DETERMINANTS OF BUILDING COLLAPSE IN KADUNA STATE, NIGERIA

Yamusa Bello YAMUSA[*1], Yakubu ABEDNEGO[1], Tukur ISMAIL[1], Emmanuel PAUL[1]

[1]Department of Civil Engineering, School of Engineering Technology, Nuhu Bamalli Polytechnic, Zaria, Nigeria

Abstract: The increase in building collapse in Nigeria is one of the major concerns to every occupant. The rate of losses incurred by the country both in terms of human and material resources is enormous each time a building collapse. Apart from the casualty of lives and property loss, also comes psychological traumas and pollution from the incidence. The objective of this study is to identify the determinants of building collapse in Kaduna State and proffer solutions that would help in combating the menace. The data was collected by means of questionnaires. The study target population is architects, town planners, building engineers, and structural engineers. Questionnaires were administered to 40 professionals (Architects, Engineers, Town Planners, and Builders) to define their response to the question of monetary delay, non-competent professionals, cutting corners, work variation, and building without approvals. The study found that monetary delays, use of non-competent professionals and the lack of monitoring of structures by the regulatory authority contribute to building collapse. It was recommended that the use of competent professionals and the untiring monitoring of structures by the regulatory authority would assist in reducing the problem to the minimum if not eradicated.

Keywords: Building, Collapse, Construction, Determinants, Professionals and Remedie

1. INTRODUCTION

Building collapse is a situation where a building that has been completed and occupied, completed but not occupied, or under construction crashes down on its own due to the action or inaction of a person or due to natural events like earthquake, storm, flooding, tsunami or wildfire (Hillary and Chinedu, 2021). It is a defect or imperfection, which occurs when the load action imposed on the building exceeds the load carrying capacity. The degree of building collapse can therefore be related to the extent of deviation from the building designs and specifications which in most cases, represents the acceptable standards within the neighbourhood, locality, State, or Country (Ikpo, 2006).

The menace of building collapse has become a major source of concern to all stakeholders of the building industry as it has resulted in numerous losses of lives and properties, especially in the last two decades which has made building occupants lose trust in the building industry as well as the technical education sector which turns out the tradesmen and craftsmen for building industry. This topic has been a trending topic in recent years as the incidences of building collapse keep skyrocketing and as such a whole lot of studies have been carried out on this topic and coincidentally their findings have not been far from each other.

Mansur Hamma-Adama et al. (2020) found out that poor (substandard) building materials remain a major cause of building collapse. They also discovered that the civil/structural engineer is solemnly associated with the components of buildings that lead to collapse and as such maximum attention should be channeled to that sector to put an end to the

unpalatable trend of building collapse. Chendo and Obi (2015), in their research on this topic, recommended proper planning, supervision, and monitoring by policymakers to ensure that all buildings are constructed according to design specifications, professionals in the construction industry should maintain their integrity and professional ethics, the need for periodic public awareness campaign through electronic and print media to sensitize the public on the advantages of using professionals as a means of realizing safe buildings, soil investigation, material tests, and environmental impacts assessment (E.I.A) should be made compulsory for all institutional, industrial and commercial buildings. All stakeholders in the building industry should adhere strictly to the building code as its negligence was a major contributor to the collapse of buildings in Nigeria in addition to the fact that the regulatory bodies e.g. COREN, CORBON ARCON, etc. don't organize enough workshops to forestall the menace of building collapse (Hillary and Chinedu, 2021). All these findings are pertinent towards curbing the spate of building collapse but very little has been done on the impact of technical education on building collapse as many feel it may be insignificant, but in reality, it may be the final piece in the jigsaw towards addressing this unwanted incidence. This has been a major source of worry to the researchers forming the basis of this study to identify incidences, causes, effects, and probable solutions to the incessant collapse of residential buildings in Nigeria.

