facilities offered, the calibre of the building materials, the insulation, and the indoor air quality. If these are determined to be inadequate, the result will be a low-quality house, which impacts social capital, health, and the capacity to participate in social activities.

2.1. Current housing challenge posed by housing deficit in Nigeria

The severe dearth of comfortable, practical, and reasonably priced housing for the growing population is one of the most challenging socioeconomic problems facing the Nigerian nation today. Although the root causes of the issue have been identified, and copious amounts of money and intense effort have been dedicated to solving it, the problem has proven resistant to long-term fixes. As of December 2018, the nation's housing shortage is expected to be 20 million units, a 15.0% increase above January 2019 forecasts. It will need almost N21 trillion to cover the deficit. With 200 million people living in the country, the current scarcity is disturbing and of concern. There was a 7 million housing shortage in Nigeria in 1991, 12 million in 2007, 14 million in 2010, and 20 million units currently lack homes. Furthermore, just 10% of Nigerians who wish to own a home can afford to buy one or build one themselves. According to Moore (2019), models of housing distribution from industrialised nations can be applied in Nigeria with varying degrees of modification to match the nation's current political and economic realities to stop the country's developing trend of housing shortage. Table 1 shows the evolution of Nigeria's housing deficit from 1991 to the present, together with the projected amount and reasons for the shortfall.

Table 1: Trend in Nigeria's housing deficit (1991-2019) (Moore, 2019).

Year	Housing deficit	population	Cause
1991 -1993	4 -7 million	104 million	Mortgage inefficiency
2007	8 – 10 million	145 million	Slum demolition and urban migration
2013-2015	16 – 17 million	178 million	Overpopulation urban expansion and increased poverty
2017-2019	18 – 22 million	184 million	Increased poverty, overpopulation and urban migration

2.1.1 The Importance of Housing Quality over Housing Quantity

Quality housing cannot be compromised in order to meet the necessary quantity, notwithstanding Nigeria's severe housing shortage. Reducing the quality of housing in order to achieve the necessary amount results in inadequate and unhealthy housing delivery, which eventually increases the required quantity. As stated by Yoade *et al.* (2018), housing quality is defined as the total of a certain dwelling unit's physical, environmental, and satisfaction level as measured against predetermined liveability qualities at a given time. The perfect house is one that fosters personal development and the achievement of life's objectives while also offering sufficient physical and mental health care for its occupants. Meanwhile, in the opinion of Smith (1991), a house encompasses not just a physical building but also elements of community, security, and economic well-being. The internal and external architecture of a house, along with the features of its inner surroundings, are the main aspects of housing quality. It might include aspects of the community as well as ideas like environmental sustainability. It affects numerous facets of development and economic activities. Hence, it could be argued that housing provides a social status indicator, a favourable image, a sense of belonging, and social connections. The four components of housing quality are as follows, as identified by Stats NZ (2019): (i) housing habitability, or the extent to which a dwelling and its surroundings offer a physically safe, physically secure, and physically healthy environment. It is focused on a home's layout, construction, materials, and services, as well as how well it has been cared for over time. (ii) Environmental sustainability: How closely housing materials, construction methods, and design interact with the environment to preserve habitability both now and in the future. Resilience to climatic impacts, such as rising sea levels, rising temperatures, droughts, and extreme weather, is a part of this. The resilience, durability, and resource efficiency of housing are factors that contribute to its environmental sustainability. (iii) Housing functionality: the degree to which housing design, construction, and location support the unique physical, mental, emotional, cultural, and social needs of individuals, families, and communities. (iv) Social and cultural sustainability: the degree to which housing design is adaptable enough to respond to changes in the specific physical, cultural, and social needs of individuals, families, and communities, thereby supporting functionality over time.

In the view of Olotuah (2016) housing is referred to as the entirety of a residential neighbourhood, setting, or micro district, including the building's physical layout as well as all services, amenities, utilities, and equipment required for each resident's and their family's overall health and social well-being. Notably, social inclusion and stable communities are predicated on high-quality housing (Grady, 2011). Both Ebong (1983) and Onibokun (1970) concurred that basic characteristics of residential housing should be present in order to draw in potential occupants and boost utilization for the accomplishment of the intended goals for which it was provided. These standards encompass appropriate home layout, sufficient airflow, suitable lighting, a well-functioning drainage system, consistent hygiene, safety, lack of congestion, sufficient water supply, and convenient access to roads.

2.1.2 Indicators of Nigerian Housing Quality

Numerous studies have highlighted the substandard housing conditions in Nigeria. Research by Adeoye (2016) and Mbazor (2018) provides evidence of this. Specifically, evaluations in Ado-Ekiti revealed poor conditions of essential housing elements such as floors, ceilings, walls, and roofs, rendering them unfit for habitation. Yoade and colleagues (2018) also found significant issues in the houses of Ede, including severe overcrowding. Furthermore, the research points out the lack of basic amenities like electricity, potable water, and adequate sanitation facilities in the densely populated areas of Ibadan. Mbazor's (2018) further research highlights the inadequacy of housing and infrastructure in Akure. Owoeye and Omole's (2012) studies indicate that many houses are in poor condition due to the low income of the occupants, leading to insufficient kitchens, bathrooms, and toilets. Jiboye (2010) also found that in Birnin Kebbi's low-density areas, residents suffer from a lack of basic physical facilities, contributing to an unsanitary environment and inadequate housing.

In a study on the evaluation and measurement of residential housing quality, Meng and Hall (2006) stated that housing quality was the degree to which occupants found dwelling units and the surrounding environment acceptable. This included the layout and functionality of the structures, the kind of materials used, the use of the available space, the utilities and services offered in the units, and the utilities themselves. Okewole and Aribigbola (2006) supported this assertion in a study on innovations and sustainability and the conception and implementation of housing policies in Nigeria by noting that factors like a house's physical condition, the internal and external amenities and services it offers, and other elements that contribute to a conducive living environment were used to assess housing quality.

