

Investigating The Root Causes Recurring Building Collapse in Nigeria: A Systematic Review and Meta-Analysis

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Abstract

Building collapses have become a recurrent phenomenon in Nigeria, with tragic consequences for the victims and their families. The causes of these collapses are many and varied, and they reveal a deep-seated problem in the way buildings are designed, constructed, and maintained in the country. This study examined the root causes recurring building failure in Nigeria using systemic review and meta-analysis. In order to assess the general perspective of individuals who have worked on connected studies, relevant publications, seminar papers, research articles, and so on were investigated. Data for the study were gathered from previous records of building collapses in Nigeria. To build a model, the data were presented and evaluated using ordinary least squares (OLS). The investigation was based on the collection of selected structures that collapsed around the country. According to the study, a culture of inadequate maintenance, error in building design, use of substandard materials and defective workmanship, natural occurrence, and excessive loading among others led massively to building collapses in Nigeria. The study recommended that professional organisations in the construction industry provide effective monitoring of workers and efficient material testing prior to inclusion into building activities.

Keywords: Building Collapse, Root causes, Nigeria, ordinary least squares.

Introduction

The importance of buildings in man's life and survival cannot be overstated. Despite this, the general maintenance of housing continues to be a challenge in Nigeria, as well as other countries throughout the world according to (Uzokwe, 2021) [1]. Buildings must be appropriately planned, designed, erected, and managed to achieve the required fulfilment, luxury, and safety, whether they are temporary, permanent, or monumental buildings. When a structure fails to accomplish any of its primary duties of satisfaction, safety, or integrity, the expected satisfaction, comfort, and safety are therefore said to be have been compromised which can lead to the failure or eventually collapse of the building. The unfortunate collapse of buildings can occur as a result of the full or partial failure of a building structure, and while this is a global occurrence, it is more frequent and, in most cases, fatal in countries like Nigeria where a lot is these core structure components are overlooked or not properly implemented [2].

Building failures have been reported on a regular basis in Nigeria in recent years which has unfortunately resulted to the loss of life and property. Nevertheless, there has been limited research available about any findings related to the building collapse. Building collapses are frequently reported in the media in key cities in Nigeria such as Lagos, Abuja, and

Port Harcourt, among others as well as around the world. Regrettably, since independence, the federal government of Nigeria has made concerted effort in the field of quantitative (but not qualitative) housing supply via massive policy and financial measures; nonetheless, the pace at which existing buildings are collapsing requires immediate attention. Building collapses are providing major issues to all players in the building business in Nigeria, including building consultants, governments, developers, owners, and end users. Consider what these constructions could have been if they had been constructed properly. According to Adebayo (2020) [3], Nigeria is becoming the "world's junkyard" of collapsed structures worth billions of naira, mainly in urban areas. The number of collapsed buildings across Nigeria is so worrying that it is difficult to predict the repercussions on the construction industry and the Nigerian economy. It is unfathomable that a country with such much potential in its building industry could endure such a massive building failure.

A building is simply defined as "an enclosure for locations created for specific use, intending to manage local temperature, offer services, and evacuate rubbish," according to Adebowale et al. (2021) [4]. Buildings are structural entities that can secure themselves by sending weights to the earth. Nevertheless, as a result of their collapse, these same structures have posed problems and dangers to people during and after construction.

Building failure can be said to occur when a section or entire body of a structure fails and abruptly gives way; as a result, the structure is unable to fulfil the purpose for which it was designed. The collapse of a building is a severe case of structural failure. This then denotes a total or partial collapse of the superstructure [5]. Building failure occurs when one or more elements of a building fail due to a fault induced by the incapacity of the material that makes up the components of such structure to execute their original purpose successfully, which may eventually result to building failure. Structures are intended to offer people with comforts and shelter, but these same buildings have also served as a danger trap if not properly constructed. Buildings must meet certain basic requirements, such as constructability, design performance, cost efficiency, excellence, safety, and timely completion [6].

Structures are generally required to be both aesthetic and functional, however many buildings are constructed that fail to achieve even one of these criteria. Various bodies, government agencies, and institutions have conducted studies and held workshops in key cities across the country to investigate the causes of building collapse in Nigeria, but none have been able to determine how each of the determined factors leads directly to the collapse of buildings in the country. Building design and quality management are two of the leading reasons of this unfortunate trend of building collapse in Nigeria, according to Ede (2020) [7]. Variability in materials, testing variability, decision factor, contractor inconsistency, low-skilled workers, and unethical conduct are all aspects of quality management.

The requirement for new basic infrastructure and public facilities to support the growing population has resulted in an increase in the number of additional building constructions over time. However, in recent years, the sustainability of these freshly erected structures has become a serious problem. It is crucial since the housing and building sector represents just 3.1 percent of Nigeria's Gross Domestic Product (GDP), despite an annual demand of approximately 800 000 units [8]. All over the world, housing is essential to the concept of sustainability, and it is a primary priority for governments. According to Alanu and Gana (2019) [5], the ever-increasing housing problem presents an intriguing story that ranges from an utter housing deficit to the creation and multiplication of settlements, intensification of rent costs, and building failure.