The most fundamental factor that determines an illegal structure is the building development permit. The issuance of statutory ownership of the land is done by Kaduna Geographic Information Services (KADGIS), but KASUPDA issues the building permit that certifies that the land is legitimate and can be used for the desired purpose by the developer. However, before the permit is issued, it goes through the scrutiny of our experienced professionals. They have to collectively agree on the design, whether or not it conforms with the purpose of the proposed structure and the master plan of the state KASUPDA (2022). Kaduna State Environmental Protection Agency (KEPA) is responsible for all matters relating to the environment and without prejudice amongst other duties of the authority is to enact and enforce state regulations, procedures, guidelines, and environmental standards for effective prevention, remediation, control, and monitoring of point and non-point source of pollution and degradation and prevent and stop any act that has the likelihood of adverse effect on the environment and deal with any discharge of either solid, liquid or gaseous materials deposited wilfully to the environment, and to deal with all forms of violation that encourages hazards to the environment. The Authority shall also control potable and wastewater/effluent discharges KEPA (1994).

In buildings, the design and construction stages involve the selection of a competent and experienced team that includes an architect, engineer, and other related experts. This team is responsible for guiding the client on construction ethics and procedures. The safety and integrity of the structure rely on the competency of these professionals. They will make sure to do the right thing, as any defects or failure may result in the revocation or confiscation of their practising license. Therefore, any client needs to avoid engaging the service of quacks because they have nothing legally that regulates them. So don't

be a victim of quacks in this country ARCON/CORBON (2018).

Eventualities of building collapses are happening worldwide and Nigeria is not an exception. There are reported cases of building collapse in Kaduna State. A two-story building collapsed in a housing estate at Nagoyi, along New Jos Road Zaria. The two-story building was occupied but the occupants heard funny sounds and quickly evacuated the building shortly before it collapsed. Luckily no life was lost as shown in Figure 1 (www.nairaland.com, 2022). DAILY POST reported that four 6 persons were injured while 4 were dead in Zaria, Kaduna State after the building collapsed at Unguwar Kaya in Zaria Local Government Area as shown in Figure 2 (Tauna, 2018). Another building in construction beside the Faculty of Science Complex of Kaduna State University collapsed. No loss of lives but three people got injured. The three were laborers working at the building as shown in Figure 3 (www.nairaland.com, 2015). A case reported by PREMIUM TIMES that a three-story building collapsed on Hadejia Road, a busy commercial area of Kaduna. A witness said several residents on the top floor and shop owners occupying the ground floor were trapped in the building as shown in Figure 4 (Garba, 2013). Therefore, the problem of building collapse is a phenomenon that requires a prudent solution.



Figure 1. A two-story building collapsed in a housing estate at Nagoyi, along the new Jos Road Zaria

Source: www.nairaland.com (2022)



Figure 2. Two-story building under construction collapsed, at Unguwar Kaya in Zaria Local Government Area

Source: Tauna, A. (2018)



Figure 3. Building Collapses in Kaduna State University (KASU)

Source: www.nairaland.com (2015)



Figure 4. Three-story building collapses in Hadejia Road Kaduna

Source: Garba, A. (2013)

2. LITERATURE REVIEW

It is a common practice in Kaduna and Nigeria at large that most contracts are granted to politicians who sublet or offer to businessmen known to them without proper due process and without exploring the competence of the contractors. The result is substandard execution amid development which can lead to building collapse. The government should only award contracts based on competency and not sentiment.

Contractors often receive contract offers from clients that they do not specialize in. Others will collect the work and donate to quacks and unpracticed ones within the calling for less expenses. The quality of such works is ordinarily below professional standards and becomes unsafe. These quacks are inexperienced and incompetent to sufficiently oversee, identify or issue professional instructions. Therefore, clients need to be educated on whom to award their contracts to. Only licensed professionals are mandated to execute such works.

The use of substandard bricks and building materials for development compromises the reliability of any building. Strict supervision could be adhered to to check and control the use of substandard materials that are not in line with standard specifications.

