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IMPACT OF BUILDING DEFECTS ON STRUCTURAL FUNCTIONALITY OF RESIDENTIAL BUILDING IN TALBA HOUSING ESTATE IN MINNA METROPOLIS, NIGER STATE.

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Abstract: *The study determined the impact of building defects on structural functionality of residential buildings in Talba Housing Estate in Minna, Niger State. Two research questions and two null hypotheses guided the study. The study adopted a descriptive survey design and was carried out in Minna, Niger State. The targeted population for this study was 456 respondents comprising of 362 housing occupants, 68 builders, and 26 civil engineers involved in residential building construction in Minna, Niger state. A simple random sampling technique was used to select 368 respondents; comprising of 294 housing occupants of Talba Estate, 52 builders, and 22 Civil Engineers. A structured questionnaire titled "Structural Functionality Building Defect Questionnaire (SFBDQ)" was used to cover data for the study. The instrument was subjected to face and content validation by three experts; One from Department of Industrial and Technology Education, Federal University of Technology Minna, One from Department of Urban and Regional Planning, Federal University of Technology Minna, and One from Department of Building Technology, Federal University of Technology Minna. Its reliability was analyzed using Cronbach Alpha formula and an overall index of 0.81 was obtained. The data was computed using mean and standard deviations to answer the research questions while Analysis of Variance (ANOVA) was used to test the null hypotheses at 0.05 level of significance. Statistical Package for Service Solution (SPSS) version 26 was used for the computation of the result. The findings of the study revealed that the structural defects in Talba Housing Estate in Minna, Niger State include: leaking underneath pipes, cracks in walls, roof leaks, concrete spalling, uneven floors and bowing walls among others with the grand mean ($\overline{\chi}$ = 3.28). The study also revealed that the non-structural defects in Talba Housing Estate in Minna, Niger State include; damaged gutters, clogged drains, cracked floor tiles, jammed doors, peeling paints, water stains on ceilings, broken light fixtures and plumbing fixture leaks, among others with the grand mean ($\overline{\chi}$ = 3.3). Based on the findings, it was recommended that the management of Talba Housing Estate in Minna should develop a detailed rectification plan outlining specific actions to correct the structural defects on residential buildings in the estate. The study also recommended that the management of Talba Housing Estate in Minna should make provision for maintenance or works department within the estate where case of non-structural defects can be reported by building occupants and necessary repairs can be made among others.*

Keywords: *Building Defects, Structural Functionality, Residential Building, Housing Estate*

Introduction

Residential buildings are structures designed and constructed to provide shelter and accommodation for individuals and families. Residential buildings are intended for residential use and provide a place for people to live, sleep, and carry out their daily activities. The buildings come in various forms, sizes, and architectural styles and they serve as homes for people across the world (Chima *et al.,* 2021). Residential building defects are very common and frequently arise during construction project, especially in the project which have poor workmanship, poor project management on the construction site. As the defect impact on time, cost and quality identification of defect at early stage of construction makes easy to complete project in stipulated timing. This helps to avoid or minimize defect in future work (Chima *et al.,* 2021). According to Warizi (2019), Residential building defects exists in both the new building and the older ones. Defects within new housing estate may be of non-compliance with Building Code and standard acceptable tolerances and standards. Meanwhile the older housing estate or building out of warranty period, may not complying with these standards but must be judged against the standard at the time of construction or refurbish common types of residential building defects which includes: structural defects

resulting in cracks or collapse, non-structural defects, defective of faulty electrical systems, design defects and construction defects.

