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Analysing the Physical Condition of Buildings: A Case Study of an Institution of Learning in Nigeria

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Abstract

Buildings depreciate with time and gradually perform less than they are expected. This is a concern for building owners and users. Research on depreciation of building tends to focus on identifying or categorising defects. However, investigations that examine the condition of public buildings that inhabit large and frequent users is limited. The aim of this research is to analyse the physical condition of public buildings in an institution of learning. This study adopts a case study approach involving physical observations and the condition rating of three buildings in an institution of learning in Nigeria. The results of the analysis showed that there were several similar defects on the walls, floors, roof, electrical and mechanical services. The results on the condition of the buildings showed average condition index values indicating that the buildings were in moderate condition with the laboratory in a better condition with an average condition rating of 0.58 and the offices with an average condition rating of 0.52 and the classes with an average condition rating of 0.44. The study argues that improving the condition or state of the buildings would lead to enhanced building performance.

Keywords: buildings, condition, building condition index, defects, building performance

1. Introduction

Buildings slowly depreciate over time and gradually perform less than they are required (Olubajo *et al.* 2024; Silva and de Brito, 2021). This is a concern for building owners and users who need or use current information about the physical condition of buildings they inhabit to avoid problems with poor performance such as building failure, accidents and fatalities. One established way to gain knowledge or information about a building or the performance of a structure is by examining the condition of the building fabric, elements, and services to determine maintenance needs. This is because the condition of a building reflects the state or performance of the building and a low performing building is usually not safe for occupants. This shows that knowledge on the condition of building per time is important for decision making and this raises questions on the type of depreciation or defects that develop in buildings that usually inhabits large volume of people over time.

Two main themes dominate the discussion on the depreciation of buildings in the literature. Some studies focus on identifying or categorising the types of defects in buildings (Olubajo *et al.* 2024; Waziri, 2016). Other studies focus on the maintenance approach in handling the depreciation of buildings (Motawa and Almarshad, 2013). However, investigations that examine or analyse the condition of public buildings such as hospitals or schools that inhabit large number of frequent users are limited. Therefore, the aim of this study is to examine the physical condition of multiple buildings in an institution of learning in Nigeria. The section that follows reviews literature on aspects of the condition of a building such as defects, performance and maintenance.

2. Literature Review

2.1 Building Defects

The construction industry is one of the largest contributors to the economic development of a country, but dealing with major challenges such as building defects can affect project cost, duration and stakeholder relationships. Thus, to reduce these adverse effects, identification of defects in the early stages of the construction is essential (Pamera and Gurmu, 2020). Building defects can be categorized as structural and non-structural defects. Structural defect refers to any defect in a structural element of a building that is attributable to defective design, faulty workmanship or use of inappropriate materials, and a combination of these. Whereas a non-structural defect in building can be described as a defect in a non-structural element of the building as a result of defective residential building work (Waziri, 2016). These defect types usually occur in building parts such as roofs, walls, floors, ceiling, toilets, doors and windows. Other common building defects such as cracks, peeling paint, rising dampness, defective plaster

rendering usually occur on walls (Wen and Mydin, 2013). Defects that directly affect the performance of structures are caused by poor design or construction (Alomari 2022). Structural defect usually occurs when something goes wrong with the design that will affect its strength and stability. It is therefore important to understand the material properties, behaviour, the design process and the static or dynamic forces acting on building (Jamaluddin *et al.* 2017). According to Ayininuola and Olalusi (2004) wall cracks, foundation settlement and buckling of columns are the most common building defects in Nigeria. Defects in building façades affect the structural integrity of buildings and degrade external appearance. This type of defect can be managed during maintenance (Lee *et al.* 2020). A building defect occurs when a building loses its ability to perform its function. Building defect can be categorized as physical defect (Pamera and Gurmu, 2020). Examples of physical defect are strength and performance failures due to the inability of the building to function as expected by the established acceptable limit suggested by standard codes (Jamaluddin *et al.* 2017). Alomari (2022) classified defects into eight categories according to the causes of their occurrence such as: poor performance, cracked objects, abrasion, separation, improper fitting, missing mission, surface appearance, and water issue. The first step in resolving any building defect is by diagnosing correctly through inspection of the cause buildings defect (Alomari 2022).

2.2 Building Performance

In recent times, the construction industry has been placing higher demands on quality, reduced risk and performance (De Almeida *et al.* 2015). This is because building performance plays a major role in the expectations expressed by owners and occupants and their fulfilment by designers and building operators (Augenbroe and Park 2005). Building performance indicators and characteristic involves the measurement and assessment along with management of energy, lighting, thermal comfort, operational processes and maintenance according to the interests of building's owners, operators, and occupants (Ahmed *et al*. 2011). Performance-based buildings strengthen the decision-making capacity of the various stakeholders and participants in the building sector (Lützkendorf and Lorenz 2006).

