(RESEARCH ARTICLE)

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Investigation of factors responsible for deterioration of building structures in tertiary institutions

Odoanyanwu Ndubuisi M, Kosisochukwu Emmanuel Chukwujindu * and Emmanuel Ikemefune Kikanme

Department of Architecture, Nnamdi Azikiwe University, Awka, Anambra State.

Abstract

Purpose: This research focused on determining factors responsible for deterioration of building structures in Tertiary institutions.

Method: The methodology involved survey design, review of related literature, two sets of structured questionnaires, direct observations, walkthrough evaluations, interviews and photographs. The sample techniques involved both purposive and stratified random sampling applied on a population of 1300 staff, students and 84 buildings respectively. Data was analyzed using frequencies, percentages and mean scores. Pearson correlation coefficient, regression analysis and student t-test were employed in testing the hypotheses.

Findings: Results revealed that structural elements were defective and building components in poor condition of maintenance. The study revealed also that maintenance of buildings in the institutions is not effective. The research concluded that lack of building maintenance, funding and management decision play an important role in the physical condition of buildings which in turn affect staff productivity and students' academic achievement.

Originality: The related literature analysis shows that no research work has being formulated from the case study on the generated research topic. It shows the originality of this research which emerges from the knowledge gap of the related reviewed literatures.

Keywords: Building; Maintenance; Structures; Funding; Deterioration; Institution and construction

1. Introduction

A building is regarded as an enclosure or "envelope" designed and constructed to provide minimum level of comfort, and conveniences for man. Building provides safety, protects human inhabitants, animals, materials and equipment from effects of weather, and gives internal comfort (Ogunoh, 2008). According to Obiegbu (2003), a building is an important modifier of microclimate because it creates a place that is insulated from climate temperature and humidity changes, protected from prevailing winds and precipitation, and controlled artificially. Stakeholders in Nigeria have consistently raised worry about the quality of maintenance and suitability of educational buildings, particularly in institutions, according to Okolie (2011). This concern provides the bases for this research. Studies carried out on maintenance of school buildings showed that maintenance fall below the level necessary to arrest deterioration (Aliyu, 1998).An assessment of our built environment in contemporary Nigeria shows that many publicly and privately owned buildings are in various states of disrepair, and dilapidation and consequently have become unsightly (Falemu &Adewole, 2006).

*Corresponding author: Kosisochukwu Emmanuel Chukwujindu
Department of Architecture, Nnamdi Azikiwe University, Awka, Anambra State.

In the light of the above, this research is focus on investigation of factors responsible for deterioration of building structures in tertiary institutions and their impact on university management.The study specifically identifies the deteriorating components, elements of buildings, as well as the causative factors.

Research Aim and Objectives

The aim of this research is to determine factors responsible for deterioration of building structures in Tertiary institutions.

1.1. Research Questions

The following research questions formed the basis of this study:

- What are the factors responsible for deterioration of building structures?

1.2. Research Hypotheses

Based on the objectives of this research, the following null hypotheses were formulated and tested in the cause of this research:

H_0: The design and construction of buildings do not significantly cause deterioration of educational buildings.

2. Factors that cause deterioration of building elements and components

Building is one of the most essential facilities, which provides shelter for human habitation and social-economic activities. Two main physical resources are involved in the construction of building. These are materials necessary to form the various elements and components of the building, and the technical ability to assemble the parts. Failure to any of the two, mentioned above, could cause considerable deterioration of building elements and components. Therefore, a building is expected to accommodate the progress of time, safety from collapse and resistant to physical hash weather. Odunlami, (2002) indicates that buildings have life spans, and all components and elements put together to make them functional, are expected to sustain this life span. He advised that, a more careful thought should be considered during design in foundation walls, floors and roof construction, because any major fault may result in the collapse of the building, during construction or after handing over, or physical occupation or use.Unfortunately, apart from daily wear and tear by building occupants or users, a number of factors affect building elements and components. According to Obiegbu, (2003), building materials and components are subjected to the effects of a number of agencies, which influence adversely their durability and performance and thereby have a major bearing on the possibility of their premature failure. He therefore, listed some possible factors that cause deterioration of building, and its elements and components as:

2.1. Natural Effects

These are temperature effects, settlements, tree root, chemical action etc.

