

The Underlying Causes of Building Collapse in the Nigerian Construction Industry

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Abstract- This study identified and evaluates the causes of building collapse, and the preventive measures that can avert such occurrences with the high frequency in the number of collapsed structures scattered around the length and breadth of Nigeria. The method employed in data collection includes the administration of a questionnaire to professionals in the Nigerian construction industry. The use of descriptive statistical techniques such as frequency distribution, percentages and mean response analysis were used to analyse data. The study identified the major causes of building collapse as weak/faulty foundations, inefficient stringent quality control in material utilisation and management, boycotting the professionals, absence of proper site investigation, and the engagement of inexperienced personnel. Some preventive measures were made as part of lasting solutions to tackle the challenges. There includes the supervision of construction works by professionals, education enlightenment on the public on the need to prevent building collapse rather than managing situations, employment of competent professionals, issue building approvals before construction commences and involvement of structural engineer in a project that goes beyond one floor. In general, this study has been able to provide a comprehensive view on the causes and the preventive measures of building collapse.

Index terms - Building Collapse, Construction Industry, Housing, Safety, Nigeria.

1 INTRODUCTION

Over the years the need for new basic infrastructure and social amenities to meet the over increasing population has led to an increasing number of construction of new buildings. However, the sustainability of these newly constructed buildings has been a major concern in recent years. It is primary because the housing and construction segment accounts for only 3.1% of Nigeria's rebased Gross domestic product (GDP) and roughly there is an over ending demand of over 800,000 units per year (Ohajuruka, 2015). Housing is significant to the concept of sustainability and is a paramount concern to governments across the globe. The ever-mounting crisis in the housing sector puts forward, and intriguing story is ranging from absolute shortage of housing units to the rise and proliferation of settlements, intensification cost of rent and building collapse (Ebehikhalu and Dawam, 2014).

Take for instance, in the build up to the previous world cup event held in Brazil; there were a series of disasters in the construction industries of which witnessed the collapse of some buildings in the centre Rio de Janeiro. However, Nigeria is not left out in this tragedy. A string of building collapse has been noted in the country. Also, recently; on September 12th, 2014, at the synagogue a six-story quest house collapsed, of which left 115 people dead on the spot and leaving 131 persons injured. This tragedy led to a national dialogue that criticised the safety of individuals and buildings due to the number of foreigner's and citizens that lost their lives in this event (Udo-Udoma, 2014).

In recent years, the Nigerian government has been striving hard to create a sustainable economy for its citizens. Since independence in 1960, Nigeria has been battling with the desire to meet the daily needs of its citizens. Which include affordable housing, good accessible roads, portable water and electricity (Ikechukwu et al., 2015). However, resources and time spent on developing these structures have

reduced the country's economic growth to around 7% for the past two decades to drop significantly with the increasing number of building collapse (Barbara et al., 2015). Drastic actions need to be taken in other to write off this tragedy.

The sites of building collapse scattered all over the nation are disturbing and leaves an impossible question as to the effectiveness of the building construction industry and the Nigerian economy as a whole. One could have only imagined how the topography would have looked like if only these buildings were constructed to specification and plan. Reports have it that Port Harcourt and Lagos has become the "world's junk-yard" of collapsed buildings running into billions of Naira yearly (Famoroti, 2005).

In 2005, the Nigerian construction industry witnessed an enormous number of outrageous building collapse. During that year, the columns in the Vanguard (Madu, 2005) and Guardian newspaper (Obiechina, 2005) recorded a high number of building collapse around the length and breadth of the Federation. It led to the Government of the Federal Republic of Nigeria to take drastic actions as to how to silent this problem by publishing the National Building Code in 2006 in response to the number of cases of collapse buildings recorded in the country the previous year (Ogunbiyi, 2014). It has not yielded many results, as most states in the federation have not passed the Urban and Regional Planning Law to enable the National Building Codes operational in all of the 36 states of the federation. Building Code is the standard and approved a requirement for the building industry. This code represents a code of good building practice, which shows the basic demands of the design, and construction of buildings and this could represent the necessary standards for the construction industry for the nation (Obiegbu, 2006). If the standards for the building are set and adhered to, it will increase the

health and safety of the buildings and the welfare of persons that use these buildings.

Nigeria as a country is not known to be hampered by the occurrences of natural disasters like other developing countries of the world. However, the country is not free from her share of the national cake, which is chiefly man-made (Falobi, 2009). It is rather unfortunate that a country this blessed with high potentials can experience such degree of building collapse. These collapsed structures would have functioned as a place of worship, residence, or can serve as business outlets or as means of transportation. They are also essential to man just as air, food and water (Salau, 1996).