The quality of housing that is now offered in low-income residential areas is inadequate and uninhabitable, as noted by Babalola *et al.* (2020). However, if housing designers, developers, and managers focus on factors that raise housing quality adequacy, the quality of housing can be considerably improved. Additional research by Akande (2021) and Akande *et al.,* (2023) emphasised the importance of end users' indoor environmental quality and health consequences when it comes to housing provision in Nigeria. Their results support Europe’s (1988) recommendation for adequate housing, which claims that inadequate housing has three major negative effects on occupants' physical health and promotes the spread of infectious diseases. In addition to the negative effects on health, the guidelines mentioned that substandard housing also interferes with occupants' physiological needs and can lead to injuries.

It is possible to argue that the four essential components of quality housing—habitability, sustainability, functionality, and socio-cultural affordability—are absent from Nigeria's existing housing delivery system based on the literature analysis on housing provision in the country. Thus, neither the demands nor the expectations of the populace have been fully satisfied by the current housing supply, nor has it performed up to expectations. Even though the nation's economy is growing and significant resources are being allocated to the housing sector, unethical practices have adversely affected both the calibre and number of available houses. In the view of Midgley and Tang (2001), institutional frameworks and organisational structures committed to people-centred development are necessary, and also deliberate efforts on the part of state and non-state actors. Harrison (2004) argued that a wide range of actors, including professionals, bureaucrats, and other decision-makers, need to be involved in the creation, interpretation, and application of housing quality standards in order to satisfy the present housing needs. If this were not the case, the majority of the teeming populace would not have access to adequate housing, and the provision of housing would be driven either by a sense of duty or as a self-serving goal rather than by ensuring the welfare of future generations (Patel, 2016). However, this aspect has received less attention in the literature, and as a result, little is known about the part played by built environment professionals (BEPs) in the development and implementation of high-quality housing. This study is guided by a conceptual framework (illustrated and presented in Figure 1) developed by the authors.

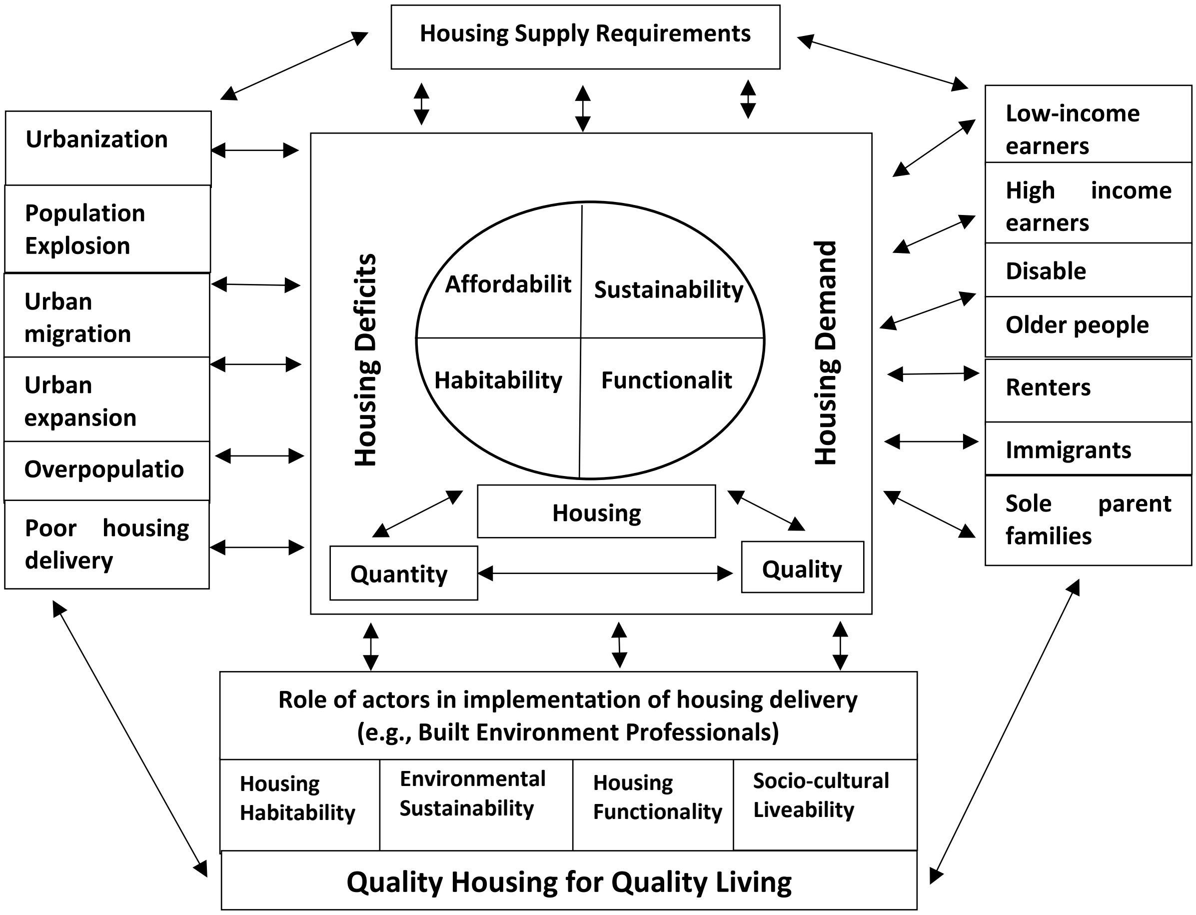

Figure 1: Conceptual Framework developed to address the factors challenging Nigeria's housing quantitative and qualitative delivery.

