ASSESSING THE IMPACT OF DEFECTS ON THE PERFORMANCE OF BUILDING STRUCTURES

A CASE STUDY OF BUILDINGS IN CAMPUS III

A PROJECT SUBMITTED TO THE DEPARTMENT OF BUILDING TECHNOLOGY. AUCHI POLYTECHNIC, AUCHI IN PARTIAL FUDILLMENT OF THE REQUIRMENT FOR THE AWARD OF HIGHER NATIONAL DIPLOMA (HND) DEGREE IN BUILDING TECHNOLOGY

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CERTIFICATION

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DEDICATION

This research work is dedicated to GOD Almighty, my creator, the secret behind my success, the one whose mercy and grace has kept me this far. He alone be praised.

ACKNOWLEDGEMENT

I give all praise, glory, honor and adoration in heaven and on earth to GOD ALMIGHTY, the highest authority in heaven and on earth, the creator of all things in the universe who has seen me through from the inception to the conclusion of this research work.

I owe a special thanks to my project supervisor **DR. BLDR. ELAMAH DANIEL.**

ABSTRACT

The quality output of a building construction project is undoubtedly related to how the building conforms to specifications and how reliably the building functions. The research was aimed at evaluating the impact of defects on the performance of buildings structure in campus three, Auchi Polytechnic. The research identified common defects in buildings in campus three, Auchi Polytechnic, identified the causes of defects of buildings in campus three, Auchi Polytechnic, examined impacts of defects on the performance of buildings structures in campus three, Auchi Polytechnic and proffered remedial measures with a view of mitigating the impacts of defects in campus three, Auchi Polytechnic. The targeted population of the study include Professional Builders, Quantity surveyors, Project managers, Building material merchants, Estate in Etsako west Local Government Area, Edo State. Also a total of 15 buildings which makes up buildings in Campus III was assessed with a sample size of 88 respondents. This data was gotten using Census and convenient random sampling technique. The data gotten from the research was analysed using both descriptive and inferential statistics. The findings from the research Concluded that; building defects is a general phenomenon in the study area and this is caysed by seeral reasons that ranges from poor building maintenance, poor workmanship during project construction, poor construction design and use of substandard building materials. However, the studyreccommends that; Soil and environmental tests must be carried out before the construction process begins so as to mitigate against the effect of early development of defects in building components; Since the building defects has been identified, construction professionals should plan ahead on the type of building material to be used and the best construction process to adopt in order to mitigate against the development of defects on building components and Adequate maintenance should be carried out on routine basis on all buildings in the study

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CHAPTER ONE

1.0 Introduction

1.1 Background of the study

The quality output of a building construction project is undoubtedly related to how the building conforms to specifications and how reliably the building functions (Milion, Alves & Paliari, 2017). In this sense, defect occurrences in buildings are strongly related to the quality of a construction project and inevitable. Evaluating the impact of defects in buildings and ranking the most impactful ones enable construction experts to choose which paths to take within continuous improvement activities, where more sustainable decisions regarding design and operations can be made.

Although recent studies on managing construction defects in institution buildings have focused on financial losses associated with maintenance activities based on the defect's frequency and severity (Milion, Alves, Paliari & Liboni, 2021), these studies do not take into account the levels of customer satisfaction with these projects (Milion; Alves, 2017). In this sense, conformity and reliability are not the only aspects of a project's quality since the customer evaluation of the building is essential to capture the project's value. Therefore, the capture and incorporation of customer requirements in institution projects is a long process that starts even before the project's conceptual design phase; hence the perceived quality of the built environment results from a combination of aspects such as the design, products used, construction methods, quality of the workforce, post-occupancy customer service and their management, among others (Ferraro, Costa & Vieira-da-Silva, 2009).

Understanding how the incidence of defects affects client satisfaction and influences building projects supports continuous improvement processes from conception to the use phase

of such building structures (Milion, 2017; Alves, 2009). This understanding can support a decision-making process that considers customer's needs alongside financial metrics related to organizations' financial health.

Defects result in reworking activities, which are likely understated in terms of the costs and impacts they cause (Liu, Love, Smith, Irani, Hajli & Sing, 2018).). Moreover, a high level of customer satisfaction with a building project exemplifies one factor that leads users to be loyal to a specific company (Paparoidamis, Katsikeas & Chumpitaz, 2017), thus representing an important performance metric to evaluate a building structure.

Buildings serve as shelters for humans and their belongings. They must be properly planned, designed and erected to obtain desired satisfaction from the environment. The factors to be observed in building construction include durability, adequate stability to prevent its failure or discomfort to the users, resistance to weather, fire outbreak and other forms of accidents. The styles of building construction are constantly changing with the introduction of new materials and techniques of construction.

Building defects is an unacceptable difference between expected and observed performance in building. Defects can be considered as occurring in a component when that component can no longer be relied upon to fulfill its principal functions. Limited deflection in a wall, which causes a certain amount of cracking/distortion in partitions, also the aesthetics of the building structure reasonably, is considered as a serious defect in a building structure, whereas excessive distortion resulting in serious damage to partitions, ceilings and floor finishes could be classed as a building defects (Ayininuola & Olalusi, 2004).

The defect in a structural and non-structural element/component of a building which is attributable to defective design, defective or faulty workmanship or defective materials or any

combination of these can be termed as failure in building (Richardson, 1992).Richardson (1992) stated, that structural failures are the result of over-stressing, that is, the imposition of loads in excess of the capacity of the structural components. Therefore, understanding the relationship between defects and influence on performance is an essential concern for the construction industry as their connection impacts an organization's business and their ability to have satisfied and returning customers. Accordingly, given this gap, defect occurrences must have their global impact on the construction company assessed, including features from the financial and technical spheres and from the customer's perspective. Such analysis enables optimization and prioritization of resources and the minimization of economic impact to the construction company, consequently supporting the tenets of more sustainable and environmentally conscious development over the long run.

Defects of various type and condition are identified in most of these institutional buildings the fabric to be less appealing fails in performing their functional requirements. Their causes range from many underlining reasons right from physical agents, biological, chemical and mechanical agents. Defects can also occur when buildings age or not used in accordance to design requirements as well as lack of adequate maintenance. These normally have negative impact not only on occupants of these buildings but society at large due to possible danger posed. The functionality of the buildings if not urgently considered might not fulfill their anticipated life span.

The findings of this study intend to help unveil the actual causes of defects in walls on the performance of building structures in campus three, Auchi polytechnic, Edo state and provide measures of avoiding them in order to promote cost effectiveness of building design and also to ensure that the building performs it's functional requirements as desired.

1.2 Statement of problems

The condition of buildings leaves much to be desired. The satisfaction derived from buildings in fulfilling the function and aesthetics properties is somehow missing in most buildings in campus three, Auchi polytechnic. Most of these buildings have developed various forms of defects on walls that might have resulted either through design deficiency or lack of adequate maintenance. The design problems have occurred through specification wrongly or difficult to understand by the constructors or designers forgetting about maintenance of such facilities in the future date culminating in expensive maintenance works which government is feeling reluctant to execute. Also, different types of building materials used mainly for maintenance works are not fitting with existing materials (Baiden and Tuuli, 2004). Other sources of defects have occurred from poor workmanship or unsuitable construction detailing, or inappropriate usage of the completed buildings or attack by pollutants and various agents.

The defects and faults identified include; structural defects e.g. cracks in walls, peeling of paints, wall discoloration and rising damp on walls. These defects can be attributed to some or all of the following, how the building was designed, maintenance and constructed performance of the contractors selected for the project at stake; and quality of materials used for the construction.

In the light of the aforementioned flaws, defects have affected the health and safety of the occupants also degenerated the aesthetics of the buildings due to growth of and linches and mould. According to Bella –Omunagbe, Ufuah, Elamah and Fadele (2010) defects causes buildings to keep out or insulate from cold and heat.

Many authours has worked on the concept of building defects. However there still exist a gap in literature on the causes and remedy of defects taking onto consideration specific building types such as institution buildings that forms this research scope.

1.3 Research question

i. What are the common of defects in buildings in campus three, Auchi polytechnic?

ii. What are the causes of defects of buildings in campus three, Auchi polytechnic?

iii. To examine impacts of defects on the performance of buildings structures in campus three, Auchi polytechnic?

iv. What are the remedial measures that will help mitigate the impacts of defects on building structures in campus three, Auchi Polytechnic?

1.4 Aim and objectives

This research work aim is to evaluate the impact of defects on the performance of buildings structure in campus three, Auchi Polytechnic.

To achieve this aim, the following objectives are set out.

i. To identify common defects in buildings in campus three, Auchi Polytechnic.

ii. To identify the causes of defects of buildings in campus three, Auchi Polytechnic.

iii. To examine impacts of defects on the performance of buildings structures in campus three, Auchi Polytechnic.

iv. To proffer remedial measures with a view of mitigating the impacts of defects in campus three, Auchi Polytechnic.

1.5 Hypothesis of the research

Ho: Building defects has no significant influence on the performance of building structures in campus three, Auchi Polytechnic.

H1: Building defects has significant influence on the performance of building structures in campus three, Auchi Polytechnic.