2.3 Building Maintenance

Buildings are essential and regular maintenance is required for a building to function optimally and accommodate the activities for which they are constructed for (Ogunoh *et al*. 2018). Building maintenance can be defined as activities or services provided in order to preserve, protect and restore a building structure after completion or after any repair or replacement to current standards to enable it to serve its intended functions throughout its entire lifespan without upsetting its original features (Olarewaju and Abdul-Aziz 2014).
According to Au-Yong *et al.* (2014) building maintenance is the combination of technical and administrative actions to ensure the items and elements of a building are in an acceptable standard to perform their required functions. Making decisions for the maintenance of a building requires the integration of various types of information and knowledge created by different members of construction professionals such as: maintenance records, work orders, causes and knock-on effects of failures, etc. Failing to capture and use this information/knowledge results in significant costs due to ineffective decisions (Motawa and Almarshad 2013).

Furthermore, literature has categorised the maintenance of buildings into two main categories namely: preventive or corrective maintenance (Stenström *et al.* 2016). A preventive maintenance is concerned with the routine maintenance plan, while, a corrective maintenance is concerned with the reactive maintenance in response to a cause of failure or break down (Motawa and Almarshad 2013). The cost of maintaining a building can reach or outweigh the initial cost of a new building when maintenance considerations is not incorporated during the design phase (Okuntade 2014). Therefore, design or construction decisions have a significant effect on the cost of maintenance. This shows that maintenance should not be a passive action or plan. Rather, maintenance should be planned ahead, and organised dynamically to achieve the best value (Olarewaju and Abdul-Aziz 2014).

2.4 Building Condition Survey or Assessment and Tools

The condition of a building is likely to change over time as the physical and operational environments presses on the building fabric and elements (Silva and de Brito 2021). This shows that regular and continuous examination of the physical condition of building is therefore required. This is in order to develop current or up-to-date information on the condition of building that is required for maintenance work (Abbott *et al*. 2007). Therefore, it is important for heads of organisations and maintenance managers of public buildings to gain knowledge regularly by monitoring the condition of their buildings to avoid defects that can lead to the failure of buildings (Yacob *et al*. 2016). A thorough analysis of the condition of a building is a complex and technical task, requiring knowledge, time and equipment. In some countries the condition of a building is analysed on the basis of diagnosing the extent of deterioration in the building elements (de Oliveira *et al.* 2008). A condition analysis of a building is one stage in the building management system that supports effective and efficient improvement and maintenance of a building

(Linggar *et al*. 2019). This analysis is the first part of a process in developing a guideline for decision making in the planning and implementing future maintenance, and the results of effective condition assessments can be used to predict the extent of damage (Linggar *et al.* 2019). The analysis of building condition is important in evaluating building quality, and to indicate building quality, assessed buildings must be rated (Ani *et al.* 2014). One reason for assessing or analysing the condition of a building is to identify building defects (Olubajo *et al*. 2024).

Analysing the physical condition of a building or building assessment is a tool for evaluating the performance of buildings to facilitate long-term maintenance expectations. According to Yacob *et al.* (2019) condition assessment or survey is a process that involves inspecting and reporting the physical condition and functional performance of building, infrastructure systems and components (Yacob *et al*. 2019). This shows that without condition surveys, there will be insufficient or no information to carry out repair works on buildings to deal with defects.

Furthermore, a condition survey or assessment can be regarded as an important safety measure. According to Arya *et al.* (2007), these measures are generally carried out in two levels namely: preliminary and detailed. These levels of condition assessment or analysis provide a systematic a process for getting information in order to project repair, renewal, or replacement needs that will preserve the building fabric or elements (Yacob *et al.* 2019). This indicates that building condition surveys are very important to support decision making that is critical for maintenance work and activities.
One approach in literature in analysing the condition of a building is the building condition index method – BCI. This approach is designed to a quantitatively and uniformly compare and monitor groups of comparable facilities over time. Once a building condition survey has been carried out, data obtained by this process is analysed and translated into a condition value or an index coined the building condition index (BCI). This building condition index (BCI) is an index number that indicates the current condition of an asset measured relative to its new condition (Chemweno *et al*., 2017).