Note: The conceptual framework was developed to guide the appropriate data collection needed to identify and address the factors challenging Nigeria's housing quantitative and qualitative delivery.

3. Material and Methods

3.1. Study Area

This study focused on three Nigerian states: Abuja, Bauchi, and Niger (Figures 2a & 2b). Abuja was chosen being the country's federal capital territory and a city where significant housing development projects are ongoing. Meanwhile, Bauchi and Minna were selected to represent cities with lesser levels of construction activity. Abuja is located in the Federal Capital Territory (FCT) in Nigeria and has a population of 776,298 people (Ogwueleka, 2013) at 9°4′N 7°29′E. Bauchi is in Nigeria's North-East geopolitical zone geographically situated between latitudes 9° 3' and 12° 3' north and longitudes 8° 50' and 11° east.

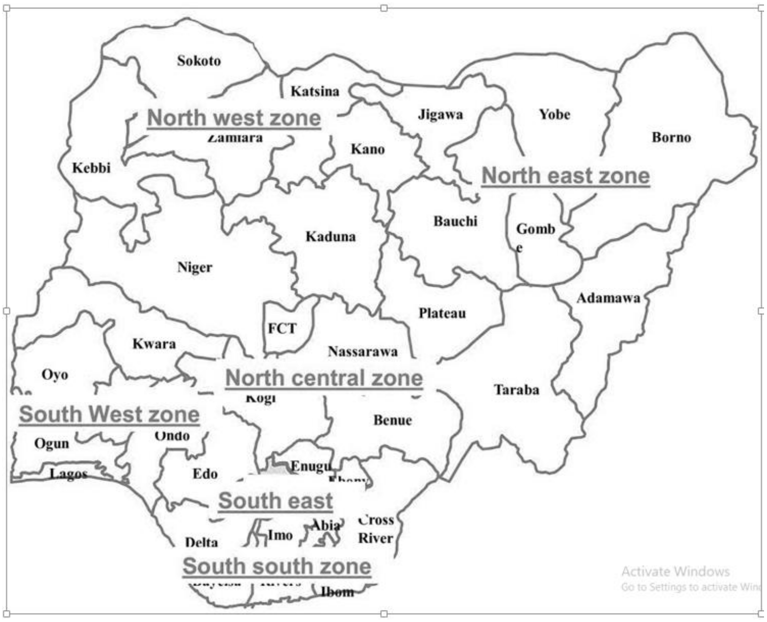

Figure 2a: Map of Nigeria showing geographical regions.

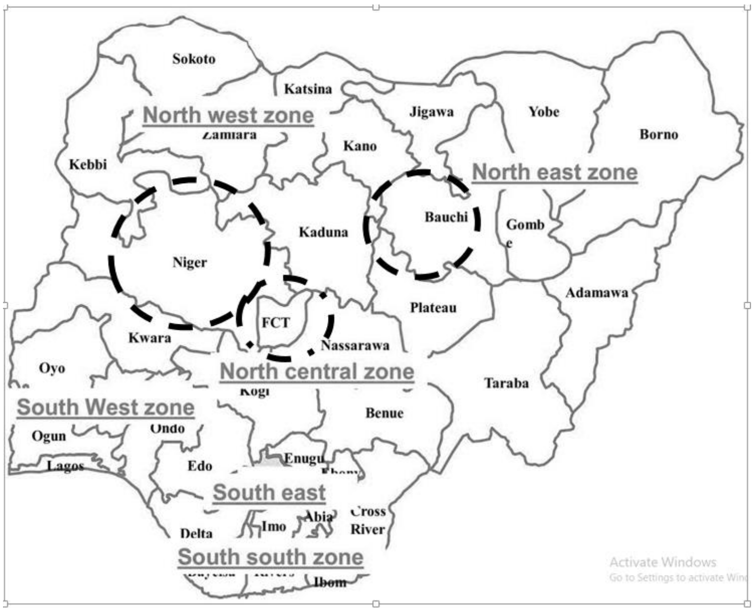

Figure 2b: Map of Nigeria showing the study area.

Niger is the largest state in Nigeria and is located in the North Central area at 10°00′N 6°00′E. Other prominent cities in Niger state include Bida, Kontagora, and Suleja. The state has an extremely warm climate, with an annual average temperature of 34 degrees Celsius. It is warm or hot all year, with only a few months that are particularly tropical. This study adopted a quantitative approach and used structured questionnaire survey to collect data from households and built environment professionals (BEPs) in the study areas as respondents.

3.1.1 Research design and instrument

A quantitative research approach and design were used in this study. This strategy was chosen because it allows for statistical analysis to quantify and generalise data (Culka, 2018). The researchers' well-designed questionnaire was utilised as the primary method of data collection because it could quickly reach a variety of audiences in the study area (Fosnacht *et al.,* 2017). The questionnaire was divided into two versions, one for households and one for BEPs involved in housing project execution, and was distributed on paper. The household questionnaire collected respondents' background information, indoor environmental data (temperature, humidity, etc.), health complaints, physical aspects of the houses (ventilation, indoor air quality, etc.), and housing quality. The BEP questionnaire also collected respondents' background information as well as additional information on the factors causing low-quality housing project delivery. These were retrieved from the extant literature using a five-point Likert scale, with 1 representing strongly disagree, 2 representing disagree, and 3 representing neutral. 4 = Agree 5 = strongly agree. Because of its high-reliability coefficients and greater possibility of eliciting responses that adequately reflect the subject matter, the Likert scale was chosen. The questionnaires for the study were piloted to allow for revisions as needed. This backs up Adu Gyamfi *et al.*'s (2022) claims that researchers can utilise a pilot survey to better understand or improve research themes, choose the most effective approach, and estimate the time and resources needed to conduct the more in-depth study version. Following pilot testing, a reliability coefficient (Cronbach's alpha) of 0.80 was determined to evaluate and ensure the data is reliable and adequate for judging the goal of the research. The achieved value was greater than the required threshold value of 0.70 to 0.95 for reliable variable performance as indicated by Tavakol and Dennick (2011).