1.6 Significance of the study

The purpose of the building industry is to provide suitable accommodation for the whole community, of the quality that can be appreciated by the community, at the cost that the community can afford, within the time required by the community and within the capacity of the building industry. However, it could be deduced that the ultimate goal for any building projects is for such projects to be delivered within the shortest possible time and less maintenance, at the lowest possible cost, within the highest possible quality so as to minimize the problem and the burden of future maintenance, repairs and replacement.

The findings of this study will be of immense benefit to the general public, building clients, the construction industries, industrial technical educators, and the Local, State and the Federal governments. Findings from this research will contribute to knowledge and also provide information for both the institution and maintenance department on the current state of building structures in the institution. The results from this study will form a base for further study for both students and other researchers.

1.7 Scope and delimitation of the study

This research work will cover and identify common defects in the study area their cause and impacts on the performance of the building structures in the study area. It will also seek to proffer solutions to the identified problems. The study will also evaluate the state of all the essential components of all the buildings in campus three, their current state with a view of their impacts on the learning and the environment at the post-construction stage

CHAPTER TWO

2.0 Literature review

2.1 Building defects

A common fact in the construction industry today is constructional defects, and this has become a key attention in the construction industry which cannot be under estimated (Hasan, Razak & Endut, 2016). Therefore, defects in building construction are one of the major construction issues that need great consideration (Barkri & Mydin, 2014). It is obvious that defects are a common occurrence in buildings worldwide and it affects the functionality and performance of the buildings this implies that defects in buildings are inevitable and must occur in a building structure.

A construction defect is defined as the inability of a building component to be installed properly and thereby if fails to perform its role efficiently. According to Yacob, Ali, and Au-Yong (2019), they are defined as flaws or faults in anything that detracts from faultlessness, whereas damage to a building occurs when construction work or building elements are not fully effective. The presence of defects in the building reduces the quality and functionality of the building. One of the hindrances to the project's success is quality, while poor quality during the construction phase helps in the occurrence of many defects (Ali & Wen, 2011). As known, in the construction context, poor quality can mean that project goal cannot be achieved, or that customer needs are not being met. In addition to reducing the quality, defects also lead to additional costs. It is clear that the costs of defects have a noteworthy impact on construction project cost performance (Park, Kwon & Wang, 2011). In a study by Yacob et al. (2019) mentioned that building defects are a problem faced by most buildings, regardless of building construction techniques or age, but it all depends on the causes and factors that cause the defects

to occur. The significance of various construction defects has been established, and their importance to building maintenance is recognized (Tayeh, Aisheh, Almanassra & Salahuddin, 2020). Building defects can be caused by an architectural design error, a manufacturing defect, the use of inferior materials, improper use of materials, a contractor's failure to comply with the design, or any combination of these factors (Ahzahar, Karim, Hassan & Eman, 2011). Furthermore, it was revealed by Waziri (2016) that several construction defects could be fully explained or partially by easily identifiable construction errors that could have been predicted and thus avoided. It is worth noting that various causes have been identified in different studies. Hence, the current study focused on collecting these reasons and arranging them in several groups according to their sources. Regarding defective buildings, the most common hurdle is recovering the costs of rectifying defects discovered before physical damage occurs (Rajendra & Philip, 2004).

2.2 Common defects in building

According to Haseeb (2017) defects are categories into two namely:

2.2.1 Structural Defects in Building Construction:

These are defects that affects the structural components of the building:

i. **Cracks in foundation (substructure)**

It is the nature of construction element to crack as they age due to expansion and contraction particularly with exposure to moisture as they get wet and dry out alternately. Defects in foundation may be as a result of overloading, cracks in foundation usually runs along the foundation and the top of the building. Cracks are usually widest at the top of the building diminishing to a hairline crack at or near the foundation level (Bakri & Mydin, 2020).

ii. **Cracks in floors and slabs (superstructure)**

Cracks form in a slab when there is a tension force in the concrete that's greater than the concrete's strength in tension. Concrete's direct tensile strength is much less than its compressive strength—about 10%. So when it's pulled too hard, it cracks. Cracks also can propagate, or continue to grow, at even lower stresses. The tension can have of a lot of causes that are external or inside the concrete itself, such as internal pressure caused by freezing water or expanding aggregates (Mohammed, 2019).

iii. Cracks in Walls (superstructure)

Cracks in walls are unsightly, but they can also be an indicator of serious structural problems afoot in a building. So, how can you tell if an unsightly little crack will become a great yawning rift in your living room wall over time? The freshly-painted walls you admired at the open-for-inspection might be hiding a potential a crack. Not all cracks indicate a serious structural problem some small hairline cracks may be purely cosmetic easily addressed with filler and paint. However, large gaping cracks can be indicators of more costly structural or foundation problems that require the intervention of a structural engineer. A building inspection report will provide an assessment of the severity and likely cause of the cracks in building walls (Mackintosh, 2021)

2.2.2 Non Structural Defects in Building Construction:

Non structural defects include:

i. Defects in brick work

Defects can arise in new brickwork because of poor design or specification, the use of sub-standard materials and poor standards of workmanship. Frost attack/damage is a common problem that usually occurs in older bricks, and those that were under burnt during the firing process. In newer construction, failure through frost attack tends to be confined

to areas of severe exposure, or where the frost resistance of the brick was incorrectly specified. The ability of brick to resist frost attack is determined by their pore structure (in particular the percentage of fine pores in the brick). Frost attack occurs through a combination of excessively wet brickwork and freezing temperatures. (Designing Buildings Ltd, 2022).

ii. Dampness in old structures

Dampness can also be classified as air moisture condensation, penetrating dampness and internal plumbing leaks, below ground moisture or building specific sources (Burkinshaw and Parrett, 2004). Rising dampness occurs as a result of capillary suction of moisture from the ground into porous masonry parts of a building components such as stone, brick, blocks, earth and mortar (Halim and Halim, 2010; Ahmed and Rahman, 2010; Riley and Cotgrave, 2005).

The moisture evaporates from either face of the wall (inside or outside), allowing more to be drawn from below. The height to which the moisture will rise is determined by the evaporation rate and the nature of the wall (Halim and Halim, 2010; Ahmed and Abdul-Rahman, 2010). The normal limit for rising dampness ranges from 0.5m to 1.5m above ground level (Halim and Halim, 2010; Ahmed and Abdul- Rahman, 2010; Trotman et al., 2004). Rising dampness may show as a high-tide-like stain on wall paper and other interior finishes, and, when it is severe, as blistering of paint and loss of plaster. Damp walls encourage the growth of mold which in conjunction with high humidity, can lead to health problems to occupants (Halim and Halim,2010).Water penetration through a building enclosure depends on the simultaneous occurrence of three things: the presence of water; an opening through which water can enter and a physical force to move the water (Beall, 2000). Water can be present as rain, melting snow and

soil moisture. Several forces such as gravity, air currents, capillary suction, surface tension, kinetic energy, air pressure and hydrostatic pressure influence the penetration of water into buildings (Beall, 2000). Drips from air conditioning or hot water system overflows, rain water, pipe leakages, water from horizontal directions, etc. can also cause penetration dampnessin buildings. These sources tend to produce small, localized patches of dampness and d ecay,whereas rising dampness may affect the base of a whole building. According to Curtis (2007), dampness resulting from condensation occurs where water in the air inside a building condenses on a cooler surface. This is usually indicative of cold spots in the building, sometimes called cold bridges (Curtis, 2007). Excessive condensation frequently results in severe mould growth which can in turn create health hazards. Damp patches can appear on plaster walls in odd places, particularly on outside walls, often appearing and disappearing on a regular basis (Burns, 2010). Condensation is mostly accompanied by mold which is black in colour but can virtually be of any colour and is very common on walls and ceiling, underneath bay windows, etc. (Burns, 2010).

Defect can be concluded that design and construction defects at the least can cause minor cracking or spalling leading to concrete deterioration and may become a source of a major structural failure. Therefore a great deal of attention and care is required in designing, detailing and construction of concrete structure.

2.3 Defects in walls

According to Bella –Omunagbe, Ufuah, Elamah and Fadele (2010) it has been observed maintenance problems is more in modern buildings than old building built over time. This is as result of failure by stakeholders in the building industry to learn from their experience and make

full use of available information from science and technology. They went further to list some walls defects such as

i. Efflorescence
ii. Stains
iii. Sulphate attack
iv. Frost action
v. Settlement
vi. Lack of stability
vii. Use of unsound material or poor workmanship
viii. Corrosion of iron and steel
ix. Drying shrinkage
x. Growth of lichens and mould
xi. Deterioration of cladding materials
xii. Inability to keep out weather
xiii. Inability to insulate from cold and heat
xiv. Inability to support imposed loads on them which result in differential ovement and hence distortion and cracking.

2.3.1Efflorescence

Efflorescence is a condition that describes the loose white powder of feathery crystals or shiny deposits of soluble salts formed on the surface of new walls both internally and externally causing damage to decoration especially to walls that were painted before complete drying of the walls. Mostly these problems occur in buildings that were built hastily. Occasionally, a white crystalline deposit will appear on its surface. These deposits are likely water-soluble salts

referred to as efflorescence. Although undesirable, efflorescence is usually not harmful to brick masonry.