A building is one, which must be safe for its occupants (Odulami, 2002). A building must meet the certain requirement before usage, and these basic requirements must include design, buildability, performance, quality, safety and must be completed in the right timeframe (Olusola et al., 2011). Nevertheless, these improperly constructed buildings have been posing threats and has become a chief concern, making many property owners generate high blood pressure and continual worry over the lifespan of their assets or investments. The loss of this property and lives has put a dent to the safety of citizens, and further development of the nation as the frequencies of their occurrence make headlines.

A building collapse is when the superstructure fails (Ayininuola and Olalusi, 2004) and the building structural components have been altered thereby resulting in the failure of the structure (Arilesere, 2002). A building is said to have failed when one or more elements of the structure cannot perform its original function efficiently due to the inability of the material making up those components to work correctly; this may eventually lead to building collapse.

The recurring incidence of building collapse has claimed a lot of lives and property in the country and has instigated several studies to be undertaken. Various workshops have been organised in the main cities in the country. Some of which are the one held at the University of Lagos, Akoka on April 5th, 2008 on the topic Building Survey- A challenging practice of consultancy of a professional builder. In Abuja a four-day international workshop from November 29th, 2010 – December 2nd, 2010 on the use of computing and information technology (IT) as a driver of innovations in the area of sustainable building. Also, the last but not the least a workshop held in Abuja on May 15th, 2012 by Nigerian Building and Road Research Institute Nigeria (NBRRI) on Building collapse. The then vice president Architect Namadi Sambo called on the building professionals to proffer adequate solutions to the menace of building bedevilling the country (Suleiman, 2012). Institutions and government parastatals or agencies have not been left out in determining the various causes of building collapse in Nigeria.

In the UK where there are little cases of building collapse, much research has been carried out, and they have tried to identify the causes and consequences with a well-developed framework in other to mitigate the occurrence of building collapse (Department for Communities and Local Government, 2011). Whereas in Nigeria where building

collapse is common, there has been little research done to understand the causes of these building collapses and a lot of precautionary measures are taken rather than preventive measures. Of which this approach recently has led to the death of 35 people in the building collapse that occurred at Lekki Gardens Lagos (Nwosu, 2016) and the Guardian newspaper also reports that over 30 people lost their lives when a five-storey building still under construction collapsed on March 10th 2016. When the collapse occurs; professional bodies such as Council for the Registration of Engineering in Nigeria (COREN), Architects Registration Council of Nigeria (ARCON) and the Government usually arrange panels to ascertain why the building collapsed and possibly recommend sanctions to those responsible. Despite these researches and panels set, there is still an increasing number of building collapse in Nigeria. Moreover, as such, this is an area that requires further research on the causes, consequences and the preferred solution in other to avert the incessant building collapse in Nigeria rather than just the reports made after the collapse. That only review why the building collapsed, the nature of collapse and the number of casualties, the building's worth and who's to blame for the collapse.

The actual research on the causes and preventive measures of building collapse have been limited to only developed countries such as the UK, USA and Canada. Recording a total of just 35 workers in 2014/2015 (HSE, 2015). In developing countries like Nigeria, where the state of building collapse is relatively high (Nwosu, 2016), there is a dearth on the actual causes and a preventive measure of building collapse. It represents a gap in the knowledge on the subject of the causes of building collapse in Nigeria. Hence, there is a need for proactive measures to deal with the factors responsible for building collapse and how they can be eliminated (Idoro, 2008). There are numerous causes of building collapse in Nigeria (Ogunbiyi, 2014). Therefore, it is important to examine the causes alongside its preventive measures. It will facilitate a definite improvement within the construction industry by promoting and enhancing modern practices to attain sustainable structures.

2 MENACE OF BUILDING COLLAPSE

There has been a high rise in the building collapse recorded in Nigeria over the last 10 years, and this is a major setback in the development of the country as buildings begin to fall more frequently causing loss of lives, properties and massive investments (Ejembi, 2016). The incidence of building collapse is common in all regions of the federation with the major cities such as Lagos and Abuja having more. The frequency to the extent of building collapse is high that no six months would pass without at least one or more occurrence of building collapse somewhere in the country. The frequency of these events have not only become a source of worry but have put the citizens at a high level of uncertainty of the construction works causing a dent in the economy. Especially to the stakeholders in the construction industry and the government as the magnitude of these incidents, become more rapid (Ayedun et al., 2012). Thus, making the Council for the Regulation of Engineering Practice in Nigeria (COREN) to advocate for capital punishment for the owners of the collapsed building and

Governments insistence on zero tolerance for building collapse (Tribune, 2016).