Defects in building can therefore arise from either or a combination of the occurrence of following situation; error in design by the Architect, flaws from the manufacturer, defects in materials, wrong use or inappropriate installation of equipment and inconformity to specification by the contractor, among others. General forms of defects in construction includes either or a combination of the following; defects in structure giving rise to cracks or collapse; defects or faults in electrical and plumbing installations; inadequacy of drains for proper disposal; insufficient provision for ventilation; poor cooling and/or heating system; poor sound insulation system, and insufficient fire prevention or protection mechanism. Ascertainment of defects in building can only be done by an expert, such as architect or engineer, who by training and experience will be able to confirm the causes of the problem, either resulting from poor design, low quality of material or poor workmanship (Shittu *et al.,* 2019). Structural defects are flaws, deficiencies, or issues within the structural components of a building or infrastructure that compromise its integrity, safety, or performance. According to Zubairu, (2021), structural defects are flaws in a building's structural element that emerge as a result of faulty design, poor execution, and the use of substandard materials. These defects include; cracks in walls, foundations, defective concrete, loose plaster or spalling in roofs/ceiling among others. Understanding the meaning and implications of these defects is crucial for ensuring the safety and stability of buildings and infrastructure (Wen *et al* 2019). According to Jeff *et al.* (2023) the structural defects that occur in residential buildings over time due to deterioration, wear and tear, overloading, and poor maintenance are wall and floor cracks, deflection, steel corrosion. It means any defect occurred in a structural element (retaining walls, columns, beams, slabs) of a building that is related to defective design, defective faulty workmanship, defective material and sometimes any combination of them.

Non-structural defect includes defect in brick work, dampness in old structures and defects in plaster works most of the defects found in the condominium house defects are the nonstructural defects caused by the material and also workmanship problems or defects such as poor workmanship, using poor quality of materials, improper curing time and methods, methods of construction, improper selection of materials, selection of poor quality cheap materials, inadequate and improper proportioning of mix constituents of concrete, mortar as well as defects such as electrical and plumbing defects (Jeff *et al.*, 2023). Wen *et al.* (2019) highlighted that it is a defect occurrence in non-structural components of the building because of defective works. It includes defect in the non-structural component of building, electrical and mechanical services, dampness in old buildings, and defects in plaster and finishing works.

Structural functionality refers to the ability of the structure to fulfill its intended purpose, providing strength, stability and safety for its occupants. According to Hinks *et al.* (2020), structural functionality of a residential building encompasses the physical and mechanical aspects of its design and construction that ensure safety, stability, and durability. It is the foundation upon which the entire living space is built, providing the necessary support for the building's various components, including floors, walls, roof, and external envelope. A structurally functional building withstands the test of time and remain resilient in the face of environmental challenges. Residential buildings must adhere to local building codes and regulations, which establish minimum standards for structural safety and performance. Compliance with these codes ensures that the building meets the necessary requirements for occupancy, minimizing the risk of structural failure especially in residential housing estates. However various factors such as foundation Issues, structural cracks, water damage, poor construction practices, design flaws, natural disasters, ageing and wear can lead to building defects, compromising their structural integrity and functionality. In the Northern part of Nigeria, the structural functionality of residential buildings appears to be questionable as structures are often seen to be devoid of cracks and structural deficiencies. These factors if not addressed, can comprise the safety, stability and overall performance of the structure of a building. Addressing these building defects requires collaboration among architects, engineers, contractors

and building occupants. Proper planning adherence to building codes and standards, quality construction practices and proactive maintenance are essential for ensuring the structural functionality and longevity of buildings. Hence, this study seeks to assess the impact of building defects on structural functionality of residential buildings in Talba Housing estate Minna, Niger State.

Statement of the Problem

Housing estate is a group of homes and other buildings facilities built together as a single development. Housing estate could be owned by government, private or individual. The main goal of these housing estates is to make decent shelter available and affordable to all Nigeria. Therefore, residential buildings in housing estates should not only be durable but functional structurally. According to Abdulkadir (2019) residential buildings in any housing estate that should be able to withstand the elements and remain structurally sound for a long period of time. The author further argued that the building should serve intended purposes effectively and efficiently without any form of defects. A residential building irrespective of its location should have a strong foundation, be well designed to hold together without shifting or cracking that might impaired the functionality of the building structure (Awasho & Alemu 2023).