Causes of efflorescence

There are many mechanisms of efflorescence, often complicated. Simply stated, efflorescence occurs when water containing dissolved salts is brought to the surface of masonry, the water evaporates and the salts are left on the surface. The salt solutions may migrate across surfaces of masonry units, between the mortar and brick units, or through the pores of the mortar or brick units. There are certain simultaneous conditions that must exist in order for efflorescence to occur

i. Soluble salts must be present within or in contact with the brickwork. These salts may be present in mortar ingredients, backing materials, trim, adjacent soil, brick, etc.
ii. A source of water must be in contact with the salts for a period of time sufficient to dissolve them.
iii. A pore structure must be present in the masonry that allows the migration of salt solutions to the surface or other locations where evaporation of water can occur. A driving force, such as a temperature or humidity gradient, directs moisture through the pore structure.

2.3.2 Stain

Stains are blemish on the surface of wall. It reduces the quality of the appearance of walls in buildings. Stains occurs when rain water containing dirt deposits on the face of the wall and this often observe on walls without coping, drains discharge point. These stains can be of different colour or shade such as green, which is caused by copper or bronze, lime deposits

causes white stain while brown stain is caused corroded metals i.e. steel or iron (Bella – Omunagbe et al, 2010)

2.3.3 Sulphate attack

This defect usually occurs in brick work and is caused by Tricalcium aluminates in cement. The effect of this reaction is reflected in form of horizontal cracks on the inner surface of the wall, also mortar joins becoming white and possessing narrow cracks in the middle and surface of the mortar joints. Which spalls off mostly at advance stage (Bella –Omunagbe et al, 2010).

2.3.4 Settlement

Settlement can be in two forms, uniform settlement and differential settlement and this possess threat to the stability of the building. Uneven settlement tends to pose no threat to a building but differential settlement can cause serious damage to the building.

According (Bella –Omunagbe et al, 2010) Causes of uneven settlement can be caused by

i. Changes in ground condition over the site
ii. Inadequately condition fill under the foundations
iii. Inadequate foundations
iv. Mining subsidence

2.4 Peeling Paint

Peeling of paint is one of the most common defects which is found on the building concealment, especially on the plastered walls, ceilings, beams and columns. These components were consistently exposed to sun light, rain, wind and dampness, resulting in peeling paint Othuman & Wang, (2011). The excessive exposure spoiled the surface of paint and thus the surface became chalky, flake and blistered. The problem of peeling paint in buildings mostly occurs on the walls, internal or external. This defect is mostly enhanced as a result of the presence of moisture in the building component.

Peeling usually occurs on building components, mainly on plastered walls, columns and other areas which are exposed to excessive rain and great dampness. Some buildings that are located near the sea may face a much higher risk once the signs of peeling paint are visible on the exterior walls.

Kasim , (2009) argued that peeling paint is always the result of poor surface preparation. The majority of peeling paint problems occurs on surfaces exposed to the rain, sun, and the variation degree of temperature. He further state that if paint peels from the interior part of the building is as a result of improper surface preparation before painting. Aside from that he further stated that moisture seeps through the wall to the surface. Peeling of paints can also be regarded as a form of flaking. Flaking the falling off of small to large section of the wall due to poor adhesion between paint and wall. This happens when the surface of the wall is not given enough time to dry after preparation before painting.

Another cause of peeling is when initial paint applied on a new plaster is of low standard.

2.5 Dampness

Dampness is generally defined as unwanted and excessive water or moisture in a building structure. The present of dampness in building is one of the most damaging failures that really must be taken care of in building structure. Othuman and Wang, (2011) stated that dampness in buildings is a condition that resulted from moisture infiltration either from internal sources (e.g. leaking pipes) or external sources (e.g. rainwater). This defect becomes serious problem when various materials in the school buildings became soak for extended periods of time. Besides, excessive moisture in the air due to poor air ventilation system inside the buildings can also lead to dampness. The common type of dampness found in school buildings is penetrating damp.

Dampness was found on the ceiling and wall due to the ingress of water. The classrooms, especially on the top floor, were greatly affected by dampness of ceiling as the roof tiles were missing or blown away by wind. The rainwater penetrated directly into the building itself, resulting in dampness.

Dampness can arise from unintended water caused by leaking pipes, gutters and flashings Othuman and Wang, (2011). The leaking water penetrated into the wall, resulting in horrible water stains. Under long term of dampness penetration and poor ventilation within the building, excessive moisture promoted the growth of mould on the surface of wall. The growth of mould and fungi are ordinary consequences caused by excessive dampness. Mould and fungi will grow when they gain enough moisture and nutrients (Soleimanzadeh, & OthumanMydin, 2013).

However, the growth of mould causes a lot of problems to the school environment. It not only physically affected the appearance of the building structure, but also led to plenty of health illnesses to the students and staffs.

Bakri (2016) state that Dampness also occur when water penetrate through capillaries or cracks between mortar joints, bricks before building up trap moisture behind hard renders

. Moreover, contribution of dampness is due to the existence of gravity. The other factor such as leaking gutters or down pipes, defective drains, burst plumbing, and condensation due to inadequate ventilation so can be the factors yielding to dampness occurrence. Dampness in building originated from a number of sources such as:

i. Rain

Precipitation can be wind driven that it penetrates joints that remain watertight in normal weather condition. The gutter overflow also can collect and be the aspects of dampness a gainst walls.

ii. Condensation

Humid air condensation on cooler surface or within, or between, building materials also can result to dampness. Air can become humid in several ways, including from the occupants' water vapours).

iii. Rising damp and flooding

It may be contract with groundwater or floodwater. It also the groundwater may be absorbed by the walls and transported up the wall by capillary action.

iv. Services leaks

It may not just from pipes and tanks, but also the overflowing of condensation forming together with ventilation systems.

v. Construction process

The construction process too can play its role in this cause of defects in walls of a building. It is where the process of mixing water to form mixtures that dry out for the

construction purpose before the building is functioned, but sometimes by retaining moisture (sealed in by impermeable finishes) that shows and causes problems in the completed building.)

vi. Use of the building

This may include the cleaning of the building, spills, and apparatus leaking.

vii. Moisture in the air

It is in contrast with condensation. Hygroscopic salts can extract moisture from the air in condition that would not allow that moisture to undergo the process of condensation. Dampness comes and goes according with the change of condition. Dampness also may leave stains or traces of mould and lichens and also in certain cases, mosses.

2.6 Discolouration

It was common to found the discoloration of paintwork in the inspected school buildings. Surface discoloration of paintwork found was in brownish, blackish and yellowish colours. This defect is often related to the presence of dampness or biological attack Chong, and Low, (2006). Mould grew aggressively on the surface of paintwork where there is excessive moisture, resulting in discoloration. A simple repainting will not correct the problem for long. Furthermore, serious discoloration will lead to structural damage and appearance damage.

2.7 Cracking

Cracks happened on the various elements in school buildings such as walls, ceilings, beams, columns and even floors. There were many structural and non-structural cracks found. Structural cracks took place in walls, beams and columns. However, non- structural cracks usually happened in plaster or other finishes with cement rendering Sui Pheng, Wee, (2001). Different types of cracking such as vertical, horizontal, diagonal and hairline were found in the school buildings.

2.8 Gap and Detachment

There were some visible gaps found between the elements, such as walls, columns, beams, ceilings, door frames etc. Large and visible gaps is common when a new building is attached to an old building OthumanMydin, and Wang, (2011). Gap was also found between the wall and door frames. Shrinkage and expansion of the door frames (timber materials) due to the atmospheric conditions may result in gap. Besides door frames, other timber materials such as ceiling battens were also found to have gap from the wall. In such circumstances, dampness may penetrate into the building and resulted in water stain. Moreover, column detached from the wall is basically caused by poor construction and workmanship OthumanMydin, (2013).

2.9 Contribution /Causes of Building Defects

2.9.1 Climatic Conditions

Nigeria is a hot and humid country where heavy rainfall and warm sunshine is all year round (Ikpo Johnson, 2006). This in turn causes the buildings tend to weather promptly, especially the building materials which are exposed to external elements such as sunlight, rain, wind and atmospheric pollution. In such circumferences, problems such as dampness, mould growth, peeling paint, discoloration and corrosion can easily happen. Defects happened not solely caused by one factors; in fact, they are interlinked.

2.9.2 Building Age

Buildings are designed to serve for a long period of time say more than 30years old. The longer a building is exposed to the atmosphere, the higher tendency for it to deteriorate. In point of fact, all elements of buildings have a tendency to decay at a lesser or greater rate due to aging.

For example, timber is basically an aging building material. It will decay after a period of time if no proper inspection and maintenance are conducted.

2.9.3 Lack of building Maintenance

Most of the people do not practice scheduled maintenance, but carry out emergency maintenance when necessary, except for the private institutions. Formally, public schools have to apply and wait for the allocation from Ministry of Education for the repair and maintenance purposes when problems have occurred. However, private schools perform their maintenance programmes which are more systematic. They conducted scheduled maintenance to every component in schools in order to keep those components in good condition.

2.9.10 Poor Workmanship

Poor workmanship can worsen the building quality and performance, such as poor installation methods, poor mixing of materials, poor handling of materials and poor planning. It is found that the tiles are not installed adequately during the construction stage. In other words, they are not well aligned and untidy. Tiles are used as finishes, therefore, must be able to withstand the heavy impact acting on it as well as enhance its aesthetic value.

