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Original Research Article

IDENTIFICATION OF THE KEY CAUSES AND MEASURES TO PREVENT BUILDING COLLAPSES IN NIGERIA

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Abstract

Buildings collapse in the Nigerian major urban cities continues to engender an excessive number of fatalities, injuries and property damage. The collapse of building infrastructure, though prominent in developing economies, is a worldwide issue. Building developments collapse at the construction stages and in some cases after commissioning. Examples abound in recent times in Abuja and Lagos. The major problem is the unquantifiable resources wasted when building construction development collapses. If the answer to this endemic problem is proper project management, it becomes imperative to institutionalize its activities in Nigeria. Building Collapse is an occurrence that has been notorious over the decades. It is caused by many factors which have their great impact on the lives and properties of man. This study reviews current causes in the building industry. In view of this development, this study is aimed at demonstrating how real estate project management strategy helps in building collapse. Data from the primary source were basically from the designed instrument, which were distributed to the population of 100 professionals in the building industries. In this paper, it was concluded that the key causes of building collapse are weak/faulty foundations, inefficient stringent quality control in material utilization, and management, boycotting the professionals, absence of proper site investigation, the absence of proper site investigation and the engagement of inexperienced personnel. The aim of the study was to identify the factors influencing the occurrence of construction

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disasters in Nigeria in order to prevent them in the future. 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.

Keywords: building collapse, construction project management, project strategy

1. INTRODUCTION

Building can be defined as a roofed and walled structures built for permanent use for man's living, working and storage, According to encyclopedia Britannica. buildings are structures, which serve as shelters for man, his properties and activities as quoted in [5]. To obtain the desired satisfaction, they must be properly designed, well planned, constructed and maintained. A household's wealth determines the usable floor area, additional facilities (e.g. a swimming pool) and the number of devices using electricity. The residents' awareness determines which technologies they use (e.g. low-energy devices and heating systems using renewable energy) [30]. Today's requirement that construction projects be economically and environmentally effective in their whole life cycle makes the issue of life cycle costs of buildings become an increasingly common element of comprehensive analyses which may involve the impact on the environment, energy consumption, society or the impact of risk [39]. Increasingly, low construction and operating costs cause problems with the load-bearing capacity of buildings and their failure rate.

Building collapse is a phenomenon characterized by the compromise in the structural integrity of a building's component elements, resulting in its eventual failure. Structural failure refers to the loss of load carrying capacity of a structural component or structure itself, that is failure of the structural component to perform as designed. This failure in many cases renders the building unsafe for habitation or continuation of construction activities and could eventually lead to collapse, damage to property and loss of lives. Building collapse risk can be described as an event or action that could cause negative impacts or consequences on the building users, investors, stakeholders and the general public, and hence affect the project objectives. From this perspective, building collapse risks can be observed as "threats to success." The collapse of buildings is primarily attributed to natural occurrences such as a rainstorm, earthquakes, flooding and typhoons [17]. In the pre-colonial period, building construction was carried out by our forefathers with local building materials and the type of buildings prevalent within the period are mud houses, with thatched roofs. According to Adebayo [1], 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.

Building collapses in the Nigerian major urban cities continues to engender an excessive number of fatalities, injuries and property damage. The recent building collapse of the synagogue church of all nations' guesthouse at Ikotu in Lagos State made headline news in all the local newspapers. The death of over 117 people mainly of other nationals and 250 injured that came to seek the face of God should be a serious concern to the key project stakeholders, governments and individuals. Statistics show that in every one month 3-5 buildings collapse in the metropolitan city of Lagos only. This is translated to 35-60 buildings in a year. These colossal economic losses associated with building collapses in terms of human lives, property damage and cost of medical care to the national economy is unacceptable. It is disheartening to note that the causes of building collapse are often attributed to a single factor, but more often there is a combination of multiple factors. The collective leadership roles of the key project participants give rise to building failures and disasters [23].