The Nigerian government has worked hard in recent years to develop a sustainable economy for its population. Nigeria has struggled to address the daily requirements of its population since its independence in 1960. Cheap homes, well-maintained roads, portable water, and power are just a few examples [9]. Nevertheless, the time and resources invested in creating these structures have slowed the country's economic development to around 7 percent in the last 20 years, and this figure is predicted to continue to shrink as the number of building collapses rises [10]. To put this disaster behind us, unprecedented measures must be taken. Building collapse sites littered across the country are

disturbing and call into question the viability of the construction industry and the Nigerian economy in general.

The Nigerian construction sector was rocked by a series of horrific building disasters in 2005. Columns in the Vanguard and Guardian newspapers during that year revealed a substantial number of building failures across the Federation [11]. In reaction to these occurrences of collapsed structures recorded in the country last year, the Federal Republic of Nigeria's government took significant measures to eradicate this menace by establishing the National Building Code in 2006 [11]. It has not produced many results because most of the states in the country have not ratified construction related laws, which is required to make the National Building Codes effective in all 36 states of the federation. The Building Code is an industry standard as well as a legally binding mandate. This code establishes a code of good building practise that outlines the fundamental requirements of building design and construction, and it may reflect the industry's necessary standards [7]. The safety of these structures, as well as the wellbeing of individuals who use them, will increase if construction standards are created and followed.

Nigeria, unlike other emerging countries around the world, is not known to be plagued by natural calamities. Nevertheless, our country Nigeria is not without her portion of these incidences of building failure, which is primarily man-made [8]. It is terrible that a nation as ours with such high potential may endure such a level of building collapse. These collapsed constructions could have been religious houses, a house, a business outlet, or a mode of transportation.

As asserted by Uzokwe (2021) [1], over the last decade, there has been a significant spike in the number of building collapses documented in Nigeria, which is a huge setback in the country's progress as buildings continue to fall more regularly, resulting to death, loss of property, and huge expenditures. Incidence of building collapses are widespread in all parts of the federation, with key city of Lagos having the highest recorded number. Building failure is so common that not a single six-month period passes by without at least one or more incidences across the country. The rate of these occurrences has not only become a subject of worry and anxiety but has also placed inhabitants in a state of heightened uncertainty about the building activities thus negatively affecting the economy. Particularly to stakeholders in the building industry and the government, as the scale of these accidents grows increasingly rapidly [9]. Lives and property have been lost as a result of building collapses in major cities in Nigeria. Ayedun et al. (2021) [9] also noted that building collapse, despite its prevalence in metropolitan areas, is not limited to cities, as it crosses cultural, ethnic, and geographical boundaries. The prevalence of building collapse has become a concern for many, generating significant trauma and a rise in the number of casualties as a result of the number of existing collapsed structures, with over 120 deaths documented cases of building collapse in 2014 according to Adebowale et al. (2021) [4]. Considering this, the current study seeks to investigate the root reasons of reoccurring building

collapses in Nigeria by a systematic review and meta-analysis.

Literature Review

The Building Concept

A structure is constructed to offer shelter for individuals to go about their daily lives. Humanity has progressed in establishing a safer and more favourable environment for continued human existence. The fundamental idea of building design is to create a structure that is both functional and fits the needs of the client. Despite the use of the term "owner's needs," design requirements, building services requirements, structural requirements, and safety concerns must all be considered [1]. As a result, the most economically safe, practical, and aesthetically pleasing structure is required, and three key specialists are involved in producing these: architects, structural engineers, and contractors. The architect is the first expert to collaborate with a client, generating a building design that meets the client's needs requirements. The architect is usually in charge of the design of the structure, quality control of architectural materials, and physical appearance of both structural and service components from the start. To put it bluntly, he or she oversees ensuring that the structure is ultimately faithful to the original plan, and thus trends to head the team of designers and construction.

The construction engineer works with the architect's plan and specifications to ensure that the structure stands and is considered safe at both the final and serviceability limit states while using the most cost-effective structural parts [12]. A building's structural stability is entirely based on the detailed design and implementation of the following structural elements: slabs, beams, pillars, foundation, and brickwork. The procedure for the design must be thorough, beginning with structural element analysis through to the final state of structure design for sections and reinforcements required by the established code of practice. At serviceability limit stages, various tests are carried out, and building performance simulations are routinely carried out. As a result, to obtain a sound structural carcass of a building, appropriate design and execution (at the construction phase) of structural components are essential. These include material specifications (for example, reinforcement steel, concrete mix, cement, steel beams, and so on) and proper site monitoring. The structural engineer's responsibility is to ensure that the design is sound and that it is implemented correctly during the construction stage; anything less poses a risk to the building's durability and safety. Structural engineers, often known as mechanical, electrical, and plumbing engineers oversee designing construction works such as conditioning systems, wiring and communication installations, fire suppression systems, and so on. These structural engineers are really interested in providing services that help with durability as well as mitigating against future disaster in a structure. As a result, they bear no responsibility for the structural stability of the structure. The UK Health and Safety Executive provides a brief explanation of the term 'contractors' and they're under function in the Construction Design Management regulations as follows: A contractor is someone who

personally hires or recruits construction workers, or manages construction projects. Contractors include subcontractors, as well as any self-employed individual or corporation who performs or oversees construction projects. Contractors must have the necessary expertise, technical know-how, experience, and, when applicable, organizational competence to complete the work safely and without endangering their health [13].