2.9.11 Insufficient Awareness

Vandalism is one of the irresponsible actions that can damage the school facilities and infrastructures Ikpo Johnson, (2006). Insufficient awareness and knowledge among the students are the root causes of vandalism. Besides, softer building materials often invite the cases of vandalism. The examples of vandalism are doodle on the walls and bash the doors. Apart from that, the consciousness of school authorities and students in the maintenance aspect is still low. They do not really alert and practice maintenance to look after the schools' facilities and infrastructures. This results in more damages and problems in the building structures.

2.10 Impact of defects on building performance

2.10.1 Impacts of defects on the Health and safety of buildings.

Buildings are generally considered safe and healthy environments. However, the potential for indoor air quality problems, occupational illnesses and injuries, exposure to hazardous materials, and accidental falls may be triggered be defects in the building structure. Notably, building designs must focus on eliminating or preventing hazards to personnel, rather than relying on personal protective equipment and administrative or process procedures to prevent mishaps. Defects cannot be completely avoided in a building but can be minimized to the barest minimum through the choice of design. Buildings, due to presence of defects pose great hazards to its occupants.

Defects may also hamper the health, safety of a building structure thereby impacting the welfare of building occupants the absence of good and adequate ventilation system in a building may be of serious health implication on its user.

2.10.2 Impact of defects on Aesthetic value of buildings.

Aesthetics includes the principles such as materials efficiency, forces and structure these principles put together gives the building an appealing characteristics to its user (Corbusier, 2013). Aesthetics of structures refers to the correctness of the structure. In addition, pure structural messages originate in the fundamental understanding of the structural behaviour that stems from the physical experience and perception of structural forms in nature.

The presence of defects in a building structure tends to limit the aesthetic value placed on a building. And this might have psychological impacts on its user (Milion & Alves, 2021).

2.10.3 Impact of defects on acoustic performance of the building

Acoustic comfort is defined as a state of contentment with acoustic conditions (Wong & Jan, 2003). On the other hand, noise is defined as un-wanted sound that leads to nuisance in the living or working environment (Peters, 2013) A building is expected to adequately keep out sound and for a building to perform such role the components (roof, ceiling, walls, windows and doors) of such buildings has to play their roles effectively . Especially this acoustic concept deals with noise and vibration. Unwanted sound which identify by listener can be named as noise and noise is mainly defined on listeners' subjective behaviours. Accordingly, sound enjoyed by one person may be annoying noise in another. Acoustic performance defers from building's orientation, quality of materials used, workmanship and interior layout of the space. Acoustic measurements can be used for three different purposes, namely, to indicate the effects of exterior noise from neighbouring working stations within the specific building, to indicate the ability of the working station in exterior noise reduction and to indicate the effects of traffic noise on work perform (Wong & Jan, 2003) A building with defective components tend not to perform efficiently and affects users satisfaction.

2.10.4 Impact Of defects On visual performance of building

Visual performance is defined as a subjective status of visual well-being induced by the visual environment. Visual performance of the building has a direct relationship between comfort as well as energy consumption of the building. Visual performance is not highly standardized as thermal comfort since it depends on the daylight, screens and glazing that filter the daylight and visual task (Nag, 2019). Luminance distribution, illuminance and its uniformity, glare, colour rending, colour of light, amount of daylight and flick are used to describe the qualities of visual performance. Illuminance measurements used to evaluate visual performance and different illuminance levels can be recognised for different tasks and different functional areas of the building (Nag, 2019). Glare can be identified as a common problem in visual performance and this problem can be enhanced by adequate building components. Daylight is a vital consideration for visual performance and it is basically assessed through daylight factor (Fasi & Budaiwi, 2015). According to authors, considering only about the daylight factor is not sufficient to evaluate daylight availability for visual performance in a building but also the

availability of doors and windows provided in a building. Therefore, due consideration should be given to assess potential natural lighting and shading devices.

2.10.5 Impact of defects on thermal performance of building

The condition of mind which expresses the satisfaction with the thermal environment is referred as thermal comfort or thermal performance of the building (Alencastro, Fuertes & Wilde, 2018). Thermal performance refers to three components; temperature, relative humidity and air movement (Silva & Ghisi, E, 2020). Further, Rathnayake, Sridarran & Abeynayake, (2020) explained that thermal environment is a combination of four physical variables (air temperature, mean radiant temperature, relative air velocity and air humidity) and two variables related to people (clothing and active level). Frequency of the operative temperature , intensity of thermal discomfort and fluctuation of thermal discomfort can be pointed out as three indicators for thermal performance of buildings. Defects in building has a huge role to play in terms of heat movement in a building. Buildings lacking adequate heat insulation components affects heat transmission in a building and affects the comfort of its occupants.

2.11 Remedial measures for building defect

i. Possible remedial measures to efflorescence

The affected area should be brushed off and washed periodically until the solution of salt ceases to crystalline again. In a situation where the problem seems to persist an investigation should be undertaken to possible rainwater or pipe leakage or leaking roof. If any of the mentioned causes is discovered repairs should be effected immediately.

ii. Remedial measures for stain

This defect can be remedy by applying stain removal such as diluted hydrochloric acid (Hcl_2) to the affected surface.

iii. Remedial measures for sulphate attack

The remedy is based on the severity of the defect, the brick work is allowed to dry off properly or some form of cladding is applied to the brick work (Bella –Omunagbe et al, 2010).

iv. Remedial measures for settlement

i. Introduction of buttress /buttresses to walls

ii. Demolition may be the best option is the wall if the wall is out of plumpness and replace with new walls.

iii. Introduction of tie rods the secure the wall.

iv. Underpinning

v. Remedial measure for peeling paints

i. Proper surface preparation before applying paint coat

ii. Use of quality paints

iii. Repainting of affected portion

iv. Check and replace possible pipe leakages

vi. Remedial measures for dampness

i. Physical insertion of damp proof course

ii. Installation of siphon

iii. Re-plastering

iv. Use of sealant

vii. Remedies to roof defect leakage and water ponding

The first step to correcting this is to remove any blockages and check for proper drainage. If it has already progressed to a leak, you likely have moisture trapped under the layers of the roof which can lead to mold or rot.

viii. Roof Shrinkage

Proper roof installation is the best defense against roof shrinkage; however, if you are already experiencing damage due to this, a qualified roofing company may replace the affected sheets and decrease the pressure by cutting the flashing and installing a new flashing.

CHAPTER THREE

3.1 Research Design

In this study, the research design that will be adopted will be the mixed method i.e. quantitative qualitative approach. This method will be adopted because it seeks to observe what is happening in the study are and the variables will be objectively analyzed without any attempt to manipulate or influence the data.

The data will be collected via well-structured check list and questionnaire. The check list will be used to record defects in the buildings surveyed and evaluate the impacts on the buildings. While the questionnaires will be used to obtain data from the occupants and users of the buildings. A walk through evaluation will be carried out to evaluate the extent of impact of defects on the building structures..

3.2 Population of the study

The targeted population of the study will include Professional Builders, Quantity surveyors, Project managers, Building material merchants, Estate in Etsako west Local Government Area, Edo State. Also a total of 15 buildings which makes up buildings in Campus III.

Description	**Population**
Professional Builders	14
Q/S	13
Estate valuers	19
Town planners	28
Architect	28
Work and maintenance officers	10
Total	**112**

	Building structure	No.	Purpose of building
1.	Block of offices	1	Administrative purpose
2.	Administrative block	1	Administrative purpose
3.	Block of classrooms	7	Academics purpose
4.	Lecture theatre	1	Academics purpose
5.	Workshop	1	Practical work
6.	Security post	1	Security purpose
7.	Mosque	1	Religious purpose
8.	Studio	1	Lecture and drawings
	Total	14	

Source: ***Field survey, 2022.***

3.3 Sample And Sampling Techniques

The Taro Yamani (1976) statistical formular will be adopted to determine the sample size.

State thus as

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

Where

N = Target population

n = Sample size

e = Level of precision

$$n = \frac{112}{[1 + 112 (0.05)^2]}$$

$$n = \frac{112}{[1 + 112 (0.0025)]} = \frac{112}{1 + 0.28}$$

n = 88

3.4 Instrumentation and procedures for data collection

For this study, check list will be adopted for the collection of data. A well- structured check list will be designed to collect data from each building. To achieve maximum result, the check will sectioned into A and B section, section A focused description and component of the building while section B will focus on core issues as it related to study objectives. The Likert

scale will be used to structure the questionnaire to capture the intensity of the respondent responses. This will take the form of a 5-point response scale of strongly agreed, Agreed, Undecided, Disagreed and strongly disagreed.

3.5 METHOD OF DATA ANALYSIS

The method used in analyzing the data will be frequency distribution table and the inferential statistics. Using tables, the calculated data will be arranged, tabulated and presented neatly to enable details analysis to be done, while the inferential statistics was adopted for the objectives. Also the SPSS (Statistical Package for social science) will be used to analyze data collected. While Chi square formular will be adopted to test the relationships between variables in the research work, and for testing whether to accept the null/alternate hypothesis as stated.

The data obtained from the objective of the study will also be analyzed using:

I. Frequency

II. Mean Item score (MIS).

III. Regression analysis

IV. Chi square test

Frequencies and Percentage

Percentile was used to analyze the profile of respondents (personal characteristics, profession, qualification, year of experience, etc.). Percentiles are ratios multiplied by 100 and help in rating several factors according to the degree of occurrence attached to them. The higher the percentage rating the higher or the more significant the importance attached to such factor(s). The essence of the percentile was to allocate a value ranging from 0 to 100 to a factor (where 100 is the highest possible value) using factor size and the total size.

