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Exploring the Patterns of Deterioration: A Case Study of Buildings in a Residential Estate in Nigeria

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ABSTRACT
Research into the deterioration of buildings tends to focus on probable causes. However, investigations that explore the nature, extent and pattern of the deterioration in residential buildings is limited. This study aims at exploring the patterns of deterioration in a residential estate with multiple buildings in Minna and the liveability of the community. The study adopts a mixed method approach with a case study and data is obtained through observations and a structured questionnaire administered by hand to residents on the condition of their buildings. The results revealed huge similarities in the nature and extent of deterioration for different building types in the estate with dampness of walls/roofs being the most severe form of deterioration (MIS =3.71) and heavy rainfall being the most likely cause of deterioration (MIS = 3.85). The study also found that majority of residents opted to live in the estate generally because they felt safe (MIS = 4.33). The study argues that the level of deterioration in the buildings might lead to lower living conditions in the estate.

KEYWORDS: Buildings, Condition assessment, Deterioration, Liveability and Residents.

I. INTRODUCTION

Buildings often deteriorate faster than home owners anticipate. This is a concern for families who invest their life savings to buy or build a house. One way to determine the nature of deterioration is to examine the condition of a building to eliminate or alleviate negative conditions that can make the building unfit for habitation (Radzuan *et al.*, 2011). This indicates that deterioration in buildings is an important aspect of construction management and raises questions on the nature and extent of deterioration.

Some authors present deterioration in buildings as defects. For example, Allotey (2014) examined the defects on public residential buildings in Ghana and adopted a descriptive approach to identify the severity of the defects. Other authors present deterioration as the degradation or anomalies in a building. For instance, Pereira *et al.* (2015) examined the degradation patterns in secondary schools in Portugal to evaluate the severity of the anomalies. Recent authors present building deterioration as decay or damage in a building. For example, Shrestha *et al.* (2024) examined the decay or damages in cultural heritage buildings in Nepal. These authors show that the concept of deterioration in buildings is arguable.

One major theme in the literature on building deterioration is the assumption that deteriorations in a building is linked or caused by certain probable factors (Balaras *et al.*, 2005). However, investigations that explore the nature, extent and patterns of deterioration in a residential estate comprised of multiple buildings is limited. Therefore, the aim of this study is to explore the patterns of deterioration in a residential estate in Minna comprised of multiple

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buildings. Specifically, the objectives of this study are to: (1) examine the nature and extent of deteriorations in the residential estate in Minna comprised of multiple buildings (2) to explore patterns (i.e. similarities or difference) in the way deteriorations occurred in the residential estate and the liveability of households or residents.

This study contributes to the literature on building condition assessment by extending our understanding on the deterioration in buildings with a focus on liveability of residential communities. The section that follows presents a review of the literature on deteriorations and liveability. This is followed by the research method adopted in this study and the results. This paper is concluded in the last section with the contribution to knowledge.

II. LITERATURE REVIEW

Causes of Deteriorations in Buildings:

Several authors assume that deteriorations in buildings can be linked to or caused by certain factors. For example, Balaras *et al.* (2005) examined factors that influence deteriorations of building elements. They compared the deteriorations of two categories of building elements and found that no single factor amongst others had any major influence on deteriorations. They argued that deterioration of building elements is influenced by a combination of factors. In the same vein, Ahzahar *et al.* (2011) evaluated common factors that contribute to defects in construction projects. Their results showed that construction materials ranked highest as the most common factor. They claim that minimizing the factors that contribute could reduce failures and defects. This claim is not supported because different building types are likely to deteriorate differently under different conditions. Similarly, Yacob *et al.* (2019) examined the relationship between defects in 300 buildings and causative factors in Malaysia. Their analysis showed that 7 causative factors have a significant relationship on the condition of the buildings and only 66 school buildings were in critical condition. They argued that a lack of maintenance led to the poor condition of the school buildings. It can be seen that the above authors share the assumption that there is a nexus between the deteriorations of buildings and certain causative factors. These authors argue that the secret to maintaining buildings in a good condition is by merely focusing or minimizing the factors that contribute to defects or failures. However, these authors fail to explore the nature, extent and patterns of deteriorations in residential communities.