Delivering any size construction project necessitates not only skills and requisite experience, but also moral obligation to the customer, team of designers, and the society at large. Aside from the corporate and legal requirements, which are all codified in law and ethical codes of conduct, a structure must be completed to standards, defined standards, and health and safety norms during erection and throughout the life cycle of the structure. Supervision and quality control of construction materials, craftsmanship, performance, testing are critical components of the construction process, and are often shared by appropriate design team and the principal contractor as stipulated in the contract and applicable regulations.

Causes Of Building Collapse

Buildings fail due to a combination of ignorance, negligence, and greed [14]. When inept people oversee planning, execution, or supervision, the result is ignorance. The use of past project specifications without cross-checking those areas that require modification, addition, or absence is one of the most typical examples of carelessness in specification drafting. Building contractors' greed, for example, theft of building supplies, notably cement, intended for manufacture on the client's site, use of inferior materials to maximise profit, and so on. When discussing building collapse, it's important to distinguish between buildings that fail during development or during their life span and those that fail after their service life, which is typically 25 years [7]. The greatest severe loss occurs when a structure has been in operation for a long period of time or just after its construction, according to research.

Preliminary works that are not up to standard

The term "preliminary works" refers to procedures such as site investigation and foundation. Where these operations are carried out haphazardly, building collapse is imminent. The purpose of a site study is to ascertain the qualities of the soil layers. According to Udo-Udoma (2019) [2], all prospective construction sites must be assessed for building compatibility as well as the type and nature of the required preparatory work. Because there may be variances across the site, special consideration should be paid to the composition of the soil and its anticipated capacities to bear load. The site's prior history should be researched, paying special attention to the presence of trees, water levels, borehole logs, beneath soil strata, and garbage dumps. A comprehensive examination of nearby structures should be performed to determine whether failure can occur as a result of localised circumstances. Soil, as posited by Bell (2019) [15], is an unconsolidated assembly of soil particles with voids between them. These spaces could be filled with water, air, or both. Soil is generated through the weathering

and erosion of rock materials, and it may have travelled before being deposited.

According to Neville and Chatterton (2018), the discovery of soil mechanics, or the study of the physical properties of any given soil type in response to loads, was a critical step toward a scientific method to foundation issues and building. Whatever a building's strength, rigidity, or structural stability, its satisfying performance is entirely dependent on the soil that supports it. By ensuring that the most appropriate foundation is recommended, adequate site investigation eliminates foundation problems.

Architectural mistakes

If the client fails to supply all necessary information on the building's requirement specification, flaws in the brief provided by the customer may cause problems even before the project begins [4]. He went on to say that design flaws include things like inaccurate measurements, bearing support issues, deformation, secondary stress and strain, elastic cracking, temperature and contraction issues, detailing and designing issues, assumed loading errors, and changes and alterations in existing buildings, all of which contribute to structural defects, disasters, and, eventually, building collapse.

Occurrence of nature

Rainfall is one of the key natural variables that cause structure collapse; others may include land slide, earthquakes, and so on. According to Chinwokwu (2020) [16], whenever there is a heavy downpour, there is a chance that one or more buildings whether finished or uncompleted will carve in the mud. The reality remains that this is an uncontrollable natural factor; structures must thus be built with such uncontrollable factors in mind.

Quality control

The importance of tight quality management in material consumption in the Nigerian construction sector cannot be overstated [7]. The construction industry's disregard for quality control has resulted in numerous defective and unsightly buildings, as well as an increase in the number of collapsed structures in recent years. The quality achieved in the Nigerian building industry is influenced by several elements, which are addressed more below.

Poorly skilled workmen

This, combined with the erratic nature of contractors, is one of the causes of construction collapses in Nigeria. The degree of skills of different types of workers in the Nigerian construction sector (which varies by location and contractor) has been determined to be declining day by day through examination. Even workers who have received training have been found to be no better than their masters. Workers with low skill find it difficult or impossible to evaluate and apply quality checks and tolerance limitations in the construction industry [2].

Lack of proper maintenance

According to Adebowale et al. (2021) [4], maintenance in Nigeria receives minimal attention. Normally, building

upkeep should begin as soon as the excavation is completed. For example, whether the foundation digging shares before or immediately after concrete laying, it must be cleared and properly maintained since earth impurities reduce concrete strength.

Unauthorized Conversion and Modification of Building Use

In Nigeria, it is common practice to add additional floors above what the initial plan allows. For instance, converting a single-story building to a two-story structure places additional stresses on the suspended floor and puts additional strain on the foundation of the structure. Adding extra apartments to suspended storeys, changing the purpose of the building (for instance, transforming a residential building to a mini factory with heavy-duty equipment on suspended floors), and so on has been the reason for the reoccurrence of the unfortunate collapse of buildings in Nigeria.