It is represented Mathematically as;

$$\mathbf{P}\ (\%) = \frac{n \times 100}{N}$$

Where: P = percentage, n = Value of the item and N = Total value of the Population.

Mean Item Score

The mean item score (MIS) was employed to assess the three out of the four objectives the research was set out to achieve. The mean item score to obtain a quantitative equivalent of the average response that was provided by respondents following a 5-point Likert scale. The highest mean item score

"MIS" was ranked 1st and others in such subsequent descending order.

Using a 5-point Likert scale where 5 is the highest score and 1 being the lowest score; the mean item score was computed using equation 3.2

$$\text{Mean} = \frac{\Sigma fw}{\Sigma f}$$

Where $\sum fw$ connotes the sum of the product of all weights and the frequency of respondents opting for such weights, while $\sum f$ is the total number of respondents

Equation 3.2 can be further expanded as equation 3.2a below

$$\text{MIS} = \frac{(5 \times f5) + (4 \times f4) + (3 \times f3) + (2 \times f2) + (1 \times f1)}{f5 + f4 + f3 + f2 + f1}$$

Criteria for drawing inference from the mean score were established as follows:

$4.90 < \text{MIS} \leq 5.00$	Very significant (or very high (impact), very easy, etc.)
$3.70 < \text{MIS} \leq 4.89$	Significant (or high (impact), easy, etc.)
$2.50 < \text{MIS} \leq 3.69$	Neutral (or medium (impact), neutral, difficult, etc.).
$1.30 < \text{MIS} \leq 2.49$	Insignificant (or low (impact), difficult, etc.)
$0.00 < \text{MIS} \leq 1.29$	Very insignificant (or very low (impact), very difficult etc.).

Regression Analysis

Regression analysis is a predictive approach. It is a statistical method to predict the changes in the dependent variable based on several independent variables. Regression analysis is the statistical technique for determining the relationship between two or more variables. Regression determines the nature or direction, extent or degree and casual relationship between variables. The case where one variable, called the dependent variable, depends on only one other variable. In this study, the simple regression analysis will be used to determine the effect of project governance on performance of public projects. The basic relationship between the independent variable, represented by X, and the dependent variable, represented by Y is expressed in a mathematical equation given as:

$$Y= a + bX$$

Where Y is the dependent variable (that's the variable that goes on the Y axis), X is the independent variable (i.e. it is plotted on the X axis), b is the slope of the line and a is the y-intercept, (Bolin, 2014).

The slope or gradient measures the degree or impact of the effect relationship between the two variables, i.e. it estimates the degree or magnitude of change in Y for a unit change in X. It is positive for direct and negative for inverse relationships.

Test of Hypothesis

To determine if associations exist between various variables, cross-tabulation will be used. Hauke and Kossowski (2011) define cross-tabulation using Spearman ranked correlation as a technique for comparing two classification variables using tables with rows and columns that correspond to the level or values of each variable's categories.

Spearman Ranked Correlation test formula: $rs = \frac{1-\sum 6D^2}{}$

$$N^3-N$$

Where rs = spearman ranked correlation test, $\sum$ = summation, D = deviation between two sets of variables and N = sample size

Decision rule: *If the p-value is smaller than alpha (α), reject null hypothesis and accept Ha*

If the p-value is greater than or equal alpha (α), accept Ho and reject Ha

CHAPTER FOUR

4.0 Data Presentation, Analysis A Results and Discussion.

4.1. Introduction

In this chapter, analysis and presentation of data collected from field were analyzed. Data collected were the bio data of the respondents also the test for the following objectives; to identify common defects in buildings in campus three, Auchi Polytechnic, to identify the causes of defects of buildings in campus three, Auchi Polytechnic, to examine impacts of defects on the performance of buildings structures in campus three, Auchi Polytechnic and to proffer remedial measures with a view of mitigating the impacts of defects in campus three, Auchi Polytechnic.

4.2 Demographic Of Respondents

Table 4.1 Demographic Of Respondents

Educational qualification	**No of respondents**	**Percentage**
OND	28	33%
HND	16	19%
BSc	12	14%
M.Sc	14	17%
PhD	13	16%
Total	83	100%
Professional Qualification	**No of respondents**	**Percentage**
Architect	19	23%
Engineer	15	18%
Professional Builder	16	19%
Quantity Surveyor	33	40%
Total	**83**	**100**
Age of respondents	**No of respondents**	**Percentage**
18-22 years	10	12%
23–27 years	9	11%
28–32 years	15	18%
33- 37 years	16	19%
37 years and above	33	40%
Total	**83**	**100%**

Source: Field survey 2022

The table above shows the demographic information of the respondents. It can be seen from the table that 33 percent of the respondents are Odinary National Diploma holders. Again, 19 percent of the respondents have Higher National Diploma certificate. 17 percent have Bachelor of Science degree. 17 percent are Masters holders. Meanwhile, 16 percent are PHD holders. Moreso, the table of the professional qualification of the respondents shows that; 43 percent of the respondents are Architects, 18 percent are Engineers and 19 percent of the respondents are Quantity Surveyors. However, the average age of the respondents assessed is 28 years.

Table 4.2 Common defects in campus III buildings

Common Defects	Maintenance & Works Department			General Occupants		
	MIS	Rank within Group	Overall Rank	MIS	Rank within Group	Overall Rank
WALL						
Efflorescence	4.07	4th	4th	3.70	3rd	6th
Sulphate attack	3.80	6th	10th	3.53	4th	9th
Discoloration	3.83	5th	9th	3.47	5th	11th
Peeling of paint	4.13	3rd	3rd	4.07	1st	1st
Dampness	4.27	2nd	2nd	3.87	2nd	3rd
Cracking	4.30	1st	1st	3.87	2nd	3rd
FLOOR						
Buckled floor	4.00	1st	5th	3.70	1st	6th
Cracked floor tiles	3.87	2nd	8th	3.57	2nd	8th
Cupping	3.47	4th	16th	3.23	5th	13th
Tapping	3.87	2nd	8th	3.47	4th	11th
Swollen edge	3.70	3rd	12th	3.50	3rd	10th
ROOF						
Weathering defect in roof	3.53	2nd	15th	3.90	1st	2nd
Leaks and water ponding	3.37	3rd	17th	3.67	2nd	7th
Roof shrinkage	3.90	1st	7th	3.57	3rd	8th
Alligatoring	3.13	4th	21st	3.57	3rd	8th
Inadequate ventilators	3.53	2nd	15th	3.53	4th	9th
Blow-offs	3.20	5th	19th	3.23	5th	13th
CEILING						
Cracks in ceiling	3.73	2nd	11th	3.80	1st	4th
Water stain on the ceiling	3.97	1st	6th	3.78	2nd	5th
Condensation stain on ceiling	3.17	4th	20th	2.93	5th	15th
Leak in ceiling	3.57	3rd	13th	3.47	4th	11th
Sagging ceiling	3.73	2nd	11th	3.53	3rd	9th
FOUNDATION						
Settlement	3.27	3rd	18th	3.53	1st	9th
Heave	3.47	2nd	16th	3.43	2nd	12th
Cracks in foundation	3.83	1st	9th	3.20	3rd	14th

Table 4.2 shows the common defects in campus III buildings.

Results from Maintenance and Works department

Common defects on wall: Cracking and dampness ranked 1st and 2nd with mean score of 4.30 and 4.27 respectively, peeling of paints and efflorescence were ranked 3rd and 4th with mean scores of 4.13 and 4.07 respectively. Discoloration and sulphate attack were ranked 5th and 6th with mean scores of 3.83 and 3.80 respectively. It is thus clear that cracks and dampness are common wall defects in the study area.

Common defects on Floor: Buckle floor, cracked floor tiles and tapping ranked 1st and 2nd with mean score of 4.00 and 3.87 respectively, swollen edges and Cupping were ranked 3rd and 4th with mean scores of 3.70 and 3.47 respectively.

Common defects on roofs: Roof shrinkage, weathering defects in roofs and inadequate ventilator ranked 1st and 2nd with mean scores of 3.90 and 3.53 respectively, Leaks and water ponding and blow offs were ranked 3rd and 4th with mean scores of 3.37 and 3.20 respectively. While alligatoring was ranked 5th with mean scores of 3.13.

Common defects in ceilings: Water stain on ceiling, cracks in ceiling and sagging ceiling were ranked 1st and 2nd with mean scores of 3.97 and 3.73 respectively, Leak in ceiling and condensation stain on ceiling were ranked 3rd and 4th with mean scores of 3.57 and 3.17 respectively.

Common defects in foundation: cracks in foundation was ranked 1st mean scores of 3.83, Heave ranked 2nd with mean scores of 3.47 and settlement was ranked 3rd with mean scores of 3.27.

Results from General occupants

Common defects on wall: peeling of paints, dampness and cracking ranked 1st and 2nd with mean scores of 4.07 and 3.87 respectively, Efflorescence and sulphate attack were ranked 3rd and 4th with mean scores of 3.70 and 3.53 respectively. Discoloration ranked 5th with a mean score of 3.47. It is thus clear that peeling of paints is a common wall defects in the study area.