Liveability of Residential Communities

One assumption in the housing literature is that the quality of living conditions or liveability of a community is linked to certain human needs or expectations (Thanoon and Haykal, 2020; Khorrami *et al.*, 2021). For example, Thanoon and Haykal (2020) examined the influence of accessibility and availability of green spaces on liveability i.e. degree of satisfaction of five residential communities. They claim that the presence and accessibility of green spaces has a positive significance on the satisfaction of residents. The implication is that green spaces enhances the living condition of a place. Furthermore, the amount of deterioration in built structures can affect the living condition of a place. For example, Asiyanbola *et al.* (2012) examined the condition of two urban communities in Ogun State and observed that facilities and services such as power supply, drainages, roads and water supply in the two communities deteriorated and were in poor condition. They argued that provision of infrastructural facilities and services will improve the liveability of the urban centres. The implication is that the condition of facilities, services and the building fabric can also affect liveability in a building.

Several studies have proposed different indices to measure the quality of living or liveability of a place or community. Some authors focused on external condition of a place. For instance,

Kennedy and Buys (2010) focused on safety, security, walkability, noise pollution as a measure of the liveability or living condition of a community. Whereas, other studies focused on internal condition of a place. For example, Khorrami et al. (2021) highlighted five factors such as the condition quality of the building, air quality, water quality, humidity and the facilities. Other authors focus on basic conditions and classify liveability based on the functional requirements. For instance, Barry (1999) focused on seven requirements namely: safety concerns, structural stability, noise exclusion, fire resistance, thermal comfort, durability of building/freedom from maintenance, resistance to passage of water.

III. RESEARCH METHOD

This study adopts a mixed method approach with a case study that involved observations and a questionnaire survey to explore the pattern of deteriorations in a residential estate in Minna that comprises of multiple buildings. The residential estate is located in Minna, Bosso local government of Niger State, Nigeria. This estate was chosen because the buildings in the estate were built over 15 years ago and consisted of 200 houses with the potential of having deteriorations to address the study objectives. The estate consists of 2-bedroom and 3-bedroom bungalows with a population of over 400 occupants.

A pilot study was conducted and eight buildings were selected for observation to explore the nature of deterioration in the residential estate. The eight buildings were chosen for three reasons. First, because of the potential of finding deteriorations in the buildings which the residents confirmed. Secondly, to obtain data on the nature of deterioration for two distinct building types i.e. two bedroom and three-bedroom buildings. Thirdly, because the residents offered to participate in the study. The observations on the nature of deteriorations were carried out over a period of two weeks, and involved documentation in field notes and taking pictures.

200 questionnaires were administered to 200 households with the support of two field assistants for three days and only 130 households responded. The questionnaire was divided into four parts to address the objectives of the study. The first part focused on the characteristics of the respondents and their houses. The second part focused on the level of deteriorations observed after the pilot study. The third part focused on probable causes of deteriorations in the estate. The fourth part focused on measuring the liveability or living condition of the buildings. The level of deterioration was measured using a 5-point Likert scale as follows: 5-very severe, 4 – severe, 3– moderately severe, 2- slightly severe and 1- least severe. The cause of deteriorations was measured using a 5-point Likert scale as follows: 5-very likely, 4 – likely, 3 – neutral, 2- unlikely and 1- very unlikely. The liveability or living conditions of the buildings was measured using a 5-point Likert scale as follows: 5- very satisfied, 4– satisfied, 3– unsure, 2- dissatisfied and 1- very dissatisfied. The data obtained on the level of deterioration, probable cause of deteriorations and the liveability or living condition of the buildings were analysed using mean item score and ranking.

IV. RESULTS AND DISCUSSION

Respondents' characteristics:

The characteristics of respondents and residents in the estate that participated in the study are presented in Table 1. The results in Table 1 show that 31.53% of respondents were Daughters, while the least were Mothers with 19.23%. The results also show that 36.15% of the respondents were employed, while 28.46 % of the respondents were retired or unemployed. Furthermore, the results indicate that 50 % of the respondents have worked for only (0 -5) years, while 10 % of respondents have worked for (16 years and above). The implication of

this when compared with the employment status of household members is that a higher percentage of respondents have not had a stable income over a long period of time to support themselves as they live in the building. The results show that 50.77% of the residents lived in three-bedroom buildings, while 49.23% of the respondents lived in two-bedroom buildings. The results also showed that 36.92% of the respondents have lived in their residence for (5- 10 years), while, 20 % of the respondents have lived in their residence for less than 5 years. The results further showed that 39.23% of the respondents have above 6 occupants currently living in their building, while 38.46 % of the respondents indicated that 4- 6 occupants living in their building.