Defects cause by the use of sub-standard materials for example, investigation reveal that aggregate containing impurities-silt and clay, the shape of the aggregate, type of water used for mixing the concrete, all in one way or the other positively or negatively influence the quality of structural elements and components of a building.

2.2. Design Error

At the design stage, most designers do not carry out soil investigation and analysis, as to know the suitable foundation design for the building.

2.3. Construction Influence on Defects

These are use of wrong specification/materials, and ignorance of certain constructional details, poor workmanship etc.

2.4. Defects due to lack of maintenance

Construction materials and components definitely have finite life, as they change and deteriorate. Therefore, regular maintenance is needed so that, to prolong the life of building elements and components.

Amobi, (2006) reiterated that, when a building or its components fails to satisfy some basic functions, that building or component is assumed to have failed functionally. He listed the factors that adversely affect the basic functions of building elements as: poor workmanship, unrelated design decisions and poor material selection. He therefore, advised that in the design of elements of structure, there must be adequate assessment of load, and exposure conditions for each element.

Amusan, (2003) in his study, opined that all elements of houses deteriorates at a greater or lesser rate, dependent on the materials, design adequacy, quality of workmanship environmental conditions, function and use of the building. This implies that a building may be regarded as a system with subsystems, such as elements, components and materials, that act together to render the functions for which it was built. According to Warszawski, (1990) a building system is defined as a set of components for a particular type of building, together with their production and erection procedures.

This is the reason why Iyagba, (2005) said, it has not yet been possible to produce maintenance free building. He maintained the reality is that all elements and components that make up a building unavoidably deteriorate with time due to inherent defects in design, construction and the effects of environmental agents and users activities.

This means that a structure is an assembly of elements, and an understanding of the behavior of the structural elements is essential to the understanding of the behavior of the whole structural form of a building (Olusola, 2002). A structural element as Olusola, (2002) puts it, carries the load on it to an adjoining structural element by a system of bending moment, shear force and axial forces acting in one, two or three directions depending on the nature of the structural element.

According to Seward, (1994) research has shown that the second largest cause of structural failures is defective detail design of the joints between members. It indicates that, the importance of sound connection design and construction of building elements and components cannot be over emphasized(Ogunoh, 2018).

3. Research Methodology

The research methodology describes the procedures employed for gathering and generating the data needed for carrying out the research work and subsequent technique for processing and analyzing the collected data. According to Fellows and Liu, (1997), research methodology refers to the principles and procedures of logical thought process which are applied to a scientific investigation. Research method is described as the subset of the methodology, different research methodology. Thus, within a research methodology, different research methods or tools may be used to achieve the aimand objectives of the research (Sutrisna, 2009).

3.1. Research Design

By virtue of the nature of the research, survey research method was adopted for this research. Survey research method according to Nworgu, (1991) is one in which group of people or items are studied by collecting and analyzing data from only few people or items considered being representative of entire group. The use of survey research method makes the data generated directly from respondents to be more distinct and finite.

3.2. Determination of Sample Size

The sample size for this study was determined using Bouely's formular as cited in Ogunoh (2008)

$$n = \frac{N}{1 + N\ (e)^2}$$

when n = sample size, N = population, e^2 = Margin of error (assumed 5%), 1 = unity or constant

Therefore $= \frac{1300}{1 + 1300\ (0.05)^2}$

$$\frac{1300}{1 + (1300x0.0025)} = \frac{1300}{1 + 3.25}$$

$\frac{1300}{4.25}$ = 306

The sample size of 306 was adopted for this study.

Table 1 Distribution of Questionnaire

Group	Campuses	
	Total	**%**
Students	180	64
Works and service Department	30	11
Physical Planning Unit	19	7
Bursary Department	15	6
Academic Staff	36	12
Sub Total	280	100%

Source: Researcher's field study (2021)

3.3. Method of Data Analysis

The data generated for this study were analyzed with appropriate statistical techniques. The techniques included frequency, percentages and mean score. The hypotheses postulated were put in null (Ho). All analysis was done using Statistical Package for Social Science (SPSS) version 21. The hypotheses were tested and its results were developed.