Common defects on Floor: Buckle floor, cracked floor tiles ranked 1st and 2nd with mean score of 3.70 and 3.57 respectively, swollen edges and tapping were ranked 3rd and 4th with mean scores of 3.50 and 3.47 respectively while cupping ranked 5th with mean score of 3.23. Thus it clear that buckle floor is a common defect in floors in the study area.

Common defects on roofs: Weathering defects in roofs and leaks and water ponding ranked 1st and 2nd with mean scores of 3.90 and 3.67 respectively, roof shrinkage, aligatoring and inadequate ventilators were ranked 3rd and 4th with mean scores of 3.57 and 3.53 respectively. While blow offs was ranked 5th with mean scores of 3.23.

Common defects in ceilings: Cracks in ceiling and water stain in ceiling were ranked 1st and 2nd with mean scores of 3.80 and 3.78 respectively, sagging ceiling and leaks in ceiling were ranked 3rd and 4th with mean scores of 3.53 and 3.47 respectively and condensation stain on ceiling was ranked 5th with mean score of 2.93.

Common defects in foundation: Settlement was ranked 1st mean scores of 3.53, Heave ranked 2nd with mean scores of 3.43 and cracks in foundation was ranked 3rd with mean scores of 3.20.

Overall Results from Maintenance and Works department

Cracking and dampness ranked 1st and 2nd with mean score of 4.30 and 4.27 respectively, while condensation stain in ceiling and aligatoring were ranked 20th and 21st with mean scores of 3.17 and 3.13 respectively. It is thus clear that cracking and dampness are the most common defects seen in buildings in the study area.

Overall Results from Occupants and Works department

Peeling of paints and weathering defects in roof ranked 1st and 2nd with mean score of 4.07 and 3.90 respectively, while cracks in foundation and condensation stain in ceiling were ranked 14th and 15st with mean scores of 3.20 and 2.93 respectively. It is thus clear that peeling of paints and weathering in roofs were the most common defects seen in buildings in the study area.

Table 4.3: Causes of Defects in Building Structures in Campus III

Causes of Defects	MIS	RANK
WALL		
Aging of the walls	4.27	1st
Salt deposit on walls	3.97	6th
Organic growth	3.87	8th
Poor surface preparation	3.90	7th
Dirty surface	3.73	10th
Use of incompatible paint	4.03	5th
Plaster shrinkage	4.13	4th
Chemical reaction	3.83	9th
Elastic deformation	4.03	5th
Thermal changes	4.20	3rd
Effect of Rain on external walls	4.23	2nd
Condensation	3.87	8th
FLOOR		
Poor workmanship	3.30	6th
Moisture from subfloor	3.90	1st
High humidity	3.30	6th
Improper floor installation	3.53	4th
Heavy impact on floors	3.17	8th
Defective tiles	3.57	3rd
Inferior materials	3.23	7th
Over loading	3.60	2nd
Extreme temperature changes	3.50	5th
ROOF		
Poor installation	3.83	1st
Leakage	3.70	4th
Improper maintenance	3.50	7th
Improper design	3.67	5th
Weathering defects of roofs	3.73	2nd
Damage of roof due to wind action	3.63	6th
Roof defects due to improper flashing	3.73	3rd
CEILING		
Ageing	3.80	1st
Hidden water	3.53	4th
Defective noggin	3.33	5th
Inferior material	3.77	2nd
Poor workmanship	3.63	3rd
FOUNDATION		
Poor building site preparation	3.37	5th
Evaporation of soil moisture	3.87	1st
Poor ground preparation	3.57	3rd
Poor soil condition	3.70	2nd
Plumbing leaks	3.57	3rd
Poor drainage	3.50	4th

Presence of existing service pipe	3.30	6th
Closeness to heavy vibrating equipment	3.70	2nd

Table 4.3 Shows Causes of Defects in Building Structures in Campus III

Causes of defects on wall: Aging, effects of rain on external walls and thermal changes ranked 1st , 2nd and 3rd with mean score of 4.27, 4.23 and 4.20 respectively, plaster shrinkage, use of incompatible paint, elastic deformation and salt deposit on walls were ranked 4th , 5th and 6th with mean scores of 4.13 and 4.03 and 3.97 respectively. Poor surface preparation, organic growth, condensation and chemical reaction were ranked 7th , 8th and 9th with mean scores of 3.90, 3.87 and 3.83 respectively and dirty surface was ranked 10th with a mean score 3.73.

Causes of defects on floor: moisture from subfloor, overloading and defective tiles ranked 1st , 2nd and 3rd with mean score of 3.90, 3.60 and 3.57 respectively, Improper floor installation, extreme temperature changes were, poor workmanship and high humidity were ranked 4th, 5th and 6th with mean scores of 3.53, 3.50 and 3.30 respectively. Inferior materials and heavy impact on floors and were ranked 7th and 8th with mean scores of 3.23 and 3.17 respectively.

Causes of defects on roof: Poor installation , weathering defects of roofs, roof defects due to improper flashing and leakage were ranked 1st , 2nd and 3rd with mean score of 3.83, 3.73 and 3.70 respectively, Improper design and damage of roof due to wind action were ranked 4th and 5th with mean scores of 3.67 and 3.63 respectively.

Causes of defects in ceiling: Ageing, inferior materials and poor workmanship, were ranked 1st, 2nd and 3rd with mean score of 3.80, 3.77 and 3.63 respectively, hidden water and defective noggin were ranked 4th and 5th with mean scores of 3.53 and 3.33 respectively.

Causes of defects in foundation: Evaporation of soil moisture, poor soil condition and closeness to heavy vibrating equipment, poor ground preparation and plumbing leaks were

ranked 1st, 2nd and 3rd with mean score of 3.87, 3.70 and 3.57 respectively, poor drainage, and poor building site preparation were ranked 4th and 5th with mean scores of 3.50 and 3.37 respectively and presence of existing service pipe was ranked 6th with mean score of 3.30.

Table 4.4: Impacts of Common Defects on Building Performances in Campus III

Impacts Of Common Defects On Building Performance	MIS	Rank
WALL		
Efflorescence		
Structural damage to building material	4.06	1st
Disintegration of Masonry	4.01	2nd
Damage of furniture	3.80	4th
Unhygienic Condition	3.77	5th
Crumbling of Plaster	3.87	3rd
Dry rot of woodwork	3.73	6th
Sulphate attack		
Cracking	3.97	1st
Lost of strength of material	3.67	4th
Disintegration of concrete	3.60	5th
Decrease in the durability of concrete	3.80	2nd
Loss in compressive strength of concrete	3.70	3rd
Discoloration		
Reduces the Aesthetic value of the building	3.63	1st
Acoustic performance of the building	3.50	2nd
Thermal performance of building	3.36	3rd
Peeling of paint		
Aesthetic value of buildings	3.80	1st
Acoustic performance of the building	3.60	2nd
Thermal performance of building	3.50	3rd
Dampness		
Impacts on the Health and safety of occupants	3.93	1st
Affecting the normal room temperature	3.87	2nd
Falling off of plaster	3.67	3rd
Damage of building furniture	3.63	4th
Cracking		
Impacts the safety of the building	3.87	1st
Accelerate the ageing process of the building	3.60	2nd
Reduce the mechanical resistance of the structure	3.50	3rd
Reduce the ability of the structure to absorb stress	3.36	4th

Table 4.4 Shows Impacts of Common Defects on Building Performances in Campus III

Impacts of wall defects on building performance (Efflorescence):

Table 4.4 revealed that structural damage to building material and disintegration of masonry ranked 1st and 2nd with mean score of 4.06 and 4.01 respectively, crumbling of plaster and damage of furniture were ranked 3rd and 4th with mean scores of 3.87 and 3.80 respectively. unhygienic condition and dry rot of wood work were ranked 5th and 6th with mean scores of 3.77 and 3.73 respectively.

Impacts of wall defects on building performance (Sulphate attack):

It was revealed that creaking, decrease in the durability of concrete and loss in compressive strength of concrete ranked 1st , 2nd and 3rd with mean score of 3.97, 3.80 and 3.70 respectively, loss of strength of material and disintegration of concrete were ranked 4th and 5th with mean scores of 3.67 and 3.60 respectively.

Impacts of wall defects on building performance (Discoloration):

It was revealed that reduction in the aesthetic value of the building was ranked 1st mean score of 3.63, acoustic performance of the building was ranked 2nd with mean score of 3.50 while thermal performance of building was ranked 3rd with mean scores of 3.36.

Impacts of wall defects on building performance (Peeling of paint):

It was revealed that reduction in the aesthetic value of the building was ranked 1st mean score of 3.80, acoustic performance of the building was ranked 2nd with mean score of 3.60 while thermal performance of building was ranked 3rd with mean scores of 3.50.

Impacts of wall defects on building performance (Dampness):

It was revealed, impacts on health and safety of occupants and affecting the normal room temperature was ranked 1st and 2nd with mean score of 3.93 and 3.87 respectively, Falling off of

plaster and damage of building furniture were ranked 3rd and 4th with mean score of 3.67 and 3.63 respectively.

Impacts of wall defects on building performance (Cracking):

It was revealed, impacts on the safety of the building and accelerating the aging process of the building were ranked 1st and 2nd with mean score of 3.87 and 3.60 respectively, reduces the mechanical resistance of the structure was ranked 3rd with mean score of 3.50 and reduction in the ability of the structure to absorb stress was ranked 4th with mean score of 3.36.