Table 1: Respondents' characteristics

Item	Description	Frequency	Percentage%
Household member	Father	19	14.62
	Mother	25	19.23
	Son	45	34.62
	Daughter	41	31.53
	Total	130	100
Employment Status	Employed	47	36.15
	Retired /Unemployed	37	28.46
	Student	46	35.38
	Total	130	100
Period employed	0-5 years	65	50
	6-10 years	33	25.38
	11-15 years	19	14.62
	16 years & above	13	10
	Total	130	100
Type of Building	2 Bedroom	64	49.23
	3 Bedroom	66	50.77
	Total	130	100
Length of stay In the building	Less than 5 years	26	20
	5-10 years	48	36.92
	10-20 years	20	15.38
	20 years & above	36	27.70
	Total	130	100
Number of occupants	0-3 persons	29	22.31
	4-6 persons	50	38.46
	Above 6 persons	51	39.23
	Total	130	100

Nature of deterioration observed:

The picture in Figures 1, 2, 3 and 4 shows the nature of deterioration that was observed in two building types selected in the residential estate. The picture in figure 1 indicates brown moulds that were observed internally in a two-bedroom building (building-1) depicting some exposure to water from above and a gradual decay or wet rot of the ceiling board. The dampness at the ceiling board/batten was also observed on the internal wall. This is likely due to damaged portions of the roof cover that has caused an ingress of rain water. The picture in figure 2 also indicates wet rot or decay that was observed internally in a three-bedroom building (building-2) due to leakages in the roof. The picture in figure 3 indicates wet rot or decay that was observed externally on the ceiling board of another two-bedroom building (building-3). This can also be attributed to leakages due to damaged portions of the roof cover. The picture in figure 4 indicates decay of timber as the battens loosen in the external ceiling for another three-bedroom building (building- 4).

Figure 1: Decay in the ceiling and damages to the paint (internal)

Figure 2: Decay in the ceiling (internal)

Figure 3: Decay in the ceiling (external)

The picture in Figures 5 and 6 shows another form of deterioration observed in another group of buildings in the residential estate different from the buildings described earlier. The picture in figure 5 indicates poorly connected wires for a socket that is exposed without a control switch

in a two-bedroom building (building-5). This surface wiring depicts unsafe electrical wiring and connections. The picture in figure 6 indicates poorly connected wires for a ceiling fan in a three-bedroom building (building-6). This surface wiring also depicts unsafe electrical wiring and connections.

Figure 4: Deterioration of the external ceiling

Figure 5: Exposed wires and sockets

Figure 6: Exposed wires and sockets

The pictures in Figures 7 and 8 show other forms of deterioration observed in another group of buildings aside from the buildings described above. The picture in figure 7 indicates an erosion of external plaster and paint in a two-bedroom building (building-7). The picture in figure 7

also indicates a deformation of the timber fascia board. The picture in figure 8 indicates a gradual erosion of the foundation externally in a three-bedroom building (building-8). This is likely to have arisen due to consist rainfall in an environment that is not adequately landscaped.

Figure 7: Deterioration of paint and plaster of external walls

Figure 8: Deterioration of paint and plaster of external walls

Level of deterioration and nature:

The results in Table 2 show that dampness of the walls and roof ranked highest with a mean value of 3.71 in the residential estate. This is followed by cracking of the walls that ranked 2nd with a mean value of 3.41. The decay of the timber in the roof ranked 3rd with a mean value of 3.25. This is followed by spalling of the concrete floor that ranked 4th with a mean value of 3.24. Damaged light fittings ranked 5th with a mean value of 3.23. This is followed by poor drainages with a mean value of 3.20. Peeling and staining of the walls ranked 7th with a mean value of 3.19, while faulty sockets ranked 8th with a mean value of 3.07. Eroded and exposed foundations ranked 9th with a mean value of 3.06, while, burnt electrical wires ranked 10th with 3.00. This is followed by the growth of algae on the walls and floors that ranked 11th with a mean value of 2.86. Broken pipes ranked 12th with a mean value of 2.54 and holes in the walls/floor ranked least as 13th with a mean value of 2.37.