Unprofessionalism

In general, it is thought that unethical conduct contributes significantly to the threat to the collapse of buildings in Nigeria. Unethical conduct, such as bribery from site managers or contractors, professionals operating in capacities beyond the purview of their profession, and so on, has an indirect harmful influence on the structure and may eventually result in its collapse. The importance of specialists in building construction in Nigeria cannot be overstated [11]. As a result, it's sad that a large portion of the country's construction industry still lacks full involvement from qualified professionals.

Key Building Collapse Prevention Measures in Nigeria

The following are key preventive measures every architect and building engineers should adopt.

Professional supervision of construction projects

According to findings, adequate supervision and monitoring is the most important aspect in preventing the collapse of buildings. The amount of construction project management and monitoring has been heavily criticized, with poor supervision on construction projects resulting to structural problems or failure, with most projects running without a construction project manager, which is not proper [9]. According to Ojo et al. (2019) [10], some questioned designers believe that structural collapse will be a thing of the past if suitable efforts are made to strengthen construction project supervision and monitoring.

Public awareness of the need of preventing rather than controlling building collapse

Another important aspect is public awareness; given the high reoccurrence of building collapses seen, continued professional advancement on modern techniques must be emphasized to keep members abreast of new construction trends [5]. This increases public awareness and is a cautious approach of reducing the reoccurring collapse of buildings.

Issue building approvals before construction commences

Prior to the start of the project, authorisation from town planning agencies is required to ensure that the construction is fit for purpose; nevertheless, even if clearance is received, it is not observed [2]. According to Uzokwe (2021) [1], there are delays in gaining licenses, while [1] reported that 70 percent of collapsed structures do not have the approvals of town planning agencies, making acquiring construction approvals a need in the current economy. Contractors or building firms in the United Kingdom would receive NHBC certification, making it easier and safer to assure standard quality control.

Empirical Review

According to Lakshmi (2019) [17], building collapse is making news in most third world countries today, and it has become widespread and disastrous. The occurrence of these building failure does show ominous indicators of reiteration, with each collapse causing enormous repercussions that none of its victims will ever forget. These include the loss of life, a significant waste of money invested in an investment or property, jobs, trust in construction professionals, increased stakeholder uncertainty, and an environmental crisis [7].

Building collapse is common in developing countries. On the 25th of November 2014, a building collapse in the western Cairo district of Matariya killed 17 persons. On November 4, 2015, a building in Lahore, Pakistan, collapsed, killing around 48 persons. In the same vein, there is the approaching occurrence of the synagogue church building collapse on September 12, 2014, which took 115 lives. Moreover, an unapproved approved building plan on the number of storeys of the building, structural weakness due to no government clearance prior to construction, bad construction ethics, and poor safety standards, in that order, are thought to have caused these three famous building disasters [18].

In Nigeria, building collapses have been classified as either natural or artificial. Its revival in the building business has been a source of concern for all, prompting studies to be conducted in order to determine its primary causes. Building collapses have been recorded in buildings under construction, structures during refurbishment, and buildings in use [12]. The recent spike in the likelihood of building collapses has spawned a slew of studies.

Non-compliance with approved building plans prior to construction initiation, non-compliance with standard guidelines by developers, the use of poor-quality materials, inefficient stringent quality control in material utilisation and management, lack of adequate supervision on construction works, and boycotting the professional community are among the primary causes of building collapse, according to Lakshmi (2019) [17] and many other researchers. According to Ojo et al. (2019) [10], these listed causes account for more than 60 percent of building collapses.

According to Ogunbiyi (2020) [11], the reasons of building failures are man's neglect of the critical areas of construction, which results in a collapse in the creation of structures. It comprises soil type/bearing capacity, contempt for building rules, and a shoddy or unauthorized building design [6]. Inadequate building materials, a lack of ongoing development, the actions of quacks in the business, numerous alterations to the original design, insufficient monitoring, and overall bad workmanship [1,18]. These factors include a lack of compliance with government-set construction laws, ineffective government-run monitoring programs to find defaulters, and a lack of understanding among contractors and clients about how to build a long-lasting, perfect structure. As [5] opined, building experts should not shoulder the responsibility alone, but rather engage with the federal or state government and the agencies concerned in preserving a holistically designed environment in terms of sustainability.

Building failure has a range of causes, according to the paper "Study of Recent Building Failures in the United States". Most observed failures can be attributed to some of the primary reasons of building collapse, which are faults in planning, adequate maintenance, details, building, and a lack of external event concern and material use as opined by Ayedun et al. (2021) [9]. A design flaw refers to errors, lapses, or inaccuracies that may have occurred during the building's design process. Detailing shortfall is a gap in the building's conception and construction process that causes discontinuity/loss of idea and breach of the construction contract. Deficiency in construction manifests itself as problems with sloppy manpower and divergence from the standard specification.

Apart from the explanations outlined above, [6,5] believe that other technical reasons for building failures include faulty foundations, shallow foundation depth, deficient concrete strength, bad concrete mix ratio, poor building material requirements, improper walling, and insufficient government maintenance plans. These factors have been discovered to have an impact on the building construction business as a result of their interference with the daily work plan of various construction proceedings on various areas of construction. Nevertheless, these are merely a few of the variables that can cause a building to collapse.