Table 2 Responses on the Age of Buildings that Deteriorate Fast

Ages of Buildings that Deteriorate Fast	No of Responses	Percentages (%)
1 – 5 years	10	10.00
6 – 10 years	30	30.00
11 years and above	50	50.00
No idea	10	10.00

Source: Researchers field survey 2021

4. Responses on the Ages of Buildings that Deteriorate Fast

The results in table 2 shows that 10 respondents which represented 10,00% are of the opinion that buildings constructed between 1-5 years ago deteriorate fast, followed by buildings constructed between 6-10 years ago as indicated by 30 (30.00%) respondents, while majority of 50 respondents representing 50.00% disagreed and maintained that buildings constructed 11 years and above deteriorate faster than other buildings.

Table 3 Rate of Deterioration of Building Elements/Components

S/N	Building Elements/Components	Variables	No of Responses	Percentages (%)
1	Foundations	High	2	2.00
		Low	-	-
2	Floor slabs and finishes	High	15	15.00
		Low	-	-
3	Walls	High	20	20.00
		Low	-	-
4	Columns	High	5	5.00
		Low	-	-
5	Beams	High	2	2.00
		Low	-	-
6	Doors and Windows	High	15	15.00
		Low	-	-
7	Plumbing fittings	High	15	15.00
		Low	-	-

8	Electrical fittings	High	15	15.00
		Low	-	-
9	Roofs/Ceilings	High	5	5.00
		Low	-	-
10	Painting and Decoration	High	6	6.00
		Low	-	-
Total			100	100

Source: Researchers Field Survey 2021

The remaining 10(10.00%) respondents have no idea at all. Consequently, the direct observations and walkthrough evaluations conducted by the researcher reveals that, apart from the buildings constructed 11 years and above, other buildings have started developing cracks, especially at Awka campus of the university. This is attributed to soil condition of the area, which is cohesive in nature. There is need therefore, to conduct soil investigation before embarking on any building development in the area, at least to know the bearing capacity of the soil and type of foundation to be used.

4.1. Respondents Responses on the Rate of Deterioration of Building Elements/Components

On the issue of the rate at which building elements, components deteriorate. Table 3 shows that foundations and beams deteriorate at the rates of 2.00% as pointed out by 2 respondents. Floor slabs and finishes, doors and windows, plumbing and electrical fittings all deteriorate at the rates of 15.00%. 20 respondents representing 20.00% said that walls deteriorate faster than other elements/components. While 6 respondents maintained that painting and decoration deteriorate at the rate of 6.00%. This trend shows that the rate at which building elements/components deteriorate in the study area are increasing. For example, based on the observation and walkthrough conducted by the researcher, revealed that most of the walls have various cracks on them. Therefore, there is need to intensify periodic inspection and maintenance of buildings in the study university.

4.1.1. Hypothesis Test

The design and construction of buildings do not significantly cause deterioration of educational buildings.

The intent of the hypothesis is to see whether design and construction of buildings cause deterioration of educational buildings.

4.2. T-Test Analysis for Design and construction of Buildings

Table 4 One-Sample Statistics

	N	Mean	Std. Deviation	Std. Error Mean
Design	7	14.2857	9.32227	3.52349
Construction	7	14.2857	5.34522	2.02031

(a)Predictors: (constant) Design and construction
Source: Researchers field survey 2021

Table 5 One-Sample Test

	Test Value = 0						
	T	df	Sig. (2-tailed)	Decision	Mean Difference	95% Confidence Interval of the Difference	
						Lower	Upper
Design	4.054	6	.007	SD	14.28571	5.6641	22.9074
Construction	7.071	6	.000	SD	14.28571	9.3422	19.2292

SD=significant difference; (a) Predictors: (constant) design and construction (b) Dependent variable: deterioration of educational buildings
Source: Researchers field survey2018

4.2.1. Decision Rule

Since the significant difference (0.007 and 0.000) of the t-test are less than 0.05 for the design and construction test respectively, we reject the null hypothesis which states that design and construction of buildings do not significantly cause deterioration of educational buildings and acceptthat design and construction of buildings significantly cause deterioration of educational buildings.