Leadership has been determined to be relevant in the 21st century building process as it has been proved that exceptional organizational performance could be achieved through leadership traits/behavior. Poor leadership and unethical behavior in terms of commitment, collusion, bribery, negligence, fraud, dishonesty, and unfair practices are prevalent in the Nigerian building industry [23]. This state of affairs calls for concern by all the stakeholders, government, individuals and the general public with regard to achieving sustainable, livable, and viable cities for the teeming population.

Failure in buildings can occur during construction and during use [11]. Any types of failure resulting from construction activities could be traceable to poor leadership and lack of commitment by the key participants. Studies conducted by the construction development board (CIDB) of South Africa to determine the causes of poor building quality from. clients' perspective identify the following factors as contributing to poor building quality and performance, poor leadership and lack of commitment existing in clients organizations, inadequate provision of financial resources for the project; lack of certified skilled labour; poor equipment; inadequate enforcement of building regulations, and use of inferior materials. Similarly, [22] states that political decisions have negative impacts on building

industry performance in Nigeria. There are instances where contracts are awarded to contractors who are not capable of undertaking the necessary work [22]. The result is a building failure or complete collapse..

Building failure could probably be attributed largely to design or construction related factors and the roles of clients and their appointed agents in not ensuring quality (Spangenberg, 2009). It has been noted that absence of planning approval and improper soil investigation contribute to unsafe structure or failure [22]. However, a critical review of the causes of building failure points to management ineptitude and clumsiness, which is a manifestation of poor leadership. Reducing the spate of buildings collapse in Nigerian major urban centres requires transparent leadership, commitment and attitudinal change among the key project leaders. As it has been proven over the years that leadership is a key component of successful organizations.

According to [29], the means by which a building project is completed demands either hope, guesswork and good fortune, or regular planning and control. The former method will almost always lead to bad fortune. Mawdesley et al., also said that the latter is a step in the right direction, although the avoidance of failure cannot be assured due to the differences in the quality of the planning. This statement describes the situation in the Nigerian building project delivery, because it is a well-known fact that the majority of building projects in Nigeria are carried out without proper planning and scheduling of the building project activities and without any input from a project management trained project manager. When the projects are planned at all, hardly do the planners use the appropriate scheduling technique to logically sequence the planned activities that make up the building project, in order to ensure effective project execution. Nevertheless, the importance of proper planning, scheduling and monitoring of building project activities cannot be underestimated, especially if project abandonment, project failure, collapse of building projects, project cost and time overruns, must be avoided. Mulvaney [32], agrees with the above view because he believes that the objective of planning is to produce a time table of work, so that each job is allocated a start date and a finish date, plus the assurance that the things necessary to deliver each job will be available when required. But in our country Nigeria, public building projects executors do not attach much importance to the scheduling of building project activities. This explains why one hardly finds any scheduling plan being adopted in any public building project. When one does find any, it must be the bar charts, irrespective of the complexity of the building project. Our building stakeholders do not believe scheduling techniques have any effect in successful building delivery. Within this period, there were no sophisticated and complex buildings like blocks of flats, maisonettes, high-rise buildings etc. What was obtainable were bungalows hence, there were no recorded cases of building collapse. In the post-colonial period especially within the period