According to Ojo et al., (2019) [10], professional organizations do not provide a community for fresh engineering graduates to be groomed and get useful experience in the nitty-gritty of non-taught building engineering activities. This community also allows recent graduates to exercise what they learned in school before moving on to practice, which helps to develop their skill and expertise understanding on building projects. In this regard, [12] accused building construction professionals of being responsible for the country's incessant building collapses as a result of their sloppy construction work, poor attitude towards work, and lack of the necessary competence and expertise to perform in that position. It is obvious that structures constructed in this manner would be traced back to the illegal use of foundations, as well as a weak and insufficient concrete mix ratio. When reinforcing, the use of

low-cost construction materials, insufficient site management, excessive revisions to the original design, poor site communication, low quality design, and climatic conditions are all unacceptable [4].

Regardless of the attractive appeal made by residents and the government on the number of building collapses witnessed, along with Nigerians' social, economic, and political practices. To contribute to the collapse of buildings by clients/contractors prepared to cut shortcuts in order to attain a higher profit margin on the project, as a result of greed, carelessness tendencies caused by external and exacerbating seismic pressures [19]. Similarly, [18] claimed that corruption in the construction industry has spread throughout the industry, resulting in a reluctance to adopt existing building codes, which are intended to discover and guide the flow of construction works, as well as a lack of government will to enforce them by Town Planning Authorities.

According to Adebayo (2020) [3], building projects have become more profit-driven in recent years, replacing the demand for designing a sustainable building with the required capacity and competence in order to stay in business in the industry with personal financial goals.

According to the Global Corruption Report (2005), corruption has resulted in a substantial increase in the cost of building supplies, which has increased the use of building materials of poor quality are used in the construction, affecting the economy's quality and standard of construction. award of contract, planning, implementation, and handover after completion are all examples of corruption. Corruption, on the other hand, may exist in one or more forms in any of the above-mentioned stages. It involves bribery, fraud, and collusion, with the effect that the building industry's quality is lowered, repair and maintenance costs are increased, and some flaws may go undetected until the project falls according to Kazeem et al. (2020) [20].

Many unskilled workers are being assigned to oversee building projects. According to the Nigerian Construction and Road Research Institute (NBBRI, 2012), shortfalls in the correct balance of experience, competence, and expertise cause approximately 70% of building collapses today. The Nigerian building industry is divided into two parts: informal and formal as highlighted by Ojo et al. (2019) [10]. All professionals in the business, including as engineers, architects, builders/contractors, quantity surveyors, and others, work in the formal sector, which is supervised by regulatory and industry laws.

The informal sector, according to the Oxford Advanced Learner's Dictionary, is a tranquil and inviting workplace. This group includes bricklayers, iron benders, carpenters, masons, welders, craftspeople, and so on. These are persons who lack any type of qualification, expertise or license, and whose professional practices are not regarded in high regard by many organizations but are monitored by professionals to satisfy the required building standards. Professionals in this field only have a practical

understanding and notion, but they are unaware of the general theory that underpins why certain decisions are made, or the degree to which achieving sustainability in construction is necessary.

Building collapses are mostly caused by natural phenomena such as rainstorms, earthquakes, flooding, and typhoons [20]. According to Falobi (2019) [8], building collapses are primarily man-made, resulting from a lack of basic expertise and experience. In areas such as building structure and design, soil type, construction material quality, tall building planning for external loads and stress from winds and earthquakes, insufficient oversight on construction projects, and poor craftsmanship.

According to the Dictionary of Architecture and Construction, a mechanical breakdown causes a building to collapse. Even an excellently designed and constructed structure would not stand on a faulty foundation as a result of design professionals' substitutions in the processes. Uzokwe (2021) [1] blames the entire nation's construction professionals, claiming that they are responsible for supplying structural designs, site scheduling, traffic management plans, health and safety plans, and logistics. However, there are many facets to this since after the designs are created, they must be approved by government officials, and most clients avoid these professionals in order to save money and profit in the end. As a result, the approval and design processes are incomplete. Regardless, Architects, Structural Engineers, Surveyors, and Builders are not the only ones to blame.

A conservative approach to averting the building failure that is impeding the economy's progress and restoring success to the Nigerian building industry, according to Adebayo (2020) [3], would rely only on clients and contractors preferring quality over overall project cost. It means that the building contractor should think about developing a sustainable building that is worthy of praise and be willing to pay a fair price for it. To help eradicate this increasing occurrence of building collapse, the site supervisor should use quality construction materials, conventional tools and equipment, skilled workers, and constant supervision daily, with the government performing routine checks periodically throughout the project life cycle. The correct competence is required for the project in order to increase efficiency and provide significant craftsmanship in building.

Methodology

Study design

An ex-post facto study design was employed to determine the recurring causes of building collapse in Nigeria. The researcher cannot modify the variance in the variables in this form of research design because their existing data is available and released by the government and architectures.

Area of the study

This study examines the root causes of recurring building collapse in Nigeria. Nigeria is a West African country. Nigeria is bordered on the west by the Republic of Benin, on the east by Chad and Cameroon, and on the north by Niger. In the

south, it is bordered by the Gulf of Guinea, while in the northeast, it is bordered by Lake Chad.