3. Research Method

This study adopts a case study approach involving physical observations on the condition of several buildings in an institution of learning in Auchi, Edo state, Nigeria. The decision to analyse buildings in this public institution is because there are several buildings in this institution of learning with potential maintenance needs that usually inhabits large volume of people. Therefore, analysing the physical condition of buildings in this institution offers valuable information that is useful in addressing defects and improve the building's performance.
Three buildings in the institution of learning were selected for a condition analysis namely: academic/ administrative office buildings, lecture halls/classrooms and laboratory buildings. The decision to focus on these three buildings in this institution of learning is because they are the oldest buildings in the institution and knowledge on the physical condition of these buildings can prevent potential fatalities, enhance maintenance/repair works that will create a conducive environment for learning. The condition analysis or survey will involve site visits, visual or physical observations and inspection of the buildings, facilities, and equipment to obtain data on the defects of the building elements or areas that require improvement in maintenance practices. The study adopts a building condition index (BCI) to analyse the condition of the buildings. BCI= asset current condition/as new condition. Average BCI= element total observed rating/total number of elements.

4. Results

Table 1: Building condition index for the Laboratory buildings

SN	ELEMENT/COMPONENT	OBSERVED RATING	BUILDING CONDITION INDEX	CONDITION INDEX	CONDITION
1	Floor	55	0.57	3	Fair
2	Walls	49.4	0.52	3	Fair
3	Roof	90	0.94	5	Excellent
4	Ceiling	47.2	0.49	2	Poor
5	Doors/ windows	40	0.42	2	Poor
6	Electrical services	80	0.84	4	Very good
7	Mechanical services	42.7	0.45	2	Poor
8	External surrounding	39.4	0.41	2	Poor
	Average condition rating	55.3	0.58	3	Fair

Table 1 shows the average condition rating of the laboratory. A total number of 8 laboratories were surveyed/analysed and their individual condition rating calculated before their average rating was calculated to determine the overall condition of the laboratory. The result showed the laboratories are in a moderate condition with an average condition rating of 0.58.

Table 2: Building condition index for the classroom building

SN	ELEMENT/COMPONENT	OBSERVE RATING	BUILDING CONDITION INDEX	CONDITION INDEX	CONDITION STATUS
1	Floor	43.3	0.45	2	poor
2	Walls	32	0.33	2	poor
3	Roof	90	094	5	Excellent
4	Ceiling	39	0.41	2	poor
5	Doors/ windows	31	0.32	2	poor
6	Electrical services	32.3	0.34	2	poor
7	Mechanical services	32.3	0.34	2	poor
8	External surrounding	40.3	0.42	2	poor
	Average condition rating	42.1	0.44	2	poor

Table 2 shows the average condition rating of the classes. A total number of 20 classes were surveyed/analysed and their individual condition rating calculated before their average rating calculated to determine the overall condition of the classes. The result showed that the average condition rating of the classes is in a poor condition with an average condition of 0.44.

Table 3: Building condition index for the Office buildings

SN	ELEMENT/COMPONENT	OBSERVE RATING	BUILDING CONDITION INDEX	CONDITION INDEX	CONDITION STATUS
1	Floor	60	0.63	3	fair
2	Walls	50	0.52	3	fair
3	Roof	90	0.94	5	Excellent
4	Ceiling	48.3	0.50	3	fair
5	Doors/ windows	39.2	0.41	2	poor
6	Electrical services	45	0.47	2	poor
7	Mechanical services	35.8	0.37	2	poor
8	External surrounding	30	0.31	2	poor
	Average condition rating	49.7	0.52	3	fair

Table 3 shows the average condition rating of the offices, a total number of 10 offices were surveyed/analysed and their individual condition rating calculated before their average rating calculated to determine the overall condition of the offices. The result showed that the offices are in a moderate condition with an average condition rating of 0.52

Picture 1: Broken chair

Picture 2: Faded paint and holes

Picture 3: Faded paint and holes on wall

Picture 4: Damaged ceiling

Picture 5: Exposed wire and faded paint

The picture in figure 1 show form of defect in the mechanical services which are chairs and tables observed mostly in the classes and labs. The picture indicates they are poorly used and misuse by the students. The picture in figures 2, 3 and 4 shows some of the nature of defect that was observed in the *labora*tories, classes and offices. The picture in figure 2 indicates faded paint in external surrounding ceilings that were observed close to the classes and laboratory, indicating gradual decay of the concrete ceiling paint. The picture in figure 3 shows hole in the walls that were observe mostly in classes and laboratory and this is likely caused due to misuse by the student and also differed maintenance that were not carried out. The picture in figure 4 indicates broken ceiling asbestos and the ceiling are not aligned which indicate that maintenance work needs to be carried out in most of the ceiling in the classes and laboratory. The picture in figure 5 indicates poorly connected wires for a socket that is exposed without a control switch in some of the laboratories and classes. This surface wiring depicts unsafe electrical wiring and connections. The picture in figure 5 also indicate faded painting which is likely due to poor workmanship of use of inferior materials. Figure 5 also indicate that the laboratories and classes require maintenance in form of painting. The findings suggest that the component is in moderate condition. An important issue emerging from these findings is that the component requires maintenance work mainly in the classes and lab.