of oil boom (1970s), the building construction industry witnessed a boom and many building construction projects were carried out. During this period also, improvements in the technological know-how, economic development and industrialization led to the improvement in the building construction processes and procedure. The sophisticated nature and complexity in modern building designs introduced various lines of risks in the building development process instead of eliminating or removing them. These new designs and technology associated with different types of risks could lead to building failures, abandonment and collapse. Hence, from the period of oil boom to the present day, Nigeria has witnessed many cases of building collapse in different parts of the country. The frequency of building collapse in Nigeria in the recent past has become a major issue and concern in her economic ratings. The spate and frequency of occurrence has become a major source of concern not only to the government but to all well-meaning Nigerians and stakeholders in the building industry. Previous research shows that there were spikes in the reported cases of building collapse in Nigeria in the years 1985, 1995, 1999, and 2005, and also suggests an upward trend in the number of cases of building collapse in the year 2010. The Council of Registered Builders of Nigeria identified 104 incidents of building collapse based on available records in Nigeria spanning from 1974 – 2016. These observations are astonishing and most worrying. In order to tackle the cases of building collapse and the associated risks, the Nigerian government at different periods made Laws to guide the building development to curb the menace and risks associated with building collapse. In 1992, the government enacted the Nigerian Urban and Regional Planning Act No. 88 of 1992 to facilitate the preparation and implementation of development plans and planning schemes with a view of establishing a better environment for living, working and recreation.

Various factors have been blamed for the collapse of buildings in Nigeria. Factors like the use of inefficient project executors, inadequate funding, rising cost of building materials, poor management cum technical know-how, carelessness and greed, Ignorance, incompetent contractors, use of substandard materials and quacks, and so on, have all received their share of this blame. But there could be other factors that are causing collapse of buildings and infrastructural facilities in Nigeria and which nobody is paying attention to.

2. THE MEANING OF PROJECT MANAGEMENT IN CONSTRUCTION

According to [21], organizations perform work. Work generally involves either operations or projects. Work by projects is temporary and unique. Temporary means that every project has a definite beginning and a definite end. Uniqueness

means that projects involve doing something which has not been done before. Lockyer [28], defined a project as a task that has a defined set of performance characteristics that involve large, expensive, unique, or high risk undertakings which have to be completed by a certain data for a certain amount of money, within some expected level of performance. He believes that all projects should have well defined objectives and sufficient resources to carry out all the required tasks.

The Meaning of Project Management According to Guide to the Project Management Body of Knowledge (2004), project management is the application of knowledge, skills, tools, and techniques to project activities in order to meet or exceed stakeholders' needs and expectations from projects. Meeting or exceeding stakeholders' needs and expectations invariably involves balancing competing demands among: (i) Time, cost and quality (ii) Stakeholders with different expectations (iii) Identified requirements (needs) and unidentified requirements (expectations) (PMI Practice Stands, 2001).

But from the perspective of different stakeholders in project management, project management has arisen from the definitive understanding of project and management, and involves the coordination of group activity in which the manager plans, organizes, staffs, directs and controls in order to achieve an objective with constraint in time, cost and performance. According to [20], project management is a blend of art and science, the art of getting things done through and with people in a formal organized group; and the science of handling large amount of data to plan and control so that project duration and cost are balanced. In project management it is important that implementation be handled by those who understand the project better as they are more likely to work within cost and time schedules and be able to do a good job.

Project failure: Project failure is illustrated by a failure to achieve the four success criteria and is manifested by the lack of application of proven project management techniques. It does not mean that the project may not have been physically completed but the question is when is the completion? Is there any time or cost overrun? Is the quality specified standard achieved? Can it stand the test of time? Can its potential be maximally realized? Is the client and end-user satisfied? If the client is proposing another project, can he insist on working with the same team? If the answers to the above questions are in the affirmative, the project is termed successful but if otherwise it means a failure. The standard quality objectives in management especially in construction management being: Cost (being on budget), Time (meeting deadlines), Quality of work (meeting client requirements), called an iron triangle For years, project managers have been taught that the success of their project will be due to what it is they do, and their fundamental role is to ensure that the project delivers its outputs to time and to budget. Work by e.g. [40], should have made it obvious to the professional project

manager that management attention must be focused on project success criteria rather than project execution. It's not an iron triangle now, it is a golden pyramid, where success is determined by project effectiveness factors.