Cities in Nigeria, lives and properties have been lost through the collapse of buildings in biggest cities such as Abuja, Lagos-Port Harcourt, Ibadan and Kaduna just to mention a few. Despite its high occurrence in the urban centres, however, building collapse is not limited to only the cities as it cuts across cultural, ethnic and geographical barriers (Ayedun et al., 2012). The incidence of building collapse has become an issue to many causing much trauma, high blood pressure, increased number of casualties due to the number of existing collapsed structures with over one hundred and twenty deaths recorded cases of building collapse in 2014 alone (Adebowale et al., 2016).

Lagos state, which is the heart of all commercial activities in the country, has recorded four of such collapses (synagogue church) in Ebute Metta that claimed 37 lives and residential buildings. On the 8th of March 2016, Babalola reported the incident of a building collapse at Lekki Garden where a five-storey building collapsed in Ikate Elgushi area of Lagos state killing 18 persons. Most recently, on Thursday evening July 21st, 2016, in Abakaliki, Ebonyi capital, a three-storey building under construction collapsed, with no life lost, but many injuries were sustained (DailyPost, 2016).

Below is a list of cases of building collapse that has occurred in Nigeria over the years.

Table 1: Tragic building collapse in Nigeria (Ejembi, 2016).

SHOWING SOME REPORTED CASES OF COLLAPSED BUILDING IN NIGERIA						
S/N	STRUCTURE	LOCATION	TYPE	DATE	SUSPECTED CAUSES	CASUALTIES
1	Synagogue church building	Ikotun area of Lagos	Six-storey guest house	September 12, 2014	Still in view	116 dead & over 100 injured
2	Lagos peninsula	Lekki district	Five-storey building under construction	March 10, 2016	Unapproved building plan	30 feared dead
3	Uncompleted building	#2 Ikoli street, Garki Abuja	Four-storey uncompleted building	August 2010	Unknown	21 dead & 9 injured
4	Jos school	Abu Naïma primary & secondary school	Two-storey building	September 2014	Structural defects	Over 10 pupils
5	Building under construction	Agbama area of Umuahia	Building under construction	May 2013	Non-adherence to building regulations	7 dead
6	Abandoned church building	Angwan Dosa, Kaduna	Abandoned church building	December 2011	Wrong demolition	25 dead
7	Building at Kaduna metropolis	Hadeja road Kaduna	Three-storey building	July 11, 2013	Non-adherence to building regulations	4 dead & 3 injured
8	Bank of industry building	Bank street, Lagos Island	21-storey building	March 2006	Building failure due to previous fire outbreak	Over 20 injured & 50 rescued
9	The Titanic	Ebute Meta area of Lagos	Four-storey building	July 18, 2006	Non-adherence to building regulations	Over 20 injured & 50 rescued
10	Building marked for demolition	Ebute Meta area of Lagos	Three-storey building	July 2013	Non-adherence to building regulations	7 dead

Table 2: Recent occurrence of Building Collapse in Nigeria (Fakere, Fadaïro & Fakere, 2012).

RECENT OCCURRENCES OF BUILDING COLLAPSE IN NIGERIA				
S/N	BUILDING LOCATION	DATE	SUSPECTED CAUSES	REMARKS (Life lost)
1	Mushin, Lagos	2000	Faulty construction	Nil
2	Oke-Bola, Ado-Ekiti	2000	Poor quality control, rain storm	Nil
3	Ogbagi street, Ikare	2001	Fire disaster	Nil
4	Ode ikoyi, Akure	2001	Foundation problem	Nil
5	Odoso compound, Ikare	2001	Fire disaster	Nil
6	Ojuelegba, Akure	2003	Poor workmanship & under-reinforcement	Nil
7	Stadium road, Akure	2003	No structural members	Nil
8	Onyearugbulem market, Akure	2003	Poor workmanship & under reinforcement of the cantilevering end	Nil
9	Ebute Meta	2003	Structural defects	8 injured
10	Eloas street, Lagos	2004	Rain storm	8 died
11	Iponri	2005	Inappropriate foundation	Nil
12	Oke Suna, Lagos	2005	Structural degeneration	1
13	Broad street, Lagos	2006	Rain storm	Not disclosed
14	Ebute Meta	2006	Structural defects	37
15	Oworonsoki	2006	Faulty construction	1
16	Abuja	2008	Faulty construction	3 died, 10 injured
17	Apogbon	2008	Structural defects	3 injured
18	Ikeja	2008	Faulty construction	Several injured
19	Ajgunle, Apapa Lagos	2008	Structural defects	3 died, 5 injured
20	Ojetinde street, Lagos	2009	Faulty construction	9 died, 3 missing, 21 injured
21	Ajgunle, Apapa Lagos	2009	Structural degeneration	Not disclosed
22	Abuja	2010	Faulty construction	Not disclosed
23	Garki, Abuja	2010	Overloading	23 died, 10 injured
24	Kano	2011	Rainstorm	6 died
25	Abuja	2011	Overloading	100 died
26	Abuja	2012	Unsupervised	2 died

3 AIMS AND OBJECTIVE OF THE STUDY

The aim of this study is to identify the causes and the preventive measures of building collapse in the Nigerian construction industry. Highlighting comprehensively the major causes of building collapse witnessed in the country, as well as the strategies for preventing such an occurrence.