Table 2: Level of deterioration

Level of deterioration	MIS	Rank	Decision
Hole in walls/floors	2.37	13th	Slightly severe
Dampness on walls or roofs	3.71	1st	Severe
Cracking of walls / leaning wall	3.41	2nd	Severe
Broken pipes	2.54	12th	Moderately severe
Decay of timber roof members	3.25	3rd	Moderately severe
Concrete spalling on walls or floor	3.24	4th	Moderately severe
Damaged light fittings	3.23	5th	Moderately severe
Algae Growth (Spirogyra) on walls or floors	2.86	11th	Moderately severe
Poor drainage	3.2	6th	Moderately severe
Burnt electrical wires	3	10th	Moderately severe
Staining, peeling and damage to paints on walls	3.19	7th	Moderately severe
Faulty sockets	3.07	8th	Moderately severe
Eroded and exposed foundations	3.06	9th	Moderately severe

The results in Table 3 show that rainfall ranked highest with a mean value of 3.85 as a probable cause of building deterioration. The implication is that exposing the building fabric to constant rain led to the deteriorations in the building. This is followed by erosion of the foundation with a mean value of 3.73. A lack of maintenance ranked 3rd with a mean value of 3.71. The implication is that an absence of maintenance of the building led many parts of the building to deteriorate. This is followed by armed robbery incidents that ranked 4th with a mean value of 3.65. Improper use of construction materials ranked 5th with a mean value of 3.61. This is followed by high voltage which ranked 6th with a mean value of 3.52 as a probable cause of deterioration. The number of sanitary or electrical facilities ranked 7th with a mean value of 3.51. The implication is that sanitary facilities are more likely to deteriorate when more people live in a building This is followed by variations in temperature that ranked 8th with a mean value of 3.49 as a probable cause of building deterioration. Poor construction practices ranked 9th with a mean value of 3.46. This is followed by overcrowding or congestion that ranked 10th with a mean value of 3.44. The implication is that as more people live in a building, this puts pressure on the utilities and fabric of the building. Lastly, wrong or poor diagnosis of a problem ranked 11th with a mean value of 3.00. The implication is that wrong or poor diagnosis of the problem in a building can lead to further deterioration. These results aligns with Balaras *et al.* (2005) study as deterioration was influenced by a combination of factors.

Table 3: Probable causes of the deterioration in buildings

Root Causes of Deterioration	MIS	Rank	Decision
High voltage	3.52	6th	Likely
Heavy Rainfall	3.85	1st	Very likely
Erosion to the Foundation	3.73	2nd	Likely
Lack of maintenance	3.71	3rd	Likely
Overcrowding / Congestion	3.44	10th	Likely
Armed robbery/crime incidents	3.65	4th	Likely
Improper material usage	3.61	5th	Likely
Number of sanitary/electrical facilities	3.51	7th	Likely
Temperature variations	3.49	8th	Likely
Poor Construction practices	3.46	9th	Likely
Wrong or poor diagnosis	3.3	11th	Likely

The results in Table 4 show that safety ranked highest amongst the indices of liveability with a mean value of 4.33. The implication is that many of the residents in the buildings felt safe living in the estate and were very satisfied. This is followed by the utilities and amenities of the buildings which ranked 2nd with a mean value of 3.78. The implication is that many of the residents were satisfied with the utilities and amenities. The structural integrity of the building ranked 3rd with a mean value of 3.69. This is followed by noise exclusion which ranked 4th with a mean value of 3.56. Fire resistance and the thermal comfort of the building ranked 5th and 6th with mean values of 3.48 and 3.47 respectively. This is followed by accessibility and durability/freedom from maintenance ranked 7th and 8th with mean values 3.46 and 3.44 respectively. The implication is that buildings in the estate required a higher degree of maintenance with a lower mean value. Lastly, resistance to the passage of water ranked least with a mean value of 2.88. The implication is that many of the residents were not sure that their buildings could resistance the passage of water.