Building collapse: The collapse of building infrastructure, though prominent in developing economies, is a worldwide issue. Building developments collapse at the construction stages and in some cases after commissioning. Examples abound in recent times in Abuja and Lagos. The major problem is the unquantifiable resources wasted when building construction development collapses. If the answer to this endemic problem is proper project management, it becomes imperative to institutionalize its activities in Nigeria.

3. THE NEED FOR PROJECT MANAGEMENT

It has become imperative for the various participants in the building industry to pay greater attention to the efficient use of all client resources required in executing capital projects. This need can be traced to difficulties being experienced with the orthodox way of operating in the building industry and the relationship that exists between client, consultants and contractors which are often not satisfactory in the traditional procurement method. The difficulties have not allowed clients to benefit from the time tested and worldwide accepted better procurement method of project management. The benefits of project management are now becoming obvious and many of the construction industry's influential clients are turning to project management as the most effective way to procure a new facility, whether it is a factory building, a multi-storey office block, or any other building project work. The objectives of project management are to apply management skills and appropriate techniques to the planning and control of all aspects of a project and to optimize the use of resources to produce a well-designed and professionally constructed facility which will meet the client's requirements of function, quality, time, cost budget and future maintenance. This is possible because project management sees to the overall planning, control and co-ordination of a project from inception to completion, targeting the client's requirements and ensuring completion on time, within cost and required quality standards. With the project management structure, management is totally separated from the design process and the construction process. According to [37], if there is one single characteristic which sets a project apart from routine commercial or industrial operations, it is novelty. No two projects are ever exactly alike, and the course of any project may not be predicted with accuracy or the final outcome completely guaranteed. A project is always a journey into the unknown, freight with risk. Projects typically demand the use of resources that are scarce or expensive, but which have to be deployed over a most complex framework of task. The purpose of project management is to minimize, contain or counter the risks

and organize and direct the resources so that the project is finished on time, within budgeted costs and with the functional or design objectives fulfilled. The ability to select appropriate contracts may not only determine the overall condition and success of the company, but even its survival [27].

4. CAUSES OF BUILDING FAILURE

Ayinnuola and Olalusi [6] cited in Babatunde and Opawole [7] stated that in Nigeria, building failure is attributed to 50% design faults, 40% construction site fault and 10% product failure. Hall cited in [44] also attributed faulty design, faulty execution of work and use of faulty materials to be major causes of building failure. Yusuf as quoted by [13] classifies the causes as physical factors, ecological status of the site, composition of technical components, social factors, economic factors, engineering factors, human factors, government policies and political factors. Akinpelu [4] said, the major causes of building collapse are environmental changes, natural and manmade hazards, improper presentation and interpretation in the design. Emmanuel cited in [44] stated that due to geologic make up, some layers of soil are just not strong enough to carry the weight of a building. This is mainly applicable to the top layer of the soil which is not suitable for construction. If this factor is neglected and the building is constructed on the soil, differential settlement of the building starts and leads to cracking of the wall and continues to sink and this can be seen in many parts of Lagos. Ayininula and Olalusi [6] stated that the quality of blocks used in Nigerian building industry is a factor in building failure. For example, the nine inch 9" (230mm) hollow blocks used for the construction of the external wall of a building are to support the weight of the decking and other floors above it in conjunction with columns. The strength of the blocks depends on the ratio of cement to sand used for moulding them, the right proportion must be used to ensure that they are strong and durable. Due to its high demands in the building industry, the block industries in Nigeria have equally increased the quantity in the bid to get the most number of blocks per bag of cement; they use more sand than necessary which eventually results in moulding weak blocks. Apart from negligence, many of our buildings have failed as a result of changes in temperature due to climate change. Ogunsemi [38] remarked that a good building is not that which merely fulfills the purpose for which it is designed and erected but a building comely and able to withstand the onslaught of weather conditions. Adedoyin and Olagunju as reported by [34] stated that most of the available building materials in the developing countries are not only flammable but also encourage the spread of fire. This situation often makes a little fire ignition to spread very fast into a large scale fire development in buildings. Fire when fully blown out, both the structure's reinforcements and concrete will be weakened. It is even worse, when the steel reinforcement is