Structural failure is positioned as the most elevated recurrence of the cause of Building Collapse. Fredrick and Ambrose (1989) recommended that the toppling of structures due to overwhelming wind loads, sliding of structures due to strong wind, and roof lifting or sliding are major sorts of building failures. Akinpelu (2002) categorized the following as

major causes of building failures, natural changes, characteristic man-made threats, and design misinterpretation. Richard (2002) opined that the weakening of reinforced concrete happens as a result of corrosion of the reinforcement, subsidence, or faulty design and construction. So, it is paramount to engage the services of professionals who are certified to carry out building design and construction.

Most materials utilized in buildings and finishes are combustible (Chendu et al., 2015). These materials such as PVC ceilings and paints boost fire spread. Fire weakens reinforcement bars and steel trusses. Making these materials fail halfway and eventually collapse the building. Fire retarding agents ought to be employed when using or selecting construction materials. Stacking of explosives, chemicals, petrol, and other flammables in homes ought to be avoided. Filling/fueling stations near private buildings ought to be closed.

A building structure can collapse if it's built on weak soil if the building isn't uniformly loaded, or if the type of foundation chosen is not appropriate for the soil or due to subsidence and erosion. The Architect-Structural Engineer ought to request continuously from the client to orchestrate soil, wind, and other fundamental test reports for the location where the building is to be erected. Compliance in this regard would give an accurate geotechnical report.

In some cases, the client makes sudden changes or issues instructions at certain stages of construction which can affect the integrity of the structure. The consultant or contractor must advise the client on the consequences of such a decision.

3. METHOD

The study covers areas within Kaduna State, specifically Kaduna and Zaria metropolis. Kaduna State is estimated to cover 431 square kilometers with a projected population in 2021 of 8.9 million people (Wiki, 2022). Kaduna is an industrial area and the centre of the north, which is responsible for the spontaneous and persistent increase in its population and the subsequent need for shelter to house the residents of the great city.

Primary data were collected through questionnaires distributed among various seasoned professionals involved in the building industry. Structured questionnaires were administered to architects, building engineers, and structural engineers in the study area by selective random sampling techniques. The questionnaires were stratified into three: "A" on the client, "B" on professional bodies (NIA, NIOB, NSE, and NITP), and "C" on Building Regulatory/Planning agencies.

The Nigeria Institute of Building (NIOB) was consulted for information on collapsed buildings in Nigeria from 1980 to 2020. Also, three key personnel were interviewed: An Architect, a Builder, and an Engineer. These are the professionals who are directly involved with building works from the preliminary stage to the completion stage.

Data surveys from journals, reports, the internet, and previous works of other authors on the subject matter were cited. The data collated were analyzed by frequency distribution and ranked using the Relative Importance Index.

$RII = (\sum W)/(AxN)$

RII = relative importance Indices;

$\sum W$ = sum of weight for each factor;

A = highest weight, N = total number of respondents.

4. RESULTS AND DISCUSSION

Questionnaires were administered to 40 professionals each (Architects, Engineers, Town Planners, and Builders) to define their response to the question of monetary delay, non-competent professionals, cutting corners, work variation, and building without approvals. 80% of the professional believes monetary delay contribute to building collapse. Buildings left or abandoned for a long period due to delay in funds which in turn results in weak concrete/slab as a result of persistent rainfall, reinforcement repositioning or omission, and poor workmanship from semi-skilled labor used on site. 85% responded to the use of non-competent professionals, this arises when clients are dodging the cost of paying chartered/competent professionals and results in engaging the services of quacks. This usually affects the overall result of all construction works. 67% attributed it to cutting corners, this is usually practised by both the clients and supervising engineers to save cost and invariably injures the construction process which could result in the subsequent building collapse. 53% of the professionals attributed building collapse to persistent work variation which happens as a result of continuous changes in the initial design which may, in turn, affect the structural stability of the structure and this may result in structural failure if not handled with a check and professional expertise. However, 75% of the professionals interviewed attributed the cause of building collapse to building without approval. The refusal of some clients and professionals to boycott the planning authorities contributes immensely to building collapse due to a lack of checks and corrections from the regulatory bodies. Clients' contributions to building collapse are presented in Table 1. The client's main factors contributing to building collapse are as a result of monetary delays to contractors, engagement of non-competent professionals, cutting corners to save cost, work variation compared to the original contract agreement, and building without approval.