3.1.2 Population, sampling, and response rate

From a housing stock of 2,000 and an estimated population of 3,000,000 within the study areas, 120 houses and 235 BEPs were chosen utilising purposive, stratified, and systematic selection procedures. To select houses based on their categories and distinctive qualities, purposeful sampling was used. The study employed maximum variation sampling, sometimes referred to as heterogeneous sampling, as a purposive sampling approach in order to collect a wide range of perspectives on housing quality and housing projects due to the diversity of dwelling types. Stratified sampling was used to divide the entire study area into strata due to the large number of people living in the study areas. Households from each zone or stratum were selected to participate, and each stratum was handled independently (Kusi, 2012). The sample for this investigation was taken using the sample size table that Krejcie and Morgan (1970) suggested. According to the Table, the suggested sample size for a population of over 3,000 is 314 people, which validates the sample size of 420 people used in this study. The rationale for the sample size chosen by the researcher is based on the following factors: (i) the population size with which the researchers are dealing and the amount of error that the researchers are willing to tolerate; (ii) the researchers' desire to collect sufficient data and have an estimate with a desired level of accuracy; and (iii) the study's limited available resources and the focus of the research question. Furthermore, the table proposed by Krejcie and Morgan (1970) was designed for scenarios in which the researchers aim to have 95 percent assurance of the results of the full population that had been surveyed. A total of 351 responses were gathered from this sample size (refer to Table 2), indicating an efficient response rate of 83.6% for the projected population within the study location.

Table 2: Respondents' response rate.

Location	Distribution (No) A	Returned (No) B	% of response rate (B/A*100)
Abuja	150	120	80.0%
Bauchi	120	116	96.6%
Bida	100	75	75.0%
Minna	50	40	80.0%
Total	420	351	83.6%

3.2 Data collection and data analysis

Using Mean Response Analysis (MRA) statistics, the variables in the questionnaire were analysed and ranked based on the responses of the participants. The mean score was calculated using a five-point Likert scale. The MRA formula is as follows: Mean score = (5n5 + 4n4 + 3n3 + 2n2 + 1n1)/ (n5 + n4 + n3 + n2 + n1), where n5, n4, n3, n2, n1 represent the number of respondents in relation to the five-point Likert scale used. This ranking helped determine which characteristics had the most influence on the quality of public housing developments. To establish the key predictors of factors influencing housing quality, the mean ratings were compared to the theoretical mean rating of 3.50. As a result, any mean value of 3.50 or higher indicated the manifestation of an influencing factor on housing quality, whilst mean values less than 3.50 indicated the expression of no influence. Based on the findings of the two surveys, the analysis used factor analysis, descriptive analysis, and inferential statistics. Version 20 of the Statistical Package for the Social Sciences (SPSS) was utilised for data analysis. A Pearson's correlation test with p=0.05 was utilised to ascertain whether there was a significant relationship between the observed variables. Moreover, the ideal inter-item correlation mean (factor loadings) should fall between 0.2 and 0.4 in terms of factor dependability. In this study, a value of at least 0.3 was applied (Pallant, 2020).

4. Results

Men made up the majority of survey participants (65.8%) in the household survey. For a Nigerian home with an average of four family members, the plurality (47.6%) of them reported a monthly income of less than N20,000 ($50), or about $1.25 per day. Kerosene (0.7%), firewood (24.6%), charcoal (2.6%), or a mix of the three (14%), are used in about 50% of homes. The relative humidity (RH) and temperature inside vary from 29% to 82% and 22°C to 40°C, respectively, exceeding the ASHRAE standard. Three important conclusions on window types, building orientation, and indoor air quality were also reached for dwelling design. The results show a correlation between the type of window, indoor air quality, poor building orientation, and the frequency of health complaints among the occupants of the homes under investigation. The household survey's findings suggested a potential connection between the major building orientation and the frequency of the illnesses that respondents reported having. The kind of window in the respondents' bedrooms and their response to the incidence of the prevalent disease in the homes were cross-tabulated in order to investigate the relationship between the type of window in the bedroom and the prevalence of the diseases indicated. Only the prevalence of specific illnesses (such as malaria, measles, and tuberculosis) was shown to be significantly correlated with the types of windows in the respondents' bedrooms. Because more houses lacked adequate ventilation, the majority of them were reported to have poor indoor air quality. This might be the result of improperly installed or insufficient windows, which prevent the building's interior from receiving the necessary amount of airflow to replace its utilised air. The demographic data for the BEPs is displayed in Table 3. The data indicates that individuals holding a Master's degree (36.3%) surpass those with a Bachelor's degree (23.9%) and an HND (19.5%).

Table 3: Summary of background profile of the BEPs respondents (n=235).