Table 4: Liveability of the Buildings in the Residential Estate in Minna

Liveability indices	MIS	Rank	Decision
Utilities/amenities in the building	3.78	2nd	Satisfied
Safety concerns	4.33	1st	Very satisfied
Structural stability	3.69	3rd	Satisfied
Fire resistance	3.48	5th	Satisfied
Thermal comfort	3.47	6th	Satisfied
Noise exclusion	3.56	4th	Satisfied
Accessibility	3.46	7th	Satisfied
Durability of building/Freedom from maintenance	3.44	8th	Satisfied
Resistance to passage of water	2.88	9th	Unsure

Pattern of deteriorations in the Estate:

The results from the data above show some similarities and differences in the nature of deterioration in the buildings at the residential estate in Minna. The results show that the nature of the deterioration in the two-bedroom buildings were similar in nature to the type of deterioration observed in the three-bedroom buildings. This is evidenced from the pictures taken during the observations and from the data obtained from the questionnaires.

The results in Table 3 indicate that persistent rainfall ranked highest as the cause of deteriorations in the buildings. This is linked to the observations/pictures on the condition of the buildings that showed brown moulds, wet rot and decay on the ceiling board and battens both internally and externally. This depicts that majority of the buildings were experiencing an ingress or exposure to water from above that is leading to a gradual decay or wet rot of the ceiling boards. This also aligns with the findings in Table 2 as dampness on wall and roof ranked first as the most severe, and decay of timber elements ranked third. This might be due to several buildings having a low-pitched roof that does not effectively drain water quickly. These findings align with the position of Morgado *et al.* (2017a) and Morgado *et al.* (2017b) that improving and planning the maintenance of pitched and flat roofs can reduce future repair costs.

The data obtained from Table 3 show a lack of maintenance ranked third. This explains why sockets, control switches and wiring of ceiling fans in buildings were exposed or hanging on the surface. The results in Table 3 show that overcrowding and congestion ranked very low as a likely cause of deterioration. This is at variance with the results in Table 1 as 38.46 % and

39.23% of the respondents indicated that above 4 persons lived in their buildings which exceeds the capacity of a two bedroom and 3-bedroom building. The results in Table 3 show that a lack of maintenance ranked higher as a likely cause of deterioration with a mean value of 3.71 and wrong diagnosis ranked 11th with a mean value of 3.30. This might be because 28.46% and 35.38 % of the residents in Table 1 are retirees or students respectively who may not be able to afford or budget regularly for maintenance. This findings aligns with Yacob *et al.* (2019) position that the lack of maintenance leads to the poor condition of buildings.

The result in Table 4 show that residents were not sure that their building is able to resist water as this ranked least with a mean value of 2.88. This confirms why dampness of the walls and roofs ranked first in Table 2 with a mean value 3.71 as the most severe form of deterioration. This issue was also evident in the pictures taken during field observations and urgently needs attention to increase the liveability in the estate. This findings resonates with Asiyanbola *et al.* (2012) stance that providing required facilities and services will improve the liveability of a place.

V. CONCLUSION

The study aimed at exploring the pattern of deteriorations in a residential estate in Minna that comprised of multiple buildings. Specifically, the study focussed on investigating the nature, extent and pattern (i.e. similarities or difference) in the way deteriorations occurred in the residential estate in Minna. A mixed method approach was adopted in a case study that involved observations and questionnaires on the condition of the buildings. The results reveal huge similarities in the nature and extent of deterioration for different building types in the residential estate with dampness on walls/roofs being the most severe form of deterioration (MIS =3.71), and heavy rainfall being the most likely cause of deterioration (MIS =3.85). The study also found that majority of resident opted to live in the residential estate generally because they felt safe (MIS =4.33). The study argues that the nature and level of deterioration observed in the buildings in the residential estate might lead to lower living conditions. The study contributes to literature on building condition assessment by extending our understanding on the deterioration with a focus on liveability of residential communities. The study recommends that the condition of buildings is investigated more often to improve the liveability of residential communities.

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