Cases of building construction process without permission are tabulated in Table 2. Blames are apportioned to Clients, planning authorities, and engineers. Clients and engineers, the planning authority, engineers and architects, and finally the client, planning authority, engineers, and architects. A total number of 40 respondents were interviewed. 2 respondents which correspond to 5% of respondents blame the clients only for buildings without construction approval. 10% of respondents and 15% of the respondents apportioned blame on the client/engineers and client/planning authorities respectively. 25% of the respondents solely blame the planning authority, engineers, and architects for buildings without construction approval. 18 of the respondents which constitute 45% largely apportioned blame on the client, planning authority, engineers, and architects for buildings without construction approval. From the data above it's obvious that the collapse of the building is due largely to the nonchalant attitude of all the stakeholders involved in the building.

A total number of 40 respondents were interviewed to determine the rate and number of people seeking building approval before

construction work as presented in Table 3. 87.5% of the Architects and 70% of the Engineers interviewed believe that people take their drawings to plan authorities for building approval while 12.5% of the Architects and 30% of the Engineers agreed that people do not seek for building approval. 55% of the clients also concurred that people take their drawings to plan authorities for approval, whereas, 45% have a contrary view. In general, those who seek approval (71%) are more than those who do not seek building approval (29%). This could be attributed to strict measures taken by the Kaduna State Government to ensure compliance by any individual or company to erect buildings in the State.

55% of the respondents believe that the cause of the building collapse could be attributable to inadequate funding which always results in clients cutting corners. Inferior and cheaper materials are thus used at the expense of the stability of the building. 83% of the respondents think that the involvement of non-professionals during the supervision of the construction of buildings also contributed to the major cause of building collapse in Nigeria. There was a consensus as 100% of the respondents unanimously agreed that the absence of technical knowledge on design interpretation is the major bane of the collapse of buildings especially in the Kaduna metropolis. 70% and 80% of the respondents agreed that building collapse in Nigeria could be attributable to climate and environmental conditions and materials usage and maintenance culture respectively. Lack of strict compliance with building codes was also identified as one of the causes of building collapse as observed by 65% of the respondents. Lastly, 75% of the respondents heaped the blame for building collapse on the planning authorities for not having enough manpower to cover all areas undergoing building construction processes.

Table 1: Client's contribution to building collapse

Causes of Building Collapse	**No. of Architects**	**% of Architects**	**No. of Engineers**	**% of Engineers**	**No. of Builders**	**% of Builders**	**Average %**
Monetary delays	28	70%	32	80%	36	90%	80%
Non-Competent professionals	30	75%	34	85%	38	95%	85%
Cutting corners	24	60%	22	55%	34	85%	67%
Work variation	18	45%	20	50%	26	65%	53%
Building without approval	28	70%	29	72%	32	82%	75%

Source: Fieldwork 2022

Table 2: Buildings without construction approval

Who to blame	Respondent (40)	Percentage %
Client only	2	5%
Client and Engineers	4	10%
Client and Planning Authority	6	15%
Planning Authority, Engineers, and Architects	10	25%
Client, Planning Authority, Engineers, and Architects	18	45%

Source: Fieldwork 2022

Table 3: Percentage of people going for approval

Opinion	No. of Architects	% of Architects	No. of Engineers	% of Engineers	No. of Clients	% of Clients	Average %
People who do not seek approval	5	12.5%	12	30%	18	45%	29%
People who seek approval	35	87.5%	28	70%	22	55%	71%

Source: Fieldwork 2022

Table 4: Determinants of causes of building collapse

Causes	Architects	Engineers	Planners	Client	Total	%
Inadequate funding/cutting corners	25	15	10	5	55	55%
Non-competent professional during supervision	15	20	30	18	83	83%
Absent of technical knowledge on design interpretation	25	25	30	20	100	100%
Climate and environmental conditions	25	20	15	10	70	70%
Material usage and maintenance culture	15	28	7	30	80	80%
Lack of strict compliance with building codes	12	13	25	15	65	65%
Laxity on the part of planning authorities	25	25	10	15	75	75%