Method of data analysis

This study examines the major reasons for recurring building collapse in Nigeria using annual time-series data. The data used is secondary in nature; hence, data obtained on the various incidences of building collapse in the country were analysis of past documents (secondary data sources) was relied on as the only source for data collection. The Ordinary Least Square (OLS) method was used for estimation using the SPSS 16.0 as the software for analysis. This study posits that there are no major causes of building collapse in Nigeria.

Model specification

The model is specified below as; $BC = f(PMC, DE, NP, PMW, EL)$

The model's econometric form is as follows.

$$BC = \beta_0 + \beta_1 PMC + \beta_2 DE + \beta_3 NP + \beta_4 PMW + \beta_5 EL + u$$

Where;

β_0 = Intercept of relationship in the model/constant

$\beta_1 - \beta_5$ = Coefficients of exogenous variable

Summary Of the Model

PMC means Poor maintenance culture

DE means Design Error

NP means Natural Phenomenon

PMW implies Poor Materials and Workmanship

EL implies Excessive loading

u means Stochastic variable (error term)

The expected correlation between each exogenous variable and the endogenous variable is known as the 'a priori' expectation. For the study, $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5 > 0$, This means that all exogenous factors should have a positive correlation with the endogenous factors.

Data Analysis

Testing Of Hypothesis

H₀: In Nigeria, there are no substantial root causes of recurring building failure.

H₁: In Nigeria, there are substantial root causes of recurring building failures.

Level of significance: 0.05

Decision rule: If the p-value is less Than the level of significance, reject the null hypothesis; otherwise, accept the null hypothesis.

Table 1: Model Summary

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|--|--------------------|----------|-------------------|----------------------------|
| 1 | 0.996 ^a | 0.991 | 0.988 | 0.662 |
| a. Predictors: (Constant), Excessive Loading, Natural Phenomenon, Poor Maintenance Culture, Design Error, Poor materials and Workmanship | | | | |
| b. Dependent Variable: Building Collapse | | | | |

R² of 0.991 simply means that the independent variables (PMC, DE, NP, PMW and EL) explain 91% much of the dependent variable (BC).

The R value of 0.996 indicates that PMC, DE, NP, PMW, EL, and BC have a high positive relationship.

Table 2: Coefficients

| Model | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95.0% Confidence Interval for B | |
|--|-----------------------------|------------|---------------------------|-------|-------|---------------------------------|-------------|
| | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| (Constant) | 0.373 | 0.413 | | 0.903 | 0.381 | -0.507 | 1.252 |
| Poor Maintenance Culture | 0.917 | 0.139 | 0.294 | 6.596 | 0.000 | 0.620 | 1.213 |
| 1 Natural Phenomenon | 0.602 | 0.253 | 0.093 | 2.386 | 0.031 | 0.064 | 1.141 |
| Poor materials and Workmanship | 1.426 | 0.270 | 0.172 | 5.278 | 0.000 | 0.850 | 2.002 |
| Excessive Loading | 1.073 | 0.124 | 0.404 | 8.680 | 0.000 | 0.809 | 1.336 |
| | 1.061 | 0.160 | 0.223 | 6.623 | 0.000 | 0.720 | 1.403 |
| a. Dependent Variable: Building Collapse | | | | | | | |

Conclusions based on Table 2 above

Based on the result in Table 2 above, the co-efficient of poor maintenance culture (PMC) is 0.917, which implies that a unit increase in PMC causes building collapse (BC) in Nigeria to rise by 0.917. The co-efficient of Design Error (DE) is 0.602, connoting that a unit increase in Design Error (DE) causes building collapse (BC) in Nigeria to rise by 0.602. The co-efficient of Natural phenomenon (NP) is 1.426, implying that a unit increase in NP causes building collapse (BC) in Nigeria to rise by 1.426. The co-efficient of poor materials and workmanship (PMW) is 1.073, implying that a unit increase in PMW causes building collapse (BC) in Nigeria to rise by 1.073. Finally, the co-efficient of Excessive loading (EL) is 1.061, implying that a unit increase in EL causes building collapse (BC) in Nigeria to rise by 1.061. PMC, DE, NP, PMW and EL have positive correlation with BC, which implies that they all are responsible for the reoccurring causes of building failure in Nigeria.

Conclusion

This study investigated the root causes recurring building failures in Nigeria: a systematic review and meta-analysis. The study revealed that, a culture of inadequate maintenance, error in building design, use of substandard materials and defective workmanship, natural occurrence, and excessive loading contributed to massive cases of reoccurring building failure or collapse in Nigeria.

The study found other causes of building collapses in Nigeria to include a lack of proper regulation and oversight of the construction industry. The government's regulatory bodies are often understaffed and underfunded, and they lack the capacity to effectively monitor the construction of buildings and ensure that they meet the necessary safety standards. This allows unscrupulous builders and developers to cut corners and use substandard materials, which can result in weak and unstable structures.

