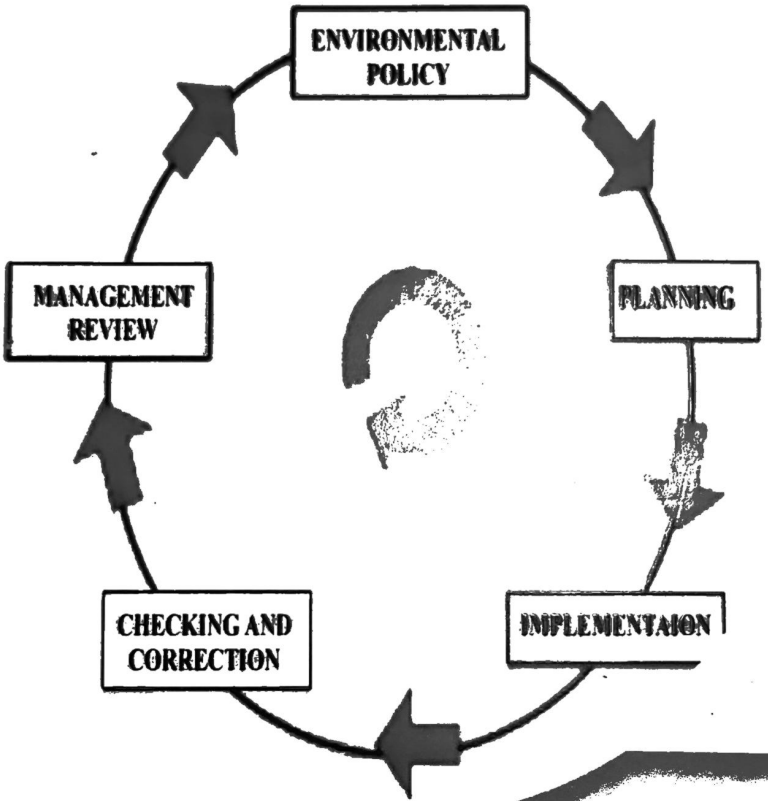