Source: Fieldwork 2022

5. CONCLUSION AND RECOMMENDATIONS

The study concludes that building development work without an endorsed building permit from the town planning development authority, non-utilisation of authoritative policies and lack of utilization of professionals are the determinants of building collapse. The cumulative impression gathered from the data collected revealed that the majority of building clients tend to prefer the services of non-competent professionals because it is less expensive and readily accessible. The absence of professionals on sites gives room for cutting corners and the usage of substandard materials. Non-professionals have taken over the services of architects, builders, and engineers, leading to the construction of defective buildings.

It is not right to commence any building development work without an endorsed building permit from the Town Development Planning Authority. Numerous drawings are utilized for development without endorsement from the approving authority and the consequences are inevitable. All drawings must be checked by relevant experts i.e. architects, engineers, builders, and town planners. study recommends that, all professionals in the building industry should collaborate bymaking their services available and reachable at moderate rates and charges. The building codes would help in reducing building collapse by enforcing a law that strengthens the administrative and evaluation procedures/processes of regulatory bodies (KASUPDA, KEPA, and FEPA) to monitor building processes from design to construction stage.

REFERENCES

Akinpelu, J. A. (2002). The Need for Code of Conduct, Building Regulations and By-laws for the Building Isndustry in Nigeria. The Professional Builder, Nigeria Institute of Building, 11-14.

ARCON/CORBON/COREN (2018). Abuja Building Collapse: Retrieved: https://www.blueprint.ng/abuja-building-collapse-arcon-corbon-move-against-quacks/.

Aronsi, S. (2007). *Housing Policies Constraints and Directions, For Low Income Housing Technologies and Policy.* New York: Pergamum Press Ltd.

Chapman, J.C. (2016). Lessons from collapsed structures: A paper presentation by Chapman associates, 78(9), 23-24.

Chendu, L. G. & Obi, N. I. (2015). Building Collapse in Nigeria: The Causes, Effects, Consequences and Remedies. *International Journal of Civil Engineering, Construction and Estate Management*, 3(4), 41-49.

Fredrick's M. & Ambrose, J. (1989). Building Engineering and systems design, New York, USA, Van Nostrand Reinhold. 2.

Garba, A. (2013). Three-story building collapses in Kaduna, several trapped, in Premium Times Nigeria.

Hamma-adama, M., Iheukwurumere, O., & Kouider, T. (2020). Analysis of Causes of Building Collapse: System Thinking Approach. *Jordan Journal of Civil Engineering*, 14(2), 188-197.

Hillary, W., & Chinedu, M. K. (2021). Residential Building Collapse in Nigeria: Incidence, Causes, Effects, Solution and Implication for Technical Education. *International Journal of Innovative Education Research*, 9(2), 153-162.

Ikpo, I. J. (2006). Building Maintenance Management. Oron: Mason Publishing Company.

KASUPDA, (2022). Ensuring Orderly Development. Copyright 2022 KADUNA STATE - Work and Workship. All Rights Reserved. Retrieved from https://dailytrust.com/kasupda-ensuring-orderly-development-dg.

KEPA, (1994). Kaduna state Environmental Protection Agency towards Economic, Social and Environmental Sustainability in Development Theory and Urban Planning Practice. *The Environmentalists*, 19(2), 145-161.

Richard, R. L. (2002). Leading the way in Concrete Repair and Protection Technology, Concrete Repair Association, Costa Rica, 1, 1.

Tauna, A. (2018). Four killed, many others injured as building collapses in Zaria, in dailypost.ng.

Wikipedia, (2022). The free encyclopedia. wikipedia.org/wiki/Kaduna.

www.nairaland.com, (2022). A Two-Story Building Collapse in Zaria, Kaduna State.

www.nairaland.com, (2015). Building Collapses in Kaduna State University (KASU).