exposed to the naked fire, they may fail in the process to provide the necessary support for both the live and dead load. This event may lead to partial or total collapse of the building. Most contractors like to cut corners by not using the specified materials adequately. The use of inferior materials and untested local building construction methods often leads to structural failure and eventual building collapse if not adequately checked. Olagunju in [35] stated that buildings start to deteriorate from the time they are completed and from that time begin to need maintenance in order to keep them in good condition. Thus, the rate of building deteriorating depends largely on nature and manner of maintenance. Poor building maintenance can cause weakening of the building structure; most especially when unplanned maintenance type is the building maintenance culture of the building owner/user. Uzokwe [44] submitted that the cause of a building failure is almost always unique to the particular building in question. However, he advanced some general reasons why buildings may be susceptible to collapse which includes the quality of the blocks used, the quality of the concrete used, poor compaction and consolidation of foundation soil and weak soil.

5. BUILDING COLLAPSES IN NIGERIA

In recent times, building collapse in Nigeria has been a source of concern to so many people particularly those associated with the building industry. This is so because there are so many cases of building collapse all over the world and particularly Nigeria. Most of these cases had resulted in colossal economic losses in terms of lives and property. Building collapse is some of the cardinal issues which have created serious concern to all the professionals like Architects, Structural Engineers, and the Builders. The government also is worried about the frequency of collapse of buildings in Nigeria. However, Aderibigbe as quoted in [18] admitted that the recurring event of collapse of buildings has forced some state governments to enforce and enact some laws recommending forfeiture of such buildings and prosecution of their owners.

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 [16]. 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 of building collapse is so 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 [5].

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 [5]. 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 in 2014 alone [2].

Lagos state, which is the heart of all commercial activities in the country, has recorded four 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 Elegushi 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 [10].

5.1. Key causes of building collapse

1. Weak/faulty foundation:

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 [5] 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 foundations 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 [26], 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 [2]. 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 [3, 14, 15], 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 [13]. Take for instance the six-storey building collapse of the synagogue is still awaiting trial in court [43].

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 [2, 13] 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 instigations are essential for designing and constructing the foundation for a structure. Kazeem et al. [24] 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 [14]. The findings of the study [2, 36] suggested that the construction industry is made up of mainly inexperienced personnel, 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.

5.2. Key preventive measures of building collapse

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 [5]. In the study by Kazeem et al. [24], 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 [41]. 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 [5]. Chendo and Obi [9] 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 [8]. 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[42], also where approval is obtained; it is not adhered to [3]. A study of Dimuna [12] revealed that there are delays in obtaining approvals, and Adebowale et al. [2] 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 emphasized such that any construction work, without the presence of a structural engineer is bound

to fail [12]. 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 [12]. 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 [19] 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 [14] suggested that employing a structural engineer from the conception phase of a project is a safe way to advertise building collapse.

6. Defective Design:

Defective Architectural and Engineering drawing may result if architects fail to do or insist on the carrying out of feasibility studies, soil and site investigation which are the bases for design of adequate architectural and structural drawings. Others include poor design details, low quality materials and work specifications. Engineers (structure and civil) may contribute if they fail to insist on carrying out essential soil test, foundation design. Errors, omissions and inaccurate data from professionals may lead to problems if not detected on time.

7. Defective Construction:

This arises when contractors fail to carry out the works in accordance with architects and engineers' specifications. They do this in order to maximize profit. Sometimes specified materials are substituted for substandard ones. Other areas of concern include poor concrete mixes, premature removal of formworks and general poor workmanship.