Table 4.5 General impacts of defects on the performance of building structures in campus III

Impacts	MIS	Rank
Health and safety	3.97	1st
Aesthetic values of building	3.63	2nd
Acoustic values of building	2.73	4th
Thermal performance of building	3.43	3rd

Table 4.5 General impacts of defects on the performance of building structures in campus III

It was revealed that impact of the health and safety was ranked 1st mean score of 3.97, acoustic value of the building was ranked 2nd with mean score of 3.63 while thermal performance of the building was ranked 3rd with mean scores of 3.43. Acoustic value of the building was ranked 4th with mean score of 2.73.

Table 4.6 Remedial Measures to mitigate common defects in buildings.

Remedial measures	MIS	Rank
Routine Inspection	4.13	1st
Preventing of trees from interfering with roof	3.63	6th
Use of fastening	3.50	7th
Engaging professionals on building construction	4.03	2nd
Regular maintenance	3.83	3rd
Dewatering	3.80	4th
Providing sufficient base area below walls and columns	3.67	5th
Ensure gutters are intact and clean	3.83	3rd
Adequate Landscape & External works	3.37	8th

Table 4.6 shows the remedial measures to mitigate common defects in buildings. It was revealed that routine inspection and engaging professionals on building construction were ranked 1st and 2nd with mean scores of 4.13 and 4.03 respectively. Regular maintenance, Ensuring gutters are

intact and clean and dewatering were ranked 3rd and 4th respectively with mean scores of 3.83 and 3.80. Providing sufficient base area below walls and columns and preventing of trees from interfering with roof were ranked 5th and 6th with mean scores of 3.67 and 3.63 respectively while Use of fastening and adequate landscape & external works was ranked 7th and 8th with mean scores 3.50 and 3.37 respectively.

4.3 Discussion of findings

Results from Maintenance and Works department

Results from the study revealed that common defects on wall in the study area included cracking and dampness which were ranked 1st and 2nd with mean score of 4.30 and 4.27 respectively, discoloration and sulphate attack were ranked 5th and 6th with mean scores of 3.83 and 3.80 respectively. It is thus clear that cracks and dampness are common wall defects in the study area.

Common defects on Floor: Buckle floor, cracked floor tiles and tapping ranked 1st and 2nd with mean score of 4.00 and 3.87 respectively, swollen edges and Cupping were ranked 3rd and 4th with mean scores of 3.70 and 3.47 respectively. From the findings it is clear that poor workmanship were done in the study area.

Common defects on roofs: Roof shrinkage, weathering defects in roofs and inadequate ventilator ranked 1st and 2nd with mean scores of 3.90 and 3.53 respectively, while alligatoring was ranked least as a roof defects in the study are. In view of the aforementioned poor quality material were used in construction of roofs.

Common defects in ceilings: Water stain on ceiling, cracks in ceiling and sagging ceiling were ranked 1st and 2nd with mean scores of 3.97 and 3.73 respectively, Leak in ceiling and

condensation stain on ceiling were ranked 3rd and 4th with mean scores of 3.57 and 3.17 respectively.

Common defects in foundation: Cracks in foundation was ranked 1st mean scores of 3.83, Heave ranked 2nd with mean scores of 3.47 and settlement was ranked 3rd with mean scores of 3.27. It is clear that the foundations were not properly deigned at the sub-structural level.

Results from General occupants

Common defects on wall: peeling of paints, dampness and cracking ranked 1st and 2nd with mean scores of 4.07 and 3.87 respectively, Efflorescence and sulphate attack were ranked 3rd and 4th with mean scores of 3.70 and 3.53 respectively. Discoloration ranked 5th with a mean score of 3.47. It is thus clear that peeling of paints is a common wall defects in the study area.

Common defects on Floor: Buckle floor, cracked floor tiles ranked 1st and 2nd with mean score of 3.70 and 3.57 respectively, swollen edges and tapping were ranked 3rd and 4th with mean scores of 3.50 and 3.47 respectively while cupping ranked 5th with mean score of 3.23. Thus it clear that buckle floor is a common defect in floors in the study area.

Common defects on roofs: Weathering defects in roofs and leaks and water ponding ranked 1st and 2nd with mean scores of 3.90 and 3.67 respectively, roof shrinkage, aligatoring and inadequate ventilators were ranked 3rd and 4th with mean scores of 3.57 and 3.53 respectively. While blow offs was ranked 5th with mean scores of 3.23.

Common defects in ceilings: Cracks in ceiling and water stain in ceiling were ranked 1st and 2nd with mean scores of 3.80 and 3.78 respectively, sagging ceiling and leaks in ceiling were ranked 3rd and 4th with mean scores of 3.53 and 3.47 respectively and condensation stain on ceiling was ranked 5th with mean score of 2.93.

Common defects in foundation: Settlement was ranked 1st mean scores of 3.53, Heave ranked 2nd with mean scores of 3.43 and cracks in foundation was ranked 3rd with mean scores of 3.20.

Overall Results from Maintenance and Works department

Cracking and dampness ranked 1st and 2nd with mean score of 4.30 and 4.27 respectively, while condensation stain in ceiling and aligatoring were ranked 20th and 21st with mean scores of 3.17 and 3.13 respectively. It is thus clear that cracking and dampness are the most common defects seen in buildings in the study area.

Overall Results from Occupants and Works department

Peeling of paints and weathering defects in roof ranked 1st and 2nd with mean score of 4.07 and 3.90 respectively, while cracks in foundation and condensation stain in ceiling were ranked 14th and 15st with mean scores of 3.20 and 2.93 respectively. It is thus clear that peeling of paints and weathering in roofs were the most common defects seen in buildings in the study area.

Causes of defects on wall: Aging, effects of rain on external walls and thermal changes ranked 1st , 2nd and 3rd with mean score of 4.27, 4.23 and 4.20 respectively, plaster shrinkage, use of incompatible paint, elastic deformation and salt deposit on walls were ranked 4th , 5th and 6th with mean scores of 4.13 and 4.03 and 3.97 respectively. Poor surface preparation, organic growth, condensation and chemical reaction were ranked 7th , 8th and 9th with mean scores of 3.90, 3.87 and 3.83 respectively and dirty surface was ranked 10th with a mean score 3.73.

Causes of defects on floor: moisture from subfloor, overloading and defective tiles ranked 1st , 2nd and 3rd with mean score of 3.90, 3.60 and 3.57 respectively, Improper floor installation, extreme temperature changes were, poor workmanship and high humidity were ranked 4th, 5th

and 6th with mean scores of 3.53, 3.50 and 3.30 respectively. Inferior materials and heavy impact on floors and were ranked 7th and 8th with mean scores of 3.23 and 3.17 respectively.

Causes of defects on roof: Poor installation , weathering defects of roofs, roof defects due to improper flashing and leakage were ranked 1st , 2nd and 3rd with mean score of 3.83, 3.73 and 3.70 respectively, Improper design and damage of roof due to wind action were ranked 4th and 5th with mean scores of 3.67 and 3.63 respectively.

Causes of defects in ceiling: Ageing, inferior materials and poor workmanship, were ranked 1st, 2nd and 3rd with mean score of 3.80, 3.77 and 3.63 respectively, hidden water and defective noggin were ranked 4th and 5th with mean scores of 3.53 and 3.33 respectively.

Causes of defects in foundation: Evaporation of soil moisture, poor soil condition and closeness to heavy vibrating equipment, poor ground preparation and plumbing leaks were ranked 1st, 2nd and 3rd with mean score of 3.87, 3.70 and 3.57 respectively, poor drainage, and poor building site preparation were ranked 4th and 5th with mean scores of 3.50 and 3.37 respectively and presence of existing service pipe was ranked 6th with mean score of 3.30.

Impacts of wall defects on building performance (Efflorescence):

Table 4.4 revealed that structural damage to building material and disintegration of masonry ranked 1st and 2nd with mean score of 4.06 and 4.01 respectively, crumbling of plaster and damage of furniture were ranked 3rd and 4th with mean scores of 3.87 and 3.80 respectively. unhygienic condition and dry rot of wood work were ranked 5th and 6th with mean scores of 3.77 and 3.73 respectively.

Impacts of wall defects on building performance (Sulphate attack):

It was revealed that creaking, decrease in the durability of concrete and loss in compressive strength of concrete ranked 1st , 2nd and 3rd with mean score of 3.97, 3.80 and 3.70 respectively, loss of strength of material and disintegration of concrete were ranked 4th and 5th with mean scores of 3.67 and 3.60 respectively.

Impacts of wall defects on building performance (Discoloration):

It was revealed that reduction in the aesthetic value of the building was ranked 1st mean score of 3.63, acoustic performance of the building was ranked 2nd with mean score of 3.50 while thermal performance of building was ranked 3rd with mean scores of 3.36.

Impacts of wall defects on building performance (Peeling of paint):

It was revealed that reduction in the aesthetic value of the building was ranked 1st mean score of 3.80, acoustic performance of the building was ranked 2nd with mean score of 3.60 while thermal performance of building was ranked 3rd with mean scores of 3.50.