The study would achieve its aim through a number of objectives, which are these:

1. To carry out a comprehensive exploration of the likely causative factors of building collapse.
2. To examine carefully the key factors responsible for building collapse in Nigeria.
3. To determine the key precautionary measures for mitigating the incessant building collapse in Nigeria.

4 LITERATURE REVIEW

Building collapse is gradually making the headlines in most developing countries today, and this has become rampant and devastating (Than, 2013). The incidence of these building collapses does show anonymous signs of reiteration, with each collapse raising tremendous effects that cannot be forgotten by any of its victims. These include loss of lives, huge loss of money spent on the investment or property, jobs, trust in building professionals and increasing uncertainty among stakeholders and environmental disaster (Ede, 2010).

Developing countries are porous to building collapse. In the western Cairo suburb of Matariya, 17 people were killed in the building collapse that occurred on the 25th November 2014. On 4th November 2015 at a factory in Lahore Pakistan witnessed a building collapse that killed about 45 people. In that vein, the looming incident of the synagogue church building collapse that claimed 115 lives on the 12 September 2014. However, these three notable building collapse is believed to have been caused by unauthorised approved building plan on the number of storeys of the building, structural failure due to no government approval before construction, poor construction ethics and poor safety standards respectively (Oloyede et al., 2010).

In Nigeria, building collapse has been recognised to be either natural or man-made occurrences. Its resurgence in the construction industry has become a worry to all and has instigated researches to be carried out in identifying its predominant causes to date. The recorded incidence of building collapse has occurred in buildings under construction, buildings undergoing renovation as well as buildings in service (Taiwo and Afolami, 2011). The frequent increase in the occurrence of building collapse today has spun strings of researches. By authors such as Matawal et al. (2014); Tanko et al. (2013); Olusola et al. (2011); Olanitori (2011); Oloyede et al. (2010) and many

others. These authors attributed the predominant causes of building collapse to the non-adherence to approved building plans before construction commencement, non-compliance with approved standards by developers, the use of substandard materials, inefficient stringent quality control in material utilisation and management, lack of proper supervision on construction works, boycotting the professionals, etc. Ojo et al. (2013), estimated that more than 60 percent of building collapse fall within these listed factors.

Bediako (2015) attributed the causes of building collapse to man's negligence in some of the vital areas in construction, which brings about a collapse in the building of structures. It includes soil type/bearing capacity, disregard for building regulations, weak and unapproved building design (Olusola et al., 2011). The use of inferior building materials (Oloyede et al., 2010), lack of continuing development, the activities of quacks in the industry, excessive alteration on the original design and inadequate monitoring and overall poor workmanship (Uzokwe, 2001). These causes can be identified as the non-compliance to building regulations set by the Government for construction, ineffective monitoring schemes put in place by the government to check defaulters and low awareness level of clients and contractors on erecting a sustainable structure fit for purpose. Alamu and Gana (2014) added that the professionals in the building industry should not bear the burden alone, but should collaborate with the government and the agencies involved in maintaining a harmoniously built environment worthy of sustainability.

According to "Study of Recent Building Failures in the United States" report: There are a varying number of causative factors of building collapse. Most failures witnessed can be traced to some principal causes of building collapse categorised as deficiencies in design, maintenance, detailing, construction and inadequate consideration of external events and use of materials (Kumalasari and Fabian, 2003). A defect in design has to do with mistakes, lapses, inaccuracies that could have occurred during the design phase of the building. Detailing deficiency is the gap witnessed in the development and construction process of the building that leads to discontinuity/ loss of concept and breach of the construction contract. Construction deficiency eventually occurs as problems with shoddy workmanship and deviation from the specification.

According to Olusola et al. (2011), Taiwo and Afolami (2011), Alamu and Gana (2014) apart from the causes listed above. There are other technical causes of building collapse, which include the adoption of the wrong foundation, shallow depth of foundation placement, weak concrete strength, poor concrete mix ratio, poor building material specifications, improper walling, quick construction methods and inadequate maintenance schemes put in place by the government. These causes are found to affect the building construction industry due to its interference in the everyday work schematics of various construction proceeding on different construction sites. However, these are only some of the factors that can lead to the collapse of buildings.