8. Use of Substandard Materials:

Use of substandard blocks from block factories. Investigation revealed that 1 bag of cement is used to mould 40-45 numbers of 225mm (9ins.) blocks. Without adequate supervision, contractors can engage in sharp practices. Cement- Sand ratio is better obtained in weight and not in volume. It is necessary that steel reinforcement bars undergo tensile strength tests to determine its standard strength. The country and the higher institutions cannot boast of adequate number of laboratories to carry out these tests including concrete cube tests for concrete and water quality. The use of substandard materials and untested construction methods is a major contributor to structural failures of buildings.

9. Absence of Building or Planning Permit:

It is illegal to commence construction works without approved drawings from the approving authorities. The 3 tiers of government- the Commission (for Federal Lands), the Board (for State lands), and the Authority (for Local Governments lands), are vested with the duties of granting approval to prospective developers. Sometimes defective drawings are used for construction without approval from

the approving authorities. Some are done out of ignorance. Others are done where the operation of the authorities are ineffective.

10. Corruption:

Sometimes drawings are not read by officers of the approving authority to detect defects. They sometimes engage in corrupt practices by granting illegal approvals.

11. Non-Adherence to approved building plans:

This comes in the form of illegal alteration to approved drawings. Sometimes, a building originally specified to undergo in-situ concreting is changed to pre-cast methods because the expatriate contractor tends to prefabricate the components overseas and ship to Nigeria. This practice if not properly controlled could spell danger years after the buildings are in use.

12. Absence of proper site and soil investigation:

The avoidance of this to determine suitability of the terrain and soil bearing capacity, which influences foundation types spells danger.

5.3. Research methodology

The study adopted a quantitative survey approach and utilized primary data. The primary data was obtained through field survey and relied on questionnaires as an instrument. Population is a group of individuals who share a felt researchable problem or possess to some degree pieces of idea, which may be used for solving a researchable problem. However, the population of study is made up of the Architects, Engineers, Quantity Surveyors, Estate Surveyors and Valuers and Builders in Lagos metropolis, which are represented in the table 1.

Table 1. Population and Sample Size

S/N	Category of Respondents	Estimated Number of Population
1	Project Managers	14
2	Architects	10
3	Quantity Surveyor	9
4	Engineers	25
5	Builders	18
6	Estate Surveyors and Valuers	24
7	Total	100

In our research 100 completed questionnaires were used for the analysis. Relative Importance Index (RII) was used to analyse the respondents' scores of the basic causes and preventive measures. The assessment made by the respondents was

made on the imposed Likert scale, where 5 means a very large influence of the factor, and 1 no impact.
The relative importance index (RII) is given by equation (5.1)

$$RII = \frac{\sum W \cdot F}{N} \tag{5.1}$$

Where W is the weighting given to each factor by the respondents, ranging from 1 to 5, F is the frequency of responses and N is the total number of samples. The rating of all the causes and preventive for degree of significance was based on the value of their respective relative importance index (RII).

5.4. Data presentation and discussion

The aim of the study was to identify the factors influencing the occurrence of construction disasters in Nigeria in order to prevent them in the future. Table 2 shows the causes of building collapses mentioned by the respondents. From the result of the survey presented in table 2, it shows that a cause: weak/faulty foundation ranked first, Inefficient stringent quality control in material utilization and management ranked second, Boycotting the professionals ranked third and Absence of proper site investigation ranked fourth and they are the most important key causes of building collapse according to respondents. The engagement of inexperienced personnel was ranked fifth.

Table 2. Responses and Ranking on Key Causes of Building Collapse

Causes of Building Collapse	Scales and number of respondents					R II	Rank	Arithmetic Average	Standard Deviation	Coefficient of Variation
	5	4	3	2	1					
Weak/faulty foundation	75	14	8	3	0	4.61	1	20	27,907	1,395
Inefficient stringent quality control in material utilization and management	68	18	8	5	1	4.47	2	20	24,650	1,232
Boycotting the professionals	70	10	14	5	1	4.43	3	20	25,385	1,269
Absence of proper site investigation	60	12	15	10	3	4.14	4	20	20,386	1,019
Engagement of inexperienced personnel	40	20	22	11	7	3.66	5	20	11,437	0,572