Impacts of wall defects on building performance (Dampness):

It was revealed, impacts on health and safety of occupants and affecting the normal room temperature was ranked 1st and 2nd with mean score of 3.93 and 3.87 respectively, Falling off of plaster and damage of building furniture were ranked 3rd and 4th with mean score of 3.67 and 3.63 respectively.

Impacts of wall defects on building performance (Cracking):

It was revealed, impacts on the safety of the building and accelerating the aging process of the building were ranked 1st and 2nd with mean score of 3.87 and 3.60 respectively, reduces the

mechanical resistance of the structure was ranked 3rd with mean score of 3.50 and reduction in the ability of the structure to absorb stress was ranked 4th with mean score of 3.36.

General impacts of defects on the performance of building structures in campus III

It was revealed that impact of the health and safety was ranked 1st mean score of 3.97, acoustic value of the building was ranked 2nd with mean score of 3.63 while thermal performance of the building was ranked 3rd with mean scores of 3.43. Acoustic value of the building was ranked 4th with mean score of 2.73.

CHAPTER FIVE

5.0 Summary of findings, Conclusion and Recommendation.

This research work aim is to evaluate the impact of defects on the performance of buildings structure in campus three, Auchi Polytechnic. The study identified common defects in buildings in campus three, Auchi Polytechni; identified the causes of defects of buildings in campus three, Auchi Polytechnic; examined impacts of defects on the performance of buildings structures in campus three, Auchi Polytechnic; and proffered remedial measures with a view of mitigating the impacts of defects in campus three, Auchi Polytechnic

Based on the research findings, the following conclusions were drawn;

Building defect is prominent on almost all the buildings in the institution. This ranges from walls to roofs, doors, windows and other building components. The degree of effect ranges from one building item to the other. However, The study revealed that the most common defects on walls are cracking on walls and dampness of wall base.

Moreso, buckled floors and cracked floors were common defects found on all parts of the buidings. Again, roof shrinkage and weathering defects in roof were among the most defects in roofs. Its also observed that water stain on the ceilings and cracks in ceilings were among the most defects seen in ceiling in the study area. the study also posited that cracks in foundations is commonly seen in foundation base. This is mostly caused by rain on external walls.

In conclusion, building defects is a general phenomenon in the study area and this is caysed by seeral reasons that ranges from poor building maintenance, poor workmanship during project construction, poor construction design and use of substandard building materials. However, the study made some recommendations.

Recommendations

1. Soil and environmental tests must be carried out before the construction process begins so as to mitigate against the effect of early development of defects in building components.
2. Since the building defects has been identified, construction professionals should plan ahead on the type of building material to be used and the best construction process to adopt in order to mitigate against the development of defects on building components
3. Adequate maintenance should be carried out on routine basis on all buildings in the study area so as to keep them in a usable state.
4. Building manuals must be made by contractors to cover for the live span of all the building components. This will enable building owners to plan ahead on either maintaining or replacement of bad building components.

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APPENDIX

Department of Building Technology,
Auchi Polytechnic,
Auchi.
Edo State
October, 2022.

Dear Respondent,

REQUEST TO COMPLETE QUESTIONNAIRE

I am a final year student of the Department of Building Technology, Federal Polytechnic, Auchi. currently carrying out a research on a topic titled: **"Assessing the Impacts of Defects on the Performance of Building Structures. A Case Study of Campus III Buildngs "** in partial fulfillment for the award of Higher National Diploma (HND) in Building Technology.

The attached questionnaire is designed to solicit information from you or your organization so that the objectives of the research can be achieved. The information supplied shall be treated confidentially and used for academic purpose only.

Thank you for your anticipated co-operation and understanding.

Yours faithfully,

Akinniranye Favour

Questionnaire

Section A : Respondents Demography

1. **Educational qualification** OND ( ) HND ( ) Bsc ( ) M.Sc ( ) P Hd ( )
2. **Professional qualification a.** Architect ( ) b. Engineer ( ) c. Professional Builder ( ) d. Quantity Surveyor ( )
3. **Working experience** 18-22 years ( ) b. 23 – 27 years ( ) c. 28 – 32 years ( ) d. 33 – 37 years ( ) e. 37 years and above ( )

Section B

Listed below are the common defects in campus III buildings. Rank in order of level of occurrence using the Likert scale below: 5- Very high 4 – High 3 – Moderate 2 – low 1 – Very low

S/N	COMMON DEFECTS	Maintenance and works dept.					General Occupant				
1	**WALL**	**5**	**4**	**3**	**2**	**1**	**5**	**4**	**3**	**2**	**1**
a.	Efflorescence										
b.	Sulphate attack										
c.	Discoloration										
d.	Peeling of paint										
e.	Dampness										
f.	Cracking										
2	**FLOOR**										
a.	Buckled floor										
b.	Cracked floor tiles										
c.	Cupping										
d.	Tapping										
e.	Swollen edge										
3	**ROOF**										
a.	Weathering defect in roof										
b.	Leaks and water ponding										
c.	Roof shrinkage										
d.	Alligatoring										
e.	Inadequate ventilators										
f.	Blow-offs										
4	**CEILING**										
a.	Cracks in ceiling										
b.	Water stain on the ceiling										
c.	Condensation stain on ceiling										
d.	Leak in ceiling										
e.	Sagging ceiling										
5.	**FOUNDATION**										
a.	Settlement										
b.	Heave										
c.	Cracks in foundation										

Below are the causes of defects in building structures in campus III buildings. Rank in order of severity using the Likert scale below: 5- very 4 – High 3 – Moderate 2 – low 1 – Very low

S/N	Causes of Defects	5	4	3	2	1
1	**WALL**					
a.	Aging					
b.	Salt deposit on walls					
c.	Organic growth					
d.	Poor surface preparation					
e.	Dirty surface					
f.	Use of incompatible paint					
g.	Plaster shrinkage					
h.	Chemical reaction					
I	Elastic deformation					
j.	Thermal changes					
k.	Effect of Rain on external walls					
l.	Condensation					
2.	**FLOOR**					
a.	Poor workmanship					
b.	Moisture from subfloor					
c.	High humidity					
d.	Improper floor installation					
e.	Heavy impact on floors					
f.	Defective tiles					
g.	Inferior materials					
h.	Over loading					
I	Extreme temperature changes					
3.	**ROOF**					
a.	Poor installation					
b.	Leakage					
c.	Improper maintenance					
d.	Improper design					
e.	Weathering defects of roofs					
f.	Damage of roof due to wind action					
g.	Roof defects due to improper flashing					
4.	**CEILING**					
a.	Ageing					
b.	Hidden water					
c.	Defective noggin					
d.	Inferior material					
e.	Poor workmanship					
5.	**FOUNDATION**					
a.	Poor building site preparation					
b.	Evaporation of soil moisture					

c.	Poor ground preparation					
d.	Poor soil condition					
e.	Plumbing leaks					
f.	Poor drainage					
g.	Presence of existing service pipe					
h.	Closeness to heavy vibrating equipment					

Below are the impacts of defects on the performance of building structures in campus III. Rank in order of severity using the Likert scale below: 5- very 4 – High 3 – Moderate 2 – low 1 – Very low

S/N	**Impacts**	**5**	**4**	**3**	**2**	**1**
a.	Health and safety					
b.	Aesthetic values of buildings					
c.	Acoustic performance of the building					
d.	Thermal performance of building					

Below are remedial measures to common defect. Please kindly rate accordingly with your level of agreement with the enlisted measures stated below: Using the Likert scale below: 5- Strongly Agreed 4 – Agreed 3 – Moderate 2 – Disagreed 1 - Strongly Disagreed

S/N	**Remedial measures**	**5**	**4**	**3**	**2**	**1**
a.	Routine Inspection					
b.	Preventing of trees from interfering with roof					
c.	Use of fastening					
d.	Engaging professionals on building construction					
e.	Regular maintenance					
g.	Dewatering					
h.	Providing sufficient base area below walls and columns					
i.	Ensure gutters are intact and clean					
j.	Adequate Landscape & External works					

Below are the impacts of common defects on building performance. Please kindly rate accordingly with the level of severity: Using the Likert scale below: 5- Very severe 4 – Severe 3 – Moderate 2 – Less severe 1 – not severe.

S/N	IMPACTS OF COMMON DEFECTS ON BUILDING PERFORMANCE			5	4	3	2	1
1	**WALL**							
a.	**Efflorescence**							
	Structural damage to building material							
	Disintegration of Masonry							
	Damage of furniture							
	Unhygienic Condition							
	Crumbling of Plaster							
	Dry rot of woodwork							
b.	**Sulphate attack**							
	Cracking							
	Lost of strength of material							
	Disintegration of concrete							
	Decrease in the durability of concrete							
	Loss in compressive strength of concrete							
c.	**Discoloration**							
	Reduces the Aesthetic value of the building							
	Acoustic performance of the building							
	Thermal performance of building							
d.	**Peeling of paint**							
	Aesthetic value of buildings							
	Acoustic performance of the building							
	Thermal performance of building							
e.	**Dampness**							
	Impacts on the Health and safety of occupants							
	Affecting the normal room temperature							
	Falling off of plaster							
	Damage of building furniture							
f.	**Cracking**							
	Impacts the safety of the building							
	Accelerate the ageing process of the building							
	Reduce the mechanical resistance of the structure							
	Reduce the ability of the structure to absorb stress							