Characteristics	Percentage	Characteristics	Percentage
Level of Education		Area of Specialization	
GCE O/Level	.9	Architecture	36.0
OND	7.1	Building	10.5
HND	19.5	Engineering	21.1
Bachelor Degree	23.9	Estate Management	8.8
Master's Degree	36.3	Quantity Surveying	7.9
Doctorate Degree	8.8	Project Management	6.1
Others	3.5	Others	9.6
Professional Association		Years of Experience	
Association of Project Managers	13.5	1 - 5yrs	28.1
Nigeria Institute of Architects	30.8	6 - 10yrs	34.2
Nigeria Institute of Quantity Surveys	5.8	11 - 15yrs	18.4
Nigeria Institute of Management	8.7	15- 19yrs	12.3
Others	41.3	20yrs and above	7.0
Average Number of Building Projects Handled Over the Last 5yrs		Cost of Building Projects Managed Over the Last 5yrs in Nigeria Naira	
1 - 5yrs	27.7	1 - 5 million	18.8
6 - 10yrs	39.3	6 - 10 million	17.9
11 - 15yrs	17.9	11 - 15 million	15.2
15- 19yrs	5.4	15- 19 million	7.1
20yrs and above	9.8	20Million and above	41.1
Course Taken in Project Management		Knowledge of Project Planning Techniques	
Yes	74.0	Yes	82.6
No	26.0	No	17.4

The percentage of respondents with a PhD was just 8.8%, and the percentage with an Ordinary National Diploma (OND) was much lower at 7.1%. The overwhelming majority of responders appear to be educated based on the data. In addition, Table 3 demonstrates that the majority of respondents (36%) were project managers (6.1%), engineers (21.1%), builders (10.5%), estate managers (8.8%), quantity surveyors (7.9%), and architects. This implies that professionals working in the built environment can benefit from the research. The fact that 71.9% of these respondents have worked for a company for more than five years shows how entrenched their careers are. This suggests that they have enough expertise to offer a meaningful response. It was concluded that the respondents are professionally and experience-wise well-equipped to offer reasonable insight into the topic under investigation based on the results of the background information provided by the respondents. Furthermore, Table 3 shows that 30.8% of respondents are members of the Nigeria Institute of Architects, which is followed by the Nigeria Institute of Management (8.7%), the Association of Project Managers (13.5%), and the Nigeria Institute of Quantity Surveys (5.8%).

4.1. Extent of project funding influence on the quality of public housing projects

Based on mean evaluations, Table 4 arranges the degree of project financial influence on the quality of public housing complexes. Based on a one-sample t-test value of 3.5, the results indicate that the breadth of project finance was deemed statistically significant ($p = 0.05$). For the project, the average fundraising influence score varied from 4.06 to 3.51. "Cost of funding the project" (mean = 4.06; SD = 0.80; $t(119) = 7.69$; $p = 0.00 < 0.05$) was the highest-ranked factor in relation to the level of project funding influence. Other factors included "adequacy of finances for the project" (mean = 3.51; SD = 0.62; $t(119) = 0.29$; $p = 0.76$). Based on the mean score, a threshold of 3.50 was used to determine the most significant impact of project finance on the project's quality. These consist of the following: "adequacy of finances for the project" (mean = 3.51; SD =

0.62; t (119) =0.29; p = 0.76), "cost of funding the project" (mean = 4.06; SD = 0.80; t (119) =7.69; p = 0.00), and "source of finance for the project" (mean = 3.77; SD = 0.81; t (119) =3.69; p = 0.00). The cost and the source of money are the only two project funding variables that have an impact on the project's quality.

Table 4: Extent of project funding influence on quality of the public housing projects.

S/N	Project funding	MS	*SD*	t-value (μ = 3.5)	*df*	Sig. (2-tailed)	R
PF1	Cost of funds for the housing project	4.06	0.80	7.69	119	0.00*	1
PF2	Source of finance for the housing project	3.77	0.81	3.69	119	0.00*	2
PF3	Adequacy of finances for the housing project	3.51	0.62	0.29	119	0.76*	3

Note: SD = Standard Deviation; R = Rank; Sig. = Level of significance; MS = Mean score. The higher the mean score the greater the extent of project funding influence on the quality of public housing projects; df = degrees of freedom, *Significant at the 95 per cent level (p < 0.05).

4.1.1 Extent of construction materials' influence on the quality of public housing project

The level of influence that construction materials have on the quality of public housing projects was evaluated by mean scores in Table 5. A one-sample t-test value of 3.5 reveals that the extent of construction materials is statistically significant (p = 0.05) according to respondents. The mean score for the building materials varied from 3.82 to 3.40. From the highest ranked "Quality of materials for the public housing project" (mean = 3.82; SD = 0.68; t (119) =5.22; p = 0.00 < 0.05) to the lowest ranked "Source of materials for the project" (mean = 3.40; SD = 0.75; t (119) =-1.33; p = 0.18), there was a range in the impact of construction materials on project quality. Based on the mean score, a threshold of 3.50 was used to determine the most important impact of building materials on project quality. The variables "Cost of materials for the project" (mean = 3.52; SD = 0.87; t (119) =0.312; p = 0.00), "Quality of materials for the public housing project" (mean = 3.82; SD = 0.68; t (119) =5.22; p = 0.00), and "Source of materials for the project" (mean = 3.40; SD = 0.75; t (119) =-1.33; p = 0.18) are related to the project. The quality of the project is only impacted by one of the material factors, namely the quality of the materials.

Table 5: The extent of construction materials influence the quality of the public housing projects.

S/N	Construction materials	MS	*SD*	t-value (μ = 3.5)	*df*	Sig. (2-tailed)	R
CM3	Quality of materials for the housing project	3.82	0.68	5.22	119	0.00*	1
CM2	Cost of materials for the housing project	3.52	0.87	0.31	119	0.75	2
CM1	Source of materials for housing	3.40	0.75	-1.33	119	0.718	3

Note: SD = Standard Deviation; R = Rank; Sig. = Level of significance; MS = Mean score

4.1.2 Factors responsible for poor quality housing project delivery

Several requirements must be met by the acquired data before factor analysis can be performed. The Kaiser-Meyer-Olkin (KMO) metric, for instance, classifies sample adequacy as follows: KMO 0.5 - 0.7 is considered bad; KMO 0.7 - 0.8 is considered acceptable; KMO 0.8 - 0.9 is considered great; and KMO > 0.9 is considered fantastic. This experiment yielded a KMO of 0.879 (Table 6), which is considered excellent as it is higher than the recommended value of 0.6 (Kaiser, 1970).