The study also found another major cause of building collapses in Nigeria to be the widespread use of unqualified and untrained builders and contractors. Many of these individuals lack the necessary skills and knowledge to construct safe and stable buildings, and they often resort to using substandard materials and shortcuts to save time and money. This can lead to serious structural defects that can cause buildings to collapse in the event of an earthquake or other natural disaster.

In addition to these factors, the study found out that there is also a lack of awareness among the general public about the importance of building safety. Many people do not understand the risks associated with unsafe buildings, and they may not be aware of the warning signs of a potential collapse. This can make it difficult for authorities to identify and address the problem before it is too late.

In summary, based on the results of this study, it was therefore concluded that a culture of inadequate maintenance, error in building design, use of substandard materials and defective workmanship, natural occurrence, and excessive loading are the recurring causes of buildings collapse in Nigeria.

Recommendations

To address these issues and prevent recurrent building collapse in Nigeria, it is essential that the government and other stakeholders take a more proactive approach. This may include strengthening regulatory oversight of the construction industry, investing in training and education for builders and contractors, and raising public awareness about the importance of building safety. Additionally, there should be a concerted effort to enforce existing laws and regulations that govern the construction industry, and to hold those who violate these laws accountable for their actions.

Ultimately, the goal should be to create a culture of safety and responsibility in the construction industry in Nigeria, one that prioritizes the safety and well-being of the people who live and work in these buildings. Only by taking a comprehensive and collaborative approach can we hope to put an end to the tragic cycle of recurrent building collapses in Nigeria.

Additionally, based on the findings of this study, the following recommendations will aid in reducing the incidence of building failures in Nigeria:

- On site, design specifications of the architect and other affiliated specialists should be properly observed.
- In the sanitization of building materials, all professional organizations in the construction sector should be involved. Developers should appoint material engineers to major construction projects.
- The Standards Organization should take a more active role in inspecting building construction materials for sale in the market.
- All public officials and building designers should be trained properly and motivated to always outsource major building construction to competent and certified contractors who will be overseen by a registered Structural Engineering consultant and an Architect who has preferably designed such projects.
- Before beginning any construction, all materials used for building such as cement, aggregates, reinforcement bars, and especially foundation dirt should be evaluated.
- Building monitoring teams must be established to go out on a regular basis to inspect all building projects in their area in order to enforce the standard building code and local bylaws.

References

1. Uzokwe, O.A. (2021). *Raising incidence of Building Collapse in Nigeria: Any Remedy?* Nigerian world 1999-2010
2. Udo-Udoma, O. (2019). *why are so many buildings collapsing in Lagos. Next City* [online].
3. Adebayo, S.O. (2020) Improving Building Techniques. Proceedings of Workshops on Building collapse: Causes, Prevention and Remedies. *The Nigerian Institute of building*, Lagos State.
4. Adebowale, P.A., Gambo, M. D., Ankeli, I.A. and Daniel, I. D. (2021). Building collapse in Nigeria: Issues and Challenges. *Conference of International Journal of Arts & Sciences*.

5. Alamu, F.B. and Gana, M.S. (2019). An Investigation on the Causes of Building Collapse in Nigeria. *International Journal of Environmental Sciences and Resources Management*, 6, pp. 12-22.
6. Olusola, K.O., Ojambiti, T.S. and Lawal, A.F. (2021). Technological and Non-Technological Factors Responsible for the Occurrence of Collapse Buildings in South-western Nigeria. *Journal of Emerging Trends in Engineering and Applied science*, 2, pp. 462-469.
7. Ede, A.N. (2020). "Structural Stability in Nigeria and Worsening Environmental Disorder: the Way Forward." *In Proceedings with the West Africa Built Environment Research Conference Accra Ghana*, pp 489-498.
8. Falobi, F. (2019) Nigeria: Tackling Disaster at Grassroots in Lagos. *Daily Independent newspaper* [online]. Available from: <http://sunnewsonline.com/>
9. Ayedun, C.A., Durodola, O.D. and Akinjare, O.A. (2021) An Empirical Ascertainment of the causes of Building Failure and Collapse in Nigeria. *Mediterranean Journal of Social Science*, 3(1) (2039-2117)
10. Ojo, I.C., Olabintan, O.D., Ojo, K.F. and Salami, R.O. (2019) Design and construction supervision a structurally sustainable tools for building failure/ collapse in Nigeria. *International Journal of computer science and information Technology & security*, 3 (22499555)
11. Ogunbiyi, M. (2020). The national Building code and the construction industry professionals in Nigeria. *International Journal of Social and Entrepreneurship* [online].
12. Tanko, J.A., Illesanmi, F.A. and Balla, S.K. (2019) Building Failure causes in Nigeria and Mitigating Roles by Engineering regulation and Monitoring, *Engineering*, 5, pp. 184-190.
13. Construction Design Management (2015). The construction (design and management) regulations 2015. Available from: <http://www.hse.gov.uk/construction/cdm/2015/contractors.htm>
14. Bamidele, E.O. (2020). Building design, build- ability and site production. In D.R. Falobi (Ed.), *Building Collapse: Causes, prevention and remedies* (pp. 74-87). The Nigerian Institute of Building, Ondo State.
15. Bell, F. (2019). *Engineering Properties of Soil and Rocks*, Butterworth-Heinemann, 3rd Edition, pgs. 1-2
16. Chinwokwu, G. (2020). The role of professionals in averting building collapse. *Proceedings of a workshop on Building collapse: Causes, prevention and remedies* (pp. 12-28). The Nigerian Institute of Building, Lagos State.
17. Lakshmi, R. (2019) Quality control and quality assurance in building construction. *National Conference on Research Advances in Communication, Computation, Electrical Science and Structures*.
18. Oloyede, S.A., Omoogun, C.B. and Akinjare, O.A. (2020). Tackling the frequent Building Collapse in Nigeria. *Journal of Sustainable development*, 3, pp. 127-132.
19. Tribune, (2020). No building collapse again, FG orders enforcement agencies. [Online]. Available from: <http://tribuneonlineng.com/no-building-collapse-fg-orders-enforcement-agencies/>
20. Kazeem, K.A., Joy-Felicia, O. and Wasiu, O.A. (2020). incessant collapse of building in Nigeria: the possible role of the use of inappropriate cement grade/ strength class. *International Journal of Civil, Environmental Structural, Construction and Architectural Engineering*, 8
21. Fakere, A. A., Fadairo, G. and Fakere, R. A. (2012). "Assessment of Building Collapse in Nigeria: A Case of Naval Building, Abuja, Nigeria." *International Journal of Engineering and Technology (IJET)*, Vol. 2, no. 4, pp.584-592, 2012.
22. Fagbenle, O.I. and Oluwunmi, A.O. (2020). Building Failure and Collapse in Nigeria: The Influence of the informal sector. *Journal of Sustainability Development*, 3
23. Project Clue. (2020). papers on reoccurring building collapse in Nigeria. Available at: <https://www.projectclue.com/estate-management/project-topics-materials-for-undergraduate-students>. [Accessed: 2022-5-1].