However, it has been observed that most residential building in most estates in Nigeria including Talba Housing Estate in Minna, Niger State has been characterized with several defects such as structural defects and nonstructural defects; cracks in floors, walls including structural elements. Syamilah & Cheong, (2019) pointed out that most government housing estates in Nigeria are faced with plumbing defects like leakages in pipes works, carpentry defects like broken door handles, among others. Inadequate parking spaces for occupants, green plants growing on paved floors, crack in structural building and no recreational space for kids are also forms or defects that impaired the structural functionality of a residential buildings in Talba Housing Estate, Minna, Niger State. Ohadugha *et al* (2019) asserted that it is a common knowledge that proportion of the occupants of Talba Housing Estate Minna, Niger State find it extremely difficult to leave comfortably in their respective buildings within the estate. This negative trend might possibly lead to several exist of people among the occupants of Talba Housing Estate, Minna leaving the Estate and the new ones are avoiding not to get houses in the Estate. Therefore, it was on this basis that the researcher sought to identify the impact of building defects on structural functionality of residential building in Talba Housing Estate in Minna, Niger State.

Purpose of the Study

The main purpose of this study was to determine the impact of building defects on structural functionality of residential buildings in Talba Housing Estate in Minna, Niger State. Specifically, the objectives of the are to identify:

1. The building structural defects in Talba Housing Estate in Minna, Niger State.
2. The non-building structural defects in Talba Housing Estate in Minna, Niger State.

Research Question

The following research questions guided the study:

- What are the building structural defects in Talba Housing Estate in Minna, Niger State?
- What are the non-building structural defects in Talba Housing Estate in Minna, Niger State?

Hypotheses

The following null hypothesis were formulated to guide the study and was tested at 0.05 level of significance.

$H0_1$: There is no significant difference between the mean responses of housing occupants, builders and civil engineers on the building structural defects that are in Talba Housing Estate.

$H0_2$: There is no significant difference between the mean responses of housing occupants, builders and civil engineers on the non-building structural defects that are in Talba Housing Estate.

Methodology

A descriptive survey design was adopted for this study. According to Nworgu and Nwanuoro (2015), it is aimed at collecting data and describing it in a systematic manner, the characteristics features of facts about a given population using questionnaire as instrument for data collection. The study was carried out in Talba Housing Estate in Minna, the capital city of Niger State, Nigeria. The targeted population for this study was 456 respondents comprising of 362 housing occupants, 68 builders, and 26 civil engineers involved in residential building construction in Minna, Niger state. The instrument for this study was a structured questionnaire titled "Structural Functionality Building Defect Questionnaire (SFBDQ)" was used by the researcher to elicit data from the respondents. All sections of the instrument were structured on a four-point rating scale of Strongly Agree (SA) = 4, Agree (A) = 3, Disagree (D) = 2, Strongly Disagree (SD) = 1. The instrument was subjected to face and content validation by three experts; One from Department of Industrial and Technology Education, Federal University Technology Minna, One from Department of Urban and Regional Planning, Federal University Technology Minna, and One from Department of Building Technology, Federal University Technology Minna. The reliability testing of the instrument was carried out in Goshen Housing Estate in Federal Capital Territory Abuja (FCT, Abuja) using 20 subjects of comprising of 15 housing occupants, 3 building contractors, and 2 civil engineers. The Cronbach's Alpha statistical technique was used to calculate the reliability coefficient of the three sections of the instrument, which was found to be 0.83, 0.85 and 0.79. The overall coefficient value of the instrument was 0.81, indicating that the instrument was reliable and considered appropriate for use. The data collected for the study was analyzed using Statistical Package for Service Solution (SPSS, Version 26). The data were analysed using mean and standard deviation to answer the research questions while Analysis of Variance (ANOVA) was used to test the null hypotheses at 0.05 level of significance.