The incidence of building collapse can be witnessed when professional bodies do not create a forum or avenue (Internships) for fresh engineering graduates to be trained and gain meaningful experience on the nitty-gritty involved in building/ civil engineering works which are not taught in schools (Kazeem et al., 2014). This forum also aids the fresh graduates to practice what they were taught in school before proceeding to practice, and this would help improve the skill and expertise knowledge on construction projects. Ayininuola and Olalusi in this regard accused the building construction professionals as those responsible for the incessant building collapse witnessed in the country, due to their negligence to construction works, poor attitude to work and lacking the required skill and expertise to function in that capacity. It is clear that buildings built in this manner would be traced to the illegal adoption of foundation, weak and inadequate concrete mix ratio. When doing your reinforcement, use of crude materials for construction works, ineffective site supervision, excessive alteration on the original design, bad communication on site, poor design and climatic conditions (Fakere et al., 2012).

Despite the glamorous call made by the citizens and the government on the frequency of building collapse witnessed, coupled with the social economic and political practises of Nigerians. To contribute to the collapse of buildings through clients/ contractors willing to cut corners just to achieve a greater profit margin on the project, arising from greed, negligence tendencies because of external and accentuating seismic forces (Tribune, 2016). In the same vein (Oloyede et al., 2010) pointed that corruption in the building industry has eaten deep down the sector causing reluctance to adopt the existing building codes, meant to detect and guide the flow of construction works with lack of political will to enforce same by the Town Planning Authorities. Adebayo (2000) opined that construction projects are now more profit driven, thus substituting the need for developing a sustainable building with the right skill and expertise to achieving personal financial targets to stay afloat in the business.

As stated in the Global Corruption Report (2005), corruption has led to the dramatic increase in the cost of building materials, thereby increasing the use of inferior grade building materials for construction and this, in turn, affects the quality and standard of construction in the economy. Corruption is evident in different stages such as, at contract award, planning and design stage, execution/ construction phase and hand over on completion phase. Corruption may, however, exist in one or more forms in each of the identified stages listed above. It includes bribery, deception, and collusion, the result of this is reducing the standard of the construction industry, increasing the cost of repair and maintenance and some defects that may never be discovered until eventual collapse of the building (Ebehikhalu and Dawam, 2014).

There is a high number of engagement of inexperienced personnel to take charge of construction works. As stated by the Nigerian Building and Road Research Institute (NBBRI, 2012), about 70% of the building collapse today are caused by inadequacies in the right balance of experience, skill and expertise. The Nigerian construction

industry consist of the informal and formal sector (Kazeem et al., 2014). The formal sector comprises of all the professionals in the industry, which include the engineers, architects, builders/ contractors, quantity surveyors, etc. and these people are guided by strict regulations by the governments and the professional organisations. The Oxford Advanced Learner's Dictionary defined the informal sector as a relaxed and friendly area. This segment comprises of the bricklayers, iron benders, carpenters, mason, welders, artisans, etc. These are individuals without any form of certification, training, education or licence, whose professional practises are not held in high regard by the various organisations but supervised by the professionals to meet the standard of buildings required. The individuals here only have the practical understanding and concept, but do not understand the theoretical concept/ approach behind why certain decisions are made and the degree of the importance of attaining sustainability in construction.

According to Ayedun et al. (2012), the collapse of buildings is primarily attributed to natural occurrences such as a rainstorm, earthquakes, flooding and typhoons (Fagbenle and Oluwunmi, 2010), (Kumalasari and Fabian, 2003). Falobi (2009) added that collapse of buildings is chiefly man-made borne out of man's negligence on some of the basic skill and expertise. In areas such as building texture and design, soil type, quality of construction materials, planning for external loads and stress from winds and earthquake for tall buildings, inadequate supervision on construction projects and poor quality of workmanship.

The Dictionary of Architecture and Construction defined building collapse as that which has a mechanical failure. Even an excellent design and constructed structure would not stand on a wrong foundation due to the substitution in the processes made by the design professionals. Dimuna (2010) puts all the blame on the nation's building professionals, saying they are the ones responsible for providing the structural designs, site scheduling, traffic management plan, health and safety plan and logistics. However, they are so many sides to this because after the designs are made, it goes for approval by the government authorities and most of the times clients shun these professionals in other to cut cost and gain profits in the end. Therefore, the process of approval and designs are not complete. That notwithstanding, the Architects, Structural Engineers, Surveyors and Builders are not to be the only ones responsible.