Appendix

| BC | PMC | DE | NP | PMW | EL | YEAR |
|----|-----|----|----|-----|----|------|
| 10 | 3 | 1 | 0 | 4 | 2 | 2001 |
| 12 | 5 | 2 | 1 | 3 | 1 | 2002 |
| 19 | 6 | 2 | 2 | 7 | 2 | 2003 |
| 14 | 4 | 1 | 0 | 6 | 3 | 2004 |
| 18 | 5 | 2 | 0 | 9 | 2 | 2005 |
| 12 | 2 | 1 | 1 | 4 | 2 | 2006 |
| 23 | 8 | 3 | 2 | 7 | 3 | 2007 |
| 9 | 3 | 1 | 0 | 4 | 1 | 2008 |
| 12 | 4 | 1 | 0 | 5 | 2 | 2009 |
| 15 | 5 | 2 | 1 | 7 | 0 | 2010 |
| 13 | 3 | 2 | 2 | 4 | 2 | 2011 |
| 17 | 5 | 1 | 1 | 7 | 3 | 2012 |
| 19 | 4 | 3 | 1 | 8 | 3 | 2013 |
| 10 | 2 | 1 | 1 | 4 | 2 | 2014 |
| 24 | 6 | 4 | 2 | 8 | 4 | 2015 |
| 26 | 8 | 3 | 1 | 9 | 5 | 2016 |
| 28 | 8 | 2 | 2 | 10 | 4 | 2017 |
| 3 | 1 | 0 | 0 | 1 | 0 | 2018 |
| 14 | 4 | 1 | 1 | 5 | 3 | 2019 |
| 15 | 3 | 2 | 1 | 5 | 3 | 2020 |
| 20 | 5 | 2 | 1 | 8 | 4 | 2021 |

Sources: Fakere, (2012) [21]; Falobi, (2002) [8]; Oke, (2011); Researcher's field work 2022

Table 2: Building collapse in Nigeria and their causes.

| No. | Causes | Total | | Building Type | | Major Building Use | | | | Calamities | |
|-----|--------------------------------------|------------|------------|---------------|-----------|--------------------|-----------|-----------|----------|------------|------------|
| | | No. | % | Pr | Pb | Res | Co | Re | Ed | De | In |
| 1 | Poor maintenance culture (PMC) | 20 | 20.00 | 8 | 2 | 2 | 1 | 2 | 0 | 11 | 18 |
| 2 | Design Error (DE) | 15 | 15.00 | 12 | 3 | 5 | 2 | 1 | 1 | 47 | 34 |
| 3 | Natural Phenomenon (NP) | 5 | 5.00 | 4 | 1 | 2 | 1 | 2 | 2 | 95 | 61 |
| 4 | Poor Materials and Workmanship (PMW) | 40 | 40.00 | 35 | 22 | 30 | 12 | 3 | 2 | 140 | 113 |
| 5 | Excessive Loading (EL) | 20 | 20.00 | 16 | 6 | 10 | 8 | 2 | 2 | 50 | 28 |
| | Total | 100 | 100 | 60 | 40 | 54 | 24 | 10 | 7 | 343 | 257 |

Source: Gathered historical data of building collapse in Nigeria.

Key: Pr - Private, Pb- Public, Res – Residential, Co – Commercial, Re –Religious, Ed – Educational, De- Death, In -injury