Results

Table 1: Mean and Standard Deviation of Respondents on the Structural Defects in Talba Housing Estate in Minna, Niger State **N =297**

S/N	Items	Mean ($\bar{x}$)	SD	Remarks
1	Cracks in walls	3.29	0.60	A
2	Dampness	3.10	0.58	A
3	Foundation cracks	2.98	0.50	A
4	Concrete spalling	3.12	0.65	A
5	Uneven or sloping floors	3.58	0.82	SA
6	Bowing walls	3.55	0.70	SA
7	Rotting wood beams	3.54	0.59	SA
8	Failing retaining walls	2.82	0.62	A
9	Sagging roof trusses	3.25	0.55	A
10	Cracked concrete slaps	3.38	0.72	A
11	Crumbling brickwork in load-bearing walls	3.55	0.78	SA
12	Cracked or failing chimneys	2.88	0.56	A
13	Shear wall failure	3.08	0.69	A
14	Corrosion in steel structural components	2.92	0.70	A
15	Soil erosion underneath foundations	3.15	0.68	A
16	Improperly installed beams	3.26	0.69	A
17	Roof leaks	3.68	0.48	SA
18	Damage to load-bearing structures	3.60	0.70	SA
19	Damaged masonry walls	2.85	0.58	A
20	Leaking underneath pipes	3.66	0.62	SA
21	Compromised seismic bracing systems	3.54	0.55	SA
	Grand Mean/SD	**3.28**	**0.64**	**Agreed**

Key: N = Number of respondents; SD = Standard Deviation; SA = Strongly Agree; A = Agree

Table 1 showed the means responses of the respondents on 21 items posed to determine the structural defects in Talba Housing Estate in Minna, Niger State with a grand mean of 3.28 which implied the respondents collectively agreed with the items that there are the structural defects in Talba Housing Estate in Minna, Niger State. The standard deviation of the items ranged from 0.48 to 0.82 which further implied that the 21 items had their standard deviation less than 1.96 indicating that the respondents were not too far from the mean and were close to one and other in their responses. This closeness of the responses adds value to the reliability of the mean.

Table 2: Mean and Standard Deviation of Respondents on the Non-structural Defects in Talba Housing Estate in Minna, Niger State **N = 297**

S/N	Items	Mean ($\bar{x}$)	SD	Remarks
1	Leaking faucets	3.53	0.50	SA
2	Faulty electrical outlets	3.20	0.64	A
3	Peeling paints	3.64	0.69	SA
4	Broken window panes	3.40	0.59	A
5	Mold growth on non-structural surfaces	3.18	0.49	A
6	Damaged gutters	3.58	0.70	SA
7	Damaged downspout	3.48	0.80	A
8	Clogged drains	3.22	0.62	A
9	Cracked floor tiles	3.56	0.55	SA
10	Jammed doors	3.45	0.48	A
11	Jammed windows	3.38	0.50	A
12	Faded paintings	3.08	0.69	A
13	Loose or missing grout in bathroom tiles	3.52	0.70	SA
14	Warped kitchen cabinet doors	3.65	0.58	SA
15	Water stains on ceilings	3.40	0.78	A
16	Water stains on walls	3.52	0.62	SA
17	Loose door handles	3.45	0.70	A
18	Plumbing fixture leaks	3.72	0.46	SA
19	Air conditioning system failures	3.10	0.62	A
20	Broken light fixtures	3.50	0.48	SA
21	Musty smells in rooms	2.80	0.44	A
22	Tears in window screens	3.11	0.50	A
	Grand Mean/SD	**3.39**	**0.60**	**Agreed**

Key: N = Number of respondents; SD = Standard Deviation; SA = Strongly Agree; A = Agree

Table 2 showed the means responses of the respondents on 22 items posed to determine the non-structural defects in Talba Housing Estate in Minna, Niger State with a grand mean of 3.39 which implied the respondents agreed that there are the non-structural defects in Talba Housing Estate in Minna, Niger State. The standard deviation of the items ranged from 0.48 to 0.80 which further implied that the 22 items had their standard deviation less than 1.96 indicating that the respondents were not too far from the mean and were close to one other in their responses. This closeness of the responses adds value to the reliability of the mean.