Table 6: Correlation Matrix of Factors responsible for public building project failure.

Correlation	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16	X17	X18	X19	X20	X21	X22	X23
X1	1																						
X2	.667	1																					
X3	.607	.494	1																				
X4	.798	.428	.428	1																			
X5	.596	.491	.455	.442	1																		
X6	.748	.440	.403	.356	.513	1																	
X7	.600	.517	.477	.537	.391	.493	1																
X8	.540	.469	.432	.423	.300	.651	.464	1															
X9	.626	.490	.341	.461	.565	.621	.418	.514	1														
X10	.400	.474	.358	.358	.365	.353	.325	.456	.388	1													
X11	.582	.425	.490	.415	.319	.300	.466	.498	.447	.625	1												
X12	.486	.683	.492	.430	.374	.427	.447	.476	.356	.372	.499	1											
X13	.671	.647	.549	.403	.397	.333	.453	.457	.448	.430	.574	.578	1										
X14	.450	.393	.357	.472	.443	.378	.515	.316	.332	.307	.398	.419	.444	1									
X15	.548	.365	.359	.427	.409	.356	.367	.485	.376	.490	.505	.430	.611	.366	1								
X16	.513	.440	.451	.372	.468	.444	.467	.400	.324	.482	.580	.564	.593	.340	.591	1							
X17	.644	.516	.359	.300	.494	.501	.375	.445	.341	.313	.423	.584	.551	.390	.571	.570	1						
X18	.484	.516	.489	.422	.453	.444	.486	.364	.340	.358	.305	.482	.533	.561	.382	.403	.470	1					
X19	.584	.413	.423	.424	.515	.476	.357	.499	.380	.546	.337	.506	.486	.488	.467	.380	.524	.529	1				
X20	.489	.407	.359	.435	.544	.461	.318	.373	.356	.331	.375	.386	.365	.322	.460	.477	.326	.514	.523	1			
X21	.713	.450	357	.377	.346	.506	.555	.380	.348	.307	.490	.545	.589	.342	.384	.489	.504	.459	.424	.493	1		
X22	.549	.316	.495	.510	.460	.477	.410	.359	.324	.654	.439	.407	.432	.369	.530	.457	.411	.449	.502	.550	.563	1	
X23	.452	.337	.338	.372	.490	-.439	.450	.539	.450	.539	.425	.394	.435	.315	.309	.355	.542	.325	.406	.457	.373	.561	1

Likewise, Bartlett's Test of Sphericity (BTS) (Bartlett, 1954), which assesses the suitability of the correlations between variables, is also passed by the data used in this investigation. The BTS verified the factorability of the correlation matrix and attained statistical significance (P-value = 0.001). Therefore, using the findings from the respondents' evaluations, the correlation matrix was investigated as a suggested default for factor extraction, as indicated in Table 6. This discovery is the basis for determining the elements crucial to the completion of housing projects in Nigeria. Principal components analysis (PCA) and factor analysis are the two methods of factor analysis that might be used for the research. Stevens (2012) states that although factor analysis and PCA often yield similar results, PCA is preferred because of its ease of use. Consequently, the PCA was applied in this study. But before PCA, the suitability of the data for factor analysis was assessed, and a look at the correlation matrix showed that there were coefficients of 0.3 and higher. To determine if the measurement data was adequate to verify and validate the factor analysis, the Meyer-Olkin (KMO) test and Bartlett's sphericity test were employed. Given that the test values for the KMO test range from 0 to 1, findings above 0.7 are necessary in order to give EFA (Hair *et al.*, 2006). There may be sufficient correlations between the variables to continue the investigation, according to a statistically significant Bartlett test (p = 0.05) (Pallant, 2020).

By focusing the explanatory power on the first factor—that is, identifying the primary components of the data—Principal Components Analysis (PCA) was utilised to extract factors. The screen test, parallel analysis, and Kaiser's criterion were used to figure out how many factors should be retained. One of the most widely used methods is Kaiser's criterion, also known as the eigenvalue rule, which essentially sets aside elements with an eigenvalue of 1.0 or higher and other factors for additional research. Using this method, factors with an eigenvalue of 1.0 or higher are kept for additional analysis. Of the twenty-three components, four had eigenvalues larger than one, according to the PCA. 42.728%, 7.867%, 7.655%, and 4.868% of the variance are explained by this, which also represents -42.728%, -7.867%, 7.655%, and 4.868% of the variance. This inquiry also used Catell's scree test. To do this, the eigenvalues of each element must be plotted, and the plot must be examined to determine the point at which the form of the curve becomes horizontal. Any factor(s) beyond the elbow or break in the plot, according to Catell (1966), should be assessed since they will primarily account for the variance in the data set. After the third component, there is a definite discontinuity, as seen by the Scree plot (Figure 3). The Catell's scree test resulted in the retention of three components for additional study. This confirmed the findings of the Parallel Analysis, which showed three components with eigenvalues larger than the matching criterion values for an identically sized data matrix generated at random.