According to Adebayo (2000), a conservative way to avert the building collapse that is impeding the economy's growth and restore success to the Nigerian construction industry would solely depend on both the clients and contractor going for quality first instead of looking at the overall project cost. It means the building developer should consider delivering a sustainable building worthy of merit, and should be ready to pay the right price for it. However, the use of quality materials for construction, standard tools and equipment's, skilled labour and strict supervision should be carried out by the site supervisor, on a daily basis with the Government performing routine checks periodically, during the project life cycle would help eradicate this increasing occurrence of building collapse. The right skill is needed for

the project to enhance efficiency and to create valuable workmanship in construction.

5 METHODOLOGY

This study was based on the analysis of data gotten from past building collapse in Nigeria over the last two decades. Adequate and concise information necessary to achieve the aim of the research was obtained from the administered questionnaires, journals, reports and previous works by other authors on the subject matter.

6 DISCUSSION

6.1 KEY CAUSES OF BUILDING COLLAPSE

From the analysis of the data obtained from the questionnaires, these are the top rated causes of building collapse in the Nigerian construction industry according to the mean ranking as shown in Table 3. The reasons are discussed below:

1 Weak/faulty foundations

The findings show that the top-rated cause of building collapse in Nigeria is weak/faulty foundations. In the same vein, the research was done on "the empirical ascertainment of the causes of building collapse in Nigeria" by Ayedun et al. (2012) adduced weak/faulty foundation as the top-ranked cause of building collapse. This is because strict measures are not put in place to ascertain if the right foundation is adopted, unlike in the UK where the building control officer from the National House Building Council (NHBC) comes to ensure that quality and standard specifications are put in place to enhance sustainability. It was reported (Naija247News, 2016) that the recent four-storey building collapse in Abuja that claimed the lives of two persons was a result of a wrong foundation. Therefore, this is no surprise why the respondents agree that weak and faulty foundation are one of the leading causes of building collapse.

2 Inefficient stringent quality control in material utilisation and management

This was the next top rated prevalent cause of building collapse in the industry. According to Lakshmi (2015), it is essential for monitoring quality control in projects, so that they comply with the standards of the built environment, facilitate adequate and well-structured buildings that are reliable, with durable materials and operating systems for long lasting and sustainable buildings.

The lack of stringent quality control in the management of the industry is inefficient, due to the disregard of the professionals who have not earned themselves some credit because corruption, and design inefficiencies exist concurrently (Adebowole et al., 2016). The respondents adduced the lack of adequate enlightenment on the consequences of building collapse while managing cost as the intriguing factor to low-quality material management.

3 Boycotting the professionals

Another top-rated cause of building collapse is boycotting the professionals. According to researchers on building collapse by Ede (2010), Adenuga (2012), Egunjobi and Adebayo (2016) boycotting the professionals is a major concern in the Nigerian construction industry and needs addressing because it is linked to the willingness of the client to cut cost, corruption and bad practices. However, clients dodge from involving the right personnel on projects just to make extra profits and reduce cost. In Nigeria, there is no active legislation on sanctioning the professional, so it makes it easy for discrepancies in the construction process which could lead to building collapse (Ebehikhalu and Dawam, 2014). Take for instance the six-storey building collapse of the synagogue is still awaiting trial in court (Udo-Udoma, 2014).

4 Absence of proper site investigation

The incessant occurrence of building collapse has instigated many types of research to identify the various causes of building collapse. A study of Adebowale et al. (2016), Ebehikhala and Dawam (2014) identified that, before structural drawings, little or no site investigation is done to determine if the soil bearing capacity is adequate for the building or not. Site investigations are essential for designing and constructing the foundation for a structure. Kazeem et al. (2014) highlighted the need for proper site investigations on the construction site to eradicate this incessant building collapse to enable a sustainable built environment.

5 Engagement of inexperienced personnel

The engagement of inexperienced persons has long been a primary concern of the Nigerian construction industry (Ede, 2010). The findings of the study by Adeagbo (2014), Oyedele et al. (2010) suggested that the construction industry is made up of mainly inexperienced personnel's, ranging from tertiary institution graduates to entrepreneurs, which only have theoretical knowledge but limited practical experience. This study suggested that a forum should be created for fresh graduates to be trained and gangster meaningful experience on the nitty gritty of the building/civil engineering works which are not taught in schools.

6.2 KEY PREVENTIVE MEASURES OF BUILDING COLLAPSE

From the analysis of the data obtained from the questionnaires, these are the top rated preventive measures of building collapse in the Nigerian construction industry according to the mean ranking as shown in Table 4. The causes are discussed below:

1 Supervision of construction works by professionals (Architect, Builders and Engineers)

The findings show that the top-ranked factor is proper supervision and monitoring is vital for preventing building collapse. The level of supervision and monitoring of construction projects has been highly criticised with little or no supervision on projects leading to structural defects or failure, and most projects run without a project manager which is not ideal (Ayedun et al., 2012). In the study by Kazeem et al. (2014), some surveyed designers said that building collapse would be history if adequate measures are

taken to improve on supervision and monitoring of construction projects.