Table 3: One-way Analysis of Variance Table Showing the Difference in the Mean Responses of Housing Occupants, Builders and Civil Engineers on the Structural Defects that are in Talba Housing Estate

	Sum of Squares	Df	Mean Square	F	Sig.	Remark
Between Groups	49.805	2	28.410	842.150	.004	SD
Within Groups	6.402	295	.044			
Total	56.104	297				

(P<0.05) SD = Significant Difference

Table 3 revealed that there was significant difference in the mean responses of housing occupants, builders and civil engineers on the structural defects that are in Talba Housing Estate. The F value of 842.15 was obtained with a corresponding P-value of .004. The null hypothesis was rejected because the P-value was less than 0.05. The mean and standard deviation for housing occupants were 2.62 and 0.28 respectively. Also, the mean and standard deviation for builders were 3.48 and 0.61 respectively. Similarly, the mean and standard deviation for civil engineers were 3.60 and 0.41 respectively. Hence, null hypothesis one (Ho_1) was rejected. This implied that there was significant difference in the mean responses of housing occupants, builders and civil engineers on the structural defects that are in Talba Housing Estate. Post-Hoc (Turkey HSD) test was conducted to determine whereby the significance difference in the mean responses of the respondents.

The Post-hoc Turkey HSD test revealed that there was significant difference between the mean responses of builders and civil engineers (P = 0.59) and housing occupants and civil engineers (P = 0.70) since their P-value were above 0.05. However, there was significant difference in the mean responses of housing occupants and builders as regard the structural defects that are in Talba Housing Estate since their P-value (P= .001) was less than 0.05 level of significance. This could be as a result of their varying perspectives, experiences and interests of housing occupants and builders as regards structural defects present in residential housing estates.

Table 4: One-way Analysis of Variance Table Showing the Difference in the Mean Responses of Housing Occupants, Builders and Civil Engineers on the Non-structural Defects that are in Talba Housing Estate

	Sum of Squares	Df	Mean Square	F	Sig.	Remark
Between Groups	240.112	2	64.504	549.110	.001	SD
Within Groups	18.529	295	.085			
Total	270.130	297				

(P<0.05) SD = Significant Difference

Table 4 revealed that there was significant difference in the mean responses of housing occupants, builders and civil engineers on the non-structural defects that are in Talba Housing Estate. The F value of 549.110 was obtained with a corresponding P-value of .001. The null hypothesis was rejected because the P-value was less than 0.05. The mean and standard deviation for housing occupants were 2.90 and 0.42 respectively. Also, the mean and standard deviation for builders were 3.84 and 0.65 respectively. Similarly, the mean and standard deviation for civil engineers were 3.61 and 0.38 respectively. Hence, null hypothesis two (Ho_2) was rejected. This implied that there was significant difference in the mean responses of housing occupants, builders and civil engineers on the non-structural defects that are in Talba Housing Estate. Since there was significant difference in the mean responses of the respondents, a Turkey HSD Post-Hoc test was conducted.

The Turkey HSD Post-hoc test revealed that there was significant difference between the mean responses of builders and civil engineers (P = 0.81) and housing occupants and builders (P = 0.54) since their P-value were above 0.05. However, there was significant difference in the mean responses of housing occupants and civil engineers as regard the non-structural defects that are in Talba Housing Estate since their P-value (P= .001) was less than 0.05 level of significance. This could be as a result of the experience of housing occupants living in the housing estate.

Discussion of Findings

The major findings of the study were discussed in the order of the research questions and hypotheses formulated for study.