4.3. Regression Analysis for Design and Construction of Buildings

Table 6 Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	0.847	0.717	0.660	5.76064
2	1.000[b]	1.000	1.000	0.00000

(a) Predictors: (constant) Design and Construction
Source**:** Researchers field survey 2018

Table 7 ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	419.790	1	419.790	12.650	0.016[b]
	Residual	165.925	5	33.185		
	Total	585.714	6			
2	Regression	585.714	2	292.857	.	.[c]
	Residual	0.000	4	0.000		
	Total	585.714	6			

(a) Predictors: (constant) Design and construction Source: Researchers field survey 2021
(b) Dependent variable: Deterioration of educational buildings.

4.3.1. Statistical Results

The regression model summary table shows that the correlation coefficient (R) of 0.847 and 1.000 indicate a very strong linear relationship between design and construction. The coefficient of determination (R^2) value of 0.717 and 1.000 indicates that almost all the variations that exit in design and construction of the buildings significantly cause deterioration of educational buildings were accounted for in the institution and the significant difference of the F-statistic is less than 0.05 indicating an overall significance.

4.3.2. Decision Rule

Since the significant difference, P-value- 0.016 at which the regression coefficient B (0.897) was obtained is less than 0.05, we reject the null hypothesis which says that design and construction n of buildings do not significantly cause deterioration of educational buildings and accept the alternative hypothesis which says that design and construction of buildings significantly cause deterioration of educational buildings. This shows that design and construction of buildings have a significant effect on maintenance of buildings.

4.4. Plates 1-6 Showing Photographs of Maintenance Problems in the Institution

Plate 1 Longitudinal Crack and Dampness at the Foundation; Source: Researchers field study (2018)

Plate 2 Crack and Dampness at the Foundation ; Source: Researchers field study (2018)

Plate 3 Longitudinal, Vertical and Diagonal Cracks; Source: Researchers field study (2018)

Plate 4 Cracked Floor on Building; Source: Researchers field study (2018)

Plate 5 Cracked Floor Slab; Source: Researchers field study (2018)
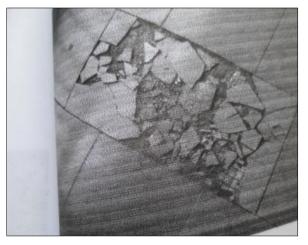

Plate 6 Defective Floor tiles; Source: Researchers field study (2018)

5. Discussion

The research is based on determine factors responsible for deterioration of building structures in Tertiary institutions. Data and information obtained from the quantitative research instruments were used to test the hypothesis postulated by the researcher. The result from this study demonstrated that many designers do not integrate buildability and maintainability analysis during the design stage of buildings. A survey carried out by Adekoya, (2006) reveals that, one of the factors that contribute to deterioration of buildings is failure to carryout maintainability analysis during the design stage. Ikpo, (2008) share the same view that designers do not highlight the importance of maintainability analysis at the design stage, which in turn affect the performance of the finished product. In view of this, the researcher therefore, recommends that buildability and maintainability analysis be integrated during the stage of buildings. Builders who are responsible for production of such document should be part of the design team, because of their expertise, in order to ensure maximization of project goals.

6. Conclusion

The research is based on determine factors responsible for deterioration of building structures in Tertiary institutions. Therefore, without adequate maintenance management and functional buildings, teaching and learning cannot be achieved. It is expected that the results of this research will assist in re-engineering the maintenance management of buildings and decision-making process of the functions and procurement of both existing and future buildings in the institution. The research will contribute in no small way in reducing the building maintenance problems in the institution. Therefore it has opened a window of opportunities for researchers in this area.

Compliance with ethical standards

Acknowledgments

Disclosure of conflict of interest

There is no conflict of interest in this manuscript article

Statement of informed consent

The authors has the consent of the case study establishment for the survey, interview and the respondents data collected in the study area.

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