2 Education enlightenment on the public on the need to prevent building collapse rather than managing situations

Another top-ranked factor is enlightening the public, with the high frequency of building collapse witnessed, continuing professional development need be emphasised on modern practices to keep members abreast with the new trends in construction (Taiwo and Afolami, 2011). This broadens the knowledge of the public and is a conservative method of reducing building collapse.

3 Employment of competent professionals

The analysis revealed that hiring incompetent professionals was ranked 2nd as a primary cause of building collapse (Ayedun et al., 2012). Chendo and Obi (2015) checked for the impact of employing incompetent professionals and majority of surveyed respondents mentioned stated that it was the cause of building collapse. Therefore, is it no surprise that this is ranked 3rd in this study because in achieving success on any construction project the right skill and expertise are required. However, in most cases, the cost of employing competent professionals is always an issue, but where the cost of implementation is high, implementation becomes worrisome Bello, 2012). So in preventing building collapse employing the right and qualified persons for the job is essential.

4 Issue building approvals before construction commences

Approvals from the town planning authorities are necessary before the commencement of the project, to ensure that the structure is fit for purpose (Tanko et al., 2013), also where approval is obtained; it is not adhered to (Adenuga, 2012). A study of Dimuna (2010) revealed that there are delays in obtaining approvals, and Adebowale (2016) stated that 70% of collapsed buildings do not have government support, making the obtaining of building approvals a necessity in the current economy. In the UK the contractors or construction firms would have a certification from NHBC making it easier and better in assuring standard quality control.

5 Involvement of structural engineer in a project that goes beyond one floor

In construction, the need for a structural engineer cannot be over emphasised such that any construction work, without the presence of a structural engineer is bound to fail (Dimuna, 2010). The involvement of a structural engineer is paramount for any construction project to ensure serviceability, detailing of economic structure and maintaining consistencies with the health and safety procedures (Dimuna, 2010). It is mandatory for an engineer to man a site so that if inferior materials are brought, it would not be long until it is discovered. However, Falobi (2009) identified that the inadequate awareness, and low combative financial power have been subject to hiring, other unqualified personnel to act as the structural

engineer, and this is one of the main causes of building collapse because the appropriate skill and expertise are in question. Ede (2010) suggested that employing a structural engineer from the conception phase of a project is a safe way to advert building collapse.

7 RECOMMENDATION AND CONCLUSION

Recommendations for further studies

Going by the results obtained from this research, the following recommendations can be made:

- This study recommends that a profound investigation needs to be conducted on the practicability of the suggested solutions, primarily training fresh graduates on the nitty-gritty of engineering works, which are not taught in schools.
- Further studies on building collapse need to be carried out on buildings during and after construction, linking and comparing both occurrences.
- The need to collect and record data of various building collapse with a proper investigation on the actual causes.
- The need to investigate the extent of academic literature on cases of building collapse.

8 CONCLUSION

The causes and the preventive measures for building collapse in Nigeria have been investigated. The analysis and discussions of the findings is obtained. Besides, the research sample is limited to the professionals (Architects, Site engineer, client, contractor and Town planners) in the Nigerian construction industry, and these conclusions will be attributed to mainly these sample. From the findings from this study, it can be concluded that the key causes of building collapse are weak/faulty foundations, inefficient stringent quality control in material utilisation, and management, boycotting the professionals, absence of proper site investigation, the absence of proper site investigation and the engagement of inexperienced personnel. However, the analysis of the results gathered, reveal that, there was variance in opinions, as to the causes of building collapse among professionals in an attempt to exonerate themselves from the blame for building collapse. These were classified as the areas in the building sector that were prone to building collapse. Therefore, this study claims that the above-listed causes of building collapse are predominant in the Nigerian construction industry.

The key preventive measures for building collapse were supervision of construction works by professionals, education enlightenment on the public on the need to prevent building collapse rather than managing situations, employment of competent professionals, issue building approvals before construction commences, and involvement of structural engineer in a project that goes beyond one floor. Therefore, this study suggests that these preventive measures should guide the construction industry, and its practices in covering the grey areas associated with building collapse, in other to guarantee safety in the industry.