Findings from research question one revealed that the structural defects in Talba Housing Estate (THE) in Minna, Niger include: leaking underneath pipes, cracks in walls, roof leaks, concrete

spalling, uneven floors, bowing walls, sagging roof trusses and dampness among others. This may be due to misuse of the structures by occupants or negligence of the contractors during construction. These defects have extensively damaged the appearance of the structures and also threaten the functionality of the buildings. Furthermore, hypothesis one reveals that there was significant difference in the mean responses of housing occupants, builders and civil engineers on the structural defects that are in Talba Housing Estate. The house occupants who are currently living in the buildings have a different opinion as compared to builders and engineers who may not really know what is going on in THE regarding state of the structures.

This finding is supported by a study which Olofinnade *et al.* (2019) carried out to determine the perception of professionals on causes of structural cracks in concrete buildings. The study also highlighted structural defects on buildings to include cracks in walls, concrete spalling, uneven floors, bowing walls among others. The professionals confirmed that structural cracks on buildings affect the buildings functionality. Similarly, this finding is also supported by Waziri's, (2019) study on the design and construction defects influencing residential building maintenance in Nigeria. He also observed that the opinion of building occupants was different from building professionals as regards the structural defects found in buildings. However, this finding is contradicted by Tayeh *et al.* (2019) whose study was on the factors affecting defects occurrence in structural design stage of residential buildings in Gaza Strip. Their study revealed that the opinion of building occupants and professionals was the same. This variation in findings could be based on difference in geographical location of the study.

Research question two revealed that the non-structural defects in Talba Housing Estate in Minna, Niger State include; damaged gutters, clogged drains, cracked floor tiles, jammed doors, peeling paints, water stains on ceilings, broken light fixtures, plumbing fixture leaks, and broken window panes among others. The state of these buildings keeps deteriorating due to poor maintenance culture of occupants and management of the housing estate. Hypothesis two also revealed that there was significant difference in the mean responses of housing occupants, builders and civil engineers on the non-structural defects that are in Talba Housing Estate. The group of respondents with a different opinion was the occupants. This is because they are the current users of the buildings, hence they have first-hand information about the non-structural defects of the buildings.

This finding is supported by Ardo (2021), who assessed defects associated with altered and converted institutional buildings in Gombe State, Nigeria. The study revealed that most institutional buildings in Gombe develop non-structural defects such as clogged drains, cracked floor tiles, peeling paints, water stains on ceilings, broken light fixtures and several others. This is because the buildings were misused by the occupants and maintenance was not regular. The finding of Oseghale and Ikpo (2020) is also consistent with this finding. The study evaluated industrial facilities defects in selected industrial estates in Lagos state, Nigeria. It was found that most of the facilities had developed several non-structural defects due to poor maintenance attitude of the owners. Similarly, Olofinnade *et al.* (2019) supports this finding by revealing that there was a significant difference in the opinions of building occupants and professionals. However, Tayeh *et al.* (2019) opposed this finding in their study on the factors affecting defects occurrence in structural design stage of residential buildings in Gaza Strip. The study found out that there was no variation in the opinions of occupants and professional, which may be due to the fact that the region is more developed in terms of infrastructure.

Conclusion

Based on the findings from analyzing opinions of housing occupants, builders and civil engineers on the impact of building defects on structural functionality of residential buildings in Talba Housing Estate in Minna, Niger State, the study concludes that there are structural defects on the buildings in the estate. Some of the defects identified were: leaking underneath pipes, cracks in walls, roof leaks, concrete spalling among several others. Furthermore, residential buildings in Talba Housing Estate (THE) have developed non-structural defects such as damaged gutters, clogged drains, cracked floor tiles, peeling paints, water stains on ceilings, broken light fixtures

among others. The aforementioned defects have adverse effects on the functionality of residential buildings in THE, Minna.

Recommendations

The following recommendations were made based on the findings of this study;

1. The management of Talba Housing Estate in Minna should develop a detailed rectification plan outlining specific actions to correct the structural defects on residential buildings in the estate.
2. The management of Talba Housing Estate in Minna should make provision for maintenance or works department within the estate where case of non-structural defects can be reported by building occupants and necessary repairs can be made.

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