The results from table 1, 2 and 3, show some similarities and differences in the physical condition of the laboratory and classroom building in the engineering section. This is due to the fact it is mostly used by students, while the offices are in better condition. There is a similarity between the offices, class and laboratories as the mechanical component in all facilities don't have fire extinguisher, waste base and fire alarm. The result from table 1 and 3 also show that the general description of the classes and laboratory are very similar and this is due to the fact that their nature of defect are almost same. This is mostly due to misuse by the larger population of people i.e., the students as also observed in Javiri *et al*. (2018) study as the damages were observed in institutional buildings components due to depreciation of some component were as the result of increased human activities (student) who are mainly occupant of facility. This can be seen from the pictures taken during the survey and also from the building condition index. The average BCI for the classes, laboratory and offices are 0.44, 0.52 and 0.58 which clearly indicates that the facility and component are in a fair condition but require maintenance. The BCI clearly shows that the classes, laboratory and offices lack maintenance as most of the component which is required to make most of the component function well. This is also clearly stated by Linggar *et al.* (2019) that maintenance is required to restore the quality and performance of degraded buildings and its component in other to enable them perform Effectively and efficiently in both quality and economy.

5. Discussion

The study analysed the similarities and difference between the condition of the three buildings. The study did not find a significant difference between the classes, offices and laboratory building. Evidence presented from the condition analysis indicated that the average condition rating of the laboratory shows that the floor component is in an average condition with deteriorated surfaces that require attention and worn-out finishes that requires maintenance. The wall component had minor defects such as cracks, peeling, cobwebs and dust stains. The services are functional but need attention, the roof component is as new, the ceiling has potential problems (such as holes, cobwebs and dust stain), the electrical service components are a good condition and does not require any major maintenance. The mechanical services have significant backlog such as there are no fire alarms, no fire extinguisher and maintenance work exist. It was observed that the laboratory is in moderate condition with some worn finishes requires maintenance and also deferred maintenance works exists.

The average condition rating of the classes indicates that the floor components are in a moderate condition with some deteriorated surfaces that require attention. The services are functional but failing often and the wall component are badly deteriorated with potential structural problems such as horizontal cracks, peeling and cobweb stain and papers on the wall. The roof components is in an excellent condition, however, the ceiling components are in a bad condition. The services are functional but failing often and require maintenance. The study observed potential problems (such as holes, cobwebs and dust stain) in the window and doors that are in a bad condition and require significant attention. The electrical components failed frequently as the services are functional but fails often, it has potential problems (damaged fans and bulbs, exposed wires). They were significant backlog and require maintenance works, the mechanical services components are in poor condition with worn out chairs, tables and board, no fire extinguisher and no fire alarm. The average rating shows that asset in poor condition, services are functional but needs maintenance, deteriorated surfaces require significant attention.

The average condition rating of the offices shows that the floor component is in moderate condition of components, the services are functional but need attention and also worn finishes requires maintenance, the wall are in average condition with worn finishes and some major defects (cracks, peeling, cobweb and dust stain). Services are functional but requires attention. The roof components are in excellent condition as the components is as new, the ceiling component are in average condition with minor defects (such as holes, cobwebs and dust stain). The door and windows are in poor condition with defects (faded doors and windows are cracked). The electrical component is functional but fails often with potential problems (damaged fans and bulbs, exposed wires). Overall, the study rates the buildings in moderate condition with worn finishes that require maintenance, services are functional but needs maintenance and deferred maintenance work.

6. Conclusion

This study aimed at analysing the physical condition of several buildings in an institution of learning. Three buildings were selected in the public institution namely: the classrooms, offices and laboratories. The study adopted the building condition index approach to calculate the average condition of the building, components, facilities and amenities. The study analysed the similarities and difference between the condition of the three buildings using their average condition rating that was calculated. The analysis also focused on investigating the nature and extent of defect in component and amenities. The results showed that the physical condition of the classroom buildings is in very poor condition with an average condition rating of 0.44; the laboratory building and offices are in a fair condition with average condition of 0.52 and 0.58 respectively. The study also found that the facility is safe but require maintenance. The study is limited to the elements and components in the three buildings and the study recommends that the condition of more buildings in public institutions are investigated more often to facilitate effective maintenance that will aid adequate learning and conducive environment for the student and occupant. The study recommends that routine inspection should be highly encouraged to rescue some facilities that gives warning before final failure and as well as detecting danger. The study argues that improving the condition or state of the buildings would lead to enhanced building performance and facilitate effective maintenance.

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