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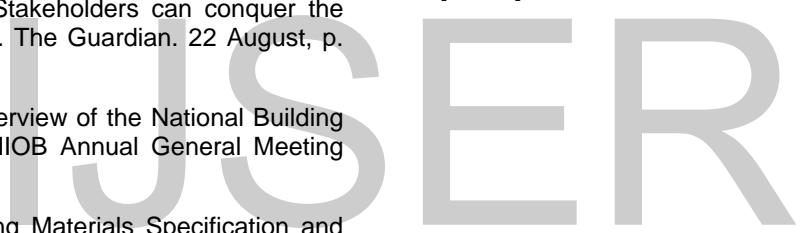
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APPENDICES

Table 3: The causes of building collapse and their ranking

S/N	Causes of building collapse	Mean	Standard deviation	Ranking
1	Non-compliance with approved specification by developers	1.5	0.746	12
2	The use of substandard materials	1.48	0.856	9
3	Non-adherence to building plans	1.49	0.842	10
4	Inefficient stringent quality control in material utilization and management	1.35	0.695	2
5	Most structural designs are handled by quacks	1.78	1.136	26
6	Absence of proper site investigation	1.39	0.539	4
7	Engagement of inexperienced personnel	1.4	0.722	5
8	Lack of proper supervision, inspection and monitoring of construction	1.45	0.634	6
9	Illegal conversion, alteration and addition to existing structure	1.51	0.811	14
10	Prevailing corrupt practices in the industry	1.53	0.826	16
11	Undue interference of client on construction works	1.96	0.934	33
12	Lack of clear building operation and sequence	1.75	0.893	24
13	Poor town planning and development	1.71	1.009	22
14	Poor maintenance culture	1.84	0.999	28
15	Professionals do not pay attention to details on site	2.13	1.247	38
16	Lack of continuing professional development	1.98	1.031	34
17	Inefficient workmanship (labour)	2.13	1.205	37
18	Over reliance of clients for decision making	2.21	1.155	40
19	Client perchant to cut corners	1.68	0.741	20
20	Lack of enforcements on the penalties of wrong construction	1.50	0.675	11
21	The activities of quacks in the industry	1.48	0.693	8

22	Removal of formwork before curing concrete decking	2.18	1.028	39
23	Improper drainage system	2.05	1.113	36
24	Non-compliance with the local building codes to enhance safety	1.65	0.858	18
25	Untimely site completion due to monetary delays	2.01	1.206	35
26	Design change without designer's authorisation	1.58	0.911	17
27	Lack of sanctions of erring professionals and property owners	1.68	0.808	19
28	Absence of coordination between professionals and property owners	1.90	1.074	32
29	Inadequate funding of construction projects	1.73	1.018	23
30	Bad communication on site	1.86	0.938	29
31	Flagrant disobedience of town planning regulations by developers	1.89	0.711	31
32	Weak/faulty foundations	1.34	0.550	1
33	Boycotting the professionals	1.35	0.576	3
34	Poor workmanship by contractors	1.51	0.693	15
35	Not using the right concrete ratio when doing your reinforcement	1.46	0.674	7
36	Excessive alteration on the original design	1.70	0.701	21
37	Sitting of soak away close to the foundation	1.84	1.012	27
38	Willingness of client to cut cost	1.50	0.636	13
39	Inadequate consideration of possible external events	1.86	0.742	30
40	Natural occurrences (rainstorm, earthquakes, flooding etc.)	1.76	1.009	25

Table 4: Preventive measures for building collapse

S/N	Preventive measures for building collapse	Mean	Standard deviation	Ranking
1	Involvement of structural engineer in a project that goes beyond one floor	1.33	0.671	5
2	Adequate staffing of town planning authorities	1.79	0.807	20
3	Issue building approvals before construction commences	1.30	0.488	4
4	Education enlightenment on the public on the need to prevent building collapse rather than managing situations	1.24	0.484	2
5	Development and passing of the national building code	1.46	0.762	11
6	Enforcement of health and safety on building sites	1.57	0.632	16
7	Employment of	1.26	0.497	3

	competent professionals			
8	Adequate training and retraining of staffs	1.34	0.476	6
9	Design of structures to resist extreme weather conditions including wind and surface run-off	1.50	0.675	12
10	Government legislation that enforce the training and effective control of artisans on construction sites	1.54	0.572	14
11	Supervision of construction works by professionals (Architect, building and engineers)	1.20	0.403	1
12	Introduction of ISO 9000 certification to assess the quality of construction	1.59	0.791	18
13	The use of post construction methods	1.65	0.748	19
14	Ensure quality control and testing should be done by independent labs before construction	1.45	0.634	10
15	Incorporate lessons learnt from similar construction projects during construction	1.54	0.762	13
16	Ensure that regular audits of defective structures are carried out and marked for demolition	1.39	0.626	8
17	Educate construction personnel on good construction practices	1.34	0.476	7
18	Create a body to be able to check building and supervise during construction	1.55	0.840	15
19	Government legislation on maintaining zero corruption level on construction	1.40	0.587	9
20	Review any designs and calculations using computer programs or multi engineers	1.59	0.807	17

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