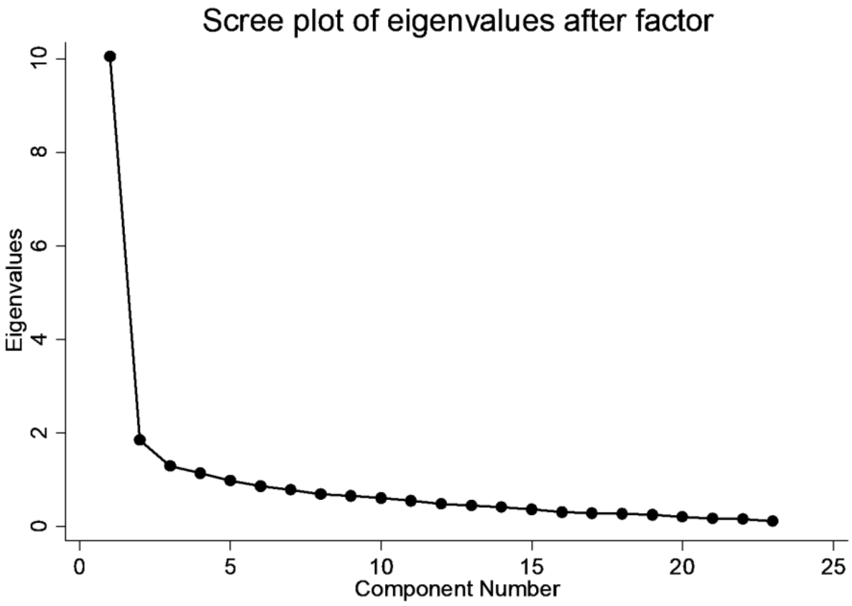

Figure 3: Catell's scree test.

An additional method introduced by Horn's parallel analysis (Horn, 1965) involves contrasting the eigenvalue sizes with those previously acquired from an identically sized random data set. Table 7 shows that only the eigenvalues above the similar values from the random data set are retained. The exact number of components that should be kept might be determined and shown to be the most accurate using this method. In the meantime, Hubbard and Allen (1987) report that Kaiser's criterion and Catell's screen test tend to permit a higher number of components than necessary.

Table 7: Monte Carlo PCA by Marley Watkins for parallel analysis.

Eigenvalue	Random Eigenvalue	Standard Dev.
1	1.9206	.0891
2	1.7500	.0634
3	1.6274	.0568
4	1.5231	.0502
5	1.4303	.0446

As indicated in Table 8, only three factors for principal component analysis with Kaiser's criterion are bigger than those for parallel analysis.

Table 8: Comparison of actual eigenvalues of Kaiser's criterion to parallel analysis.

Component number	Actual eigenvalue from PCA	Criterion value from parallel analysis	Decision
1	10.042	1.9206	Accept
2	1.849	1.7500	Accept
3	1.799	1.6274	Accept
4	1.144	1.5231	reject

The three-component solution explained 58.3% of the variation, with Component 1 accounting for 42.73%, Component 2 accounting for 7.87%, and Component 3 accounting for 7.66% (Table 9).

Table 9: Relative importance of factors with three components retained.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	10.042	42.728	42.728	10.042	42.728	42.728
2	1.849	7.867	50.596	1.849	7.867	50.596
3	1.799	7.655	58.250	1.799	7.655	58.250

The Rotated Component Matrix (Table 10) provides a clearer view of the component loadings onto the three factors in Table 9. Principal Component Analysis with a Varimax rotation was utilized.

Table 10: Rotated component matrix with varimax method.

Variable (s)	Component 1	2	3
Poor project planning	**.739**		
Insufficient working capital	**.716**	.401	
Inadequate monitoring and/or poorly carried out inspections	**.698**		
Increase in contract sums	**.641**		
Specification of costly imported materials	**.554**		.510
Contractor's incompetency leading to low performance	**.552**	.313	.487
Plans not used correctly	**.499**	.455	
Haphazard award of contract without reference to funds availability	**.474**	.352	.405
Unrealistic expectation		**.763**	
Major challenges in the project requirement		**.686**	.373
Haphazard completion of technically unsound project	.382	**.674**	
Incorrect use of project methodology	.325	**.620**	
Poor project finances	.402	**.567**	
Escalation in total cost of project	.388	**.535**	
Changing requirements and specifications	.398	**.488**	
Inadequate resources	.456	**.462**	
Initial cost and schedule not revised	.335	**.456**	.354
Challenges of delay in payment to contractors resulting from govt. Bureaucracy			**.757**
Frequent change in government			**.749**
Selection and award of contract based on lowest bidder	.442		**.718**
Increase in the scope of work		.367	**.635**
Poor or shoddy work by building professionals, consultants, etc.	.407		**.566**
Change in pre-contract consultants		.444	**.564**

Table 11 shows that Factor 1 accounts for 42.7% of the total variance loads. Factor 1 includes variables like inadequate working capital, inadequate monitoring, improperly performed inspections, increased contract sums, expensive imported material specifications, contractor incompetence resulting in substandard performance, improper use of plans, and haphazard contract award without consideration for available funds. This is named misalignment of project success. 7.9% of the variance can be attributed to factor 2, which shows high positive loadings on irrational expectations, significant challenges with the project requirements, haphazard completion of a technically unsound project, improper application of the project methodology, poor project finances, an increase in the project's overall cost, evolving requirements and specifications, a lack of resources, and an original cost and schedule that was not revised. They are referred to as unanticipated project problems. Moreover, Factor 3 represents 7.7% of the overall variance and indicates high positive loadings on challenges like government bureaucracy-caused delays in contractor payments, frequent government changes, lowest bidder selection and award, an expansion of the work scope, subpar or substandard work by consultants, building professionals, etc., and a change in pre-contract consultants. This might be called the too bureaucratic roadblocks from project initiators. Based on twenty-three variables that have previously affected project success rates and have been categorised accordingly, this analysis revealed three crucial factors: project misalignment, unforeseen project challenges, and excessive bureaucratic hiccups from the project initiator.

Table 11: Substantial factor loadings (varimax).