Rank: (Strongly agree -5, Agree -4, Undecided-3, Disagree -2, strongly disagree -1)

Table 3. Responses and Ranking on Key Preventive Measures of Building Collapse

Preventive Measures	Scales and number of respondents					R II	Rank	Arithmetic Average	Standard Deviation	Coefficient of Variation
	5	4	3	2	1					
Supervision of construction works by professionals (Architect, Builders and Engineers)	78	15	6	1	0	4.70	1	20	29,482	1,474
Education enlightenment on the public on the need to prevent building collapse rather than managing situations	75	13	10	2	0	4.61	2	20	27,921	1,396
Employment of competent professionals	70	12	12	6	0	4.46	3	20	25,393	1,270
Issue building approvals before construction commences	68	15	9	5	3	4.40	4	20	24,347	1,217
Involvement of structural engineer in a project that goes beyond one floor	65	18	8	7	2	4.37	5	20	23,091	1,155
Defective Design	63	20	12	5	0	4.41	6	20	22,530	1,126
Defective Construction	59	23	11	6	1	4.33	7	20	20,823	1,041
Use of Substandard Materials	55	20	15	7	3	4.17	8	20	18,482	0,924
Absence of Building or Planning Permit	49	26	15	10	0	4.14	9	20	16,745	0,837
Corruption	45	15	20	15	5	3.80	10	20	13,416	0,671
Non-Adherence to approved building plans	40	11	20	20	9	3.53	11	20	10,973	0,549
Absence of proper site and soil investigation	38	18	18	11	15	3.53	12	20	9,359	0,468

Rank: (Strongly agree -5, Agree -4, Undecided-3, Disagree -2, strongly disagree -1)

Table 3 shows the results of the survey regarding the respondents' answers to the question of how to prevent building collapse? Results in table 3 shows that

supervision of construction works by professionals (Architect, Builders and Engineers) ranked first, education enlightenment on the public on the need to prevent building collapse rather than managing situations ranked second, employment of competent professionals third and defective design ranked fourth; they are the most key preventive while non-Adherence to approved building plans and absence of proper site and soil investigation which ranked eleventh and twelfth respectively are the least significant measures of building collapse in Nigeria, according to respondents. It should be noted that as many as 9 of the 12 preventive measures shown have an RII greater than 3.5. This means that, according to respondents, there are many options for preventing building collapse in Nigeria that are unlikely to be used.

6. RECOMMENDATION AND CONCLUSION

Base on the findings, the following recommendations can be made:

i. This study recommends that a profound investigation needs to collect and record data of various building collapses with a proper investigation on the actual causes.

ii. It is further recommended the building collapse needs to be carried out on buildings during and after construction, linking and comparing both occurrences.

iii. The need to investigate the extent of academic literature on cases of building collapse.

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) in the Nigerian construction industry, and these conclusions will be attributed to mainly these samples. 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. Perhaps, during the use of facilities, particular attention should be paid to the condition of buildings in order to avoid a tragedy, for example by monitoring subsidence of buildings, as shown by the authors in [31], strengthen foundations or pillars. Zulkarnain et al. wrote that building defect and damages are part of the building maintenance 'bread and butter' as their input indicated in the building inspection is very much justified, particularly as to determine the building performance [45]. They said that the maintenance work should not only rectify and making good all defects at the affected area but also at the same time should be properly recorded. It is a way to closely monitor the severity of the defects occurring in the building.

Structural elements, if they are so damaged that they cannot transfer heavy loads, should be completely removed and replaced with new elements [25]. 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 order to guarantee safety in the industry. In turn, authors wrote in [33] about Early Detection of Building Collapse using Internet of Things technology. The introduction of simple sensors detecting the bend, or any gap in the building would avoid many tragedies.

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