Factor	Variables	Description	Factor Loadings
1	X13	Poor project planning	0.739
	X16	Insufficient working capital	0.716
	X12	Inadequate monitoring and /or poorly carried out inspections	0.698
	X19	Increase in contract sums	0.641
	X2	Specification of costly imported materials	0.554
	X17	Contractor's incompetency leads to low performance	0.552
	X15	Plans not used correctly	0.499
	X21	Haphazard award of contract without reference to funds availability	0.474
2	X11	Unrealistic expectation	0.763
	X7	Major challenges in the project requirement	0.686
	X18	Haphazard completion of a technically unsound project	0.674
	X22	Incorrect use of project methodology	0.62
	X8	Poor project finances	0.567
	X5	Escalation in the total cost of the project	0.535
	X3	Changing requirements and specifications	0.488
	X20	Inadequate resources	0.462
	X4	Initial cost and schedule not revised	0.456
3	X6	Challenges of delay in payment to contractors resulting from government bureaucracy	0.757
	X14	Frequent changes in government	0.749
	X9	Selection and award of contract based on the lowest bidder	0.718
	X1	Increase in the scope of work	0.635
	X10	Poor or shoddy work by building professionals, consultants, etc.	0.566
	X23	Change in pre-contract consultants	0.564

5. Discussion

One of the most important factors affecting a building's occupants' well-being is the interior environment. Windows and other building components affect airflow in naturally ventilated residential buildings. A few aspects of residential dwelling design have been linked to CO_2 accumulation and the health of the occupants in the homes studied for this study. High quantities of particulate matter were found indoors, and the energy sources that the households chose for cooking—wood, charcoal, and kerosene—may have contributed to the problem. Another important source of particles could have been the absence of landscaping close to the buildings and candlelight used in the buildings. The primary building orientation was shown to be strongly related to the occurrence of numerous diseases mentioned by respondents, including tuberculosis, meningitis, measles, and malaria. The findings support Givoni's (1994) assertion that the efficacy of appropriate and optimised design in relation to its environment, such as optimal building orientation, can contribute in boosting the health and well-being of its occupants. Meningitis was significantly associated with window type and bedroom number. This could be owing to insufficient cross-ventilation in the bedrooms caused by an improper kind and restricted number of windows, which may have reduced the ventilation threshold and, as a result, resulted in poor pollutant disposal within the bedrooms. This is congruent with the findings of Al-Tamimi *et al.,* (2011); Akande *et al.,* 2023), who observed that architectural characteristics such as building position and orientation, as well as the type and positioning of windows, have a significant influence on air movements inside a building. Furthermore, their research found that windows that are not correctly positioned to take advantage of the prevailing wind direction result in an overall insufficient design for airflow, compromising the residents' well-being, comfort, and health. Other findings in this study confirm the findings of Gao *et al.* (2016), who discovered that poor indoor air quality is one of the most important causes of health problems and is responsible for diseases spreading swiftly in the indoor environment via the airborne route.

The quality of housing projects in the studied areas is influenced by various factors, including project money, building materials, and project management skills, as revealed by the data from BEPs. These results corroborate the findings of Civelek (2018), who discovered that the low success rate of housing project schemes is a result of various issues including inadequate funding, bureaucracy, politics surrounding housing programmes, a lack of suitable organisations, and a lack of transparency in housing programme management. The third significant component, bureaucratic hiccups, demonstrates the influence of the project initiators on the project outcome, based on the factorial analysis results. Project managers should prioritise flexibility and financial adequacy since they are necessary for the effective completion of projects. This aligns with and bolsters the perspective of Ibem and Aduwo (2012), who argued that the construction of housing projects requires current and suitable financial planning in addition to a solid financial package as a means of constructing a stable financial system. This might not be the case if the management of the organisation in charge of carrying out the project does not receive a clear and prompt response from the project initiators, the government. Due to a lack of project finance, project executors, or BEPs, are unable to proceed with the project. This leads to the compromise of crucial project elements and subpar project completion. The analysis indicates that the biggest obstacle to the success of public housing projects is misalignment with project objectives. Effective project results depend on an understanding of how important strategic project planning is to averting project failure and increasing project success from the outset. This is in line with the findings of Ahmed and Sipan (2020), who found that public-private partnerships can be leveraged to create affordable housing in Nigeria and are essential project success elements for affordable housing in Abuja. The Nigerian government should support the public-private partnership by providing alternate sources of finance, the authors added, emphasising the importance of project funding. The researchers promoted the creation of more financial organisations, such as federal mortgage lenders, as well as the necessity of controlling or lowering high-interest rates and providing subsidies to assist in bringing down the cost of housing for those with low and moderate incomes.

6. Conclusions and Recommendations

This study looked into the interactions between many elements that impact Nigeria's ability to provide high-quality public housing developments. In an attempt to address the mounting housing shortages, it determined the components (i.e., housing quality) that are now absent from the delivery of housing, including housing functionality, sustainability, and habitability. When indoor air temperature and relative humidity exceed particular thresholds (for example, 28 °C and 70% RH), they can have an impact on indoor air quality. Based on this study, the design of public housing in Nigeria's hot and dry region would need to give more consideration to the hot and dry season of the year, which at times of the year may have high temperatures and relative humidity, deteriorating the air quality within the building. Furthermore, by diluting or eliminating interior air contaminants, building ventilation can improve indoor air quality. It is reasonable to suppose that the ventilation rate in Nigerian public housing design could be improved for improved indoor air quality, particularly at night. To create high-quality housing projects, stakeholders also need to focus on the following issues: (i) adequate project financing; (ii) appropriate building materials; and (iii) project management experience. There are two important aspects to the findings and their implications for practice and policy. Initially, it would enable those involved in the building industry, legislators, and academic institutions to assess the state of both new and old homes and offer suggestions or enhancements for the provision of housing. Secondly, it would help agents of the council, tenants, and homeowners make well-informed judgements regarding the quality of housing. In conclusion, it is important and insufficient to consider only the number of houses required to accommodate Nigeria's growing urban population when providing public housing; rather, other factors such as appropriate design for improved air quality, high-quality and appropriate building materials, adequate project financing, and project management expertise would result in quality delivery of livable public housing in Nigeria.

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The author(s) declare(s) no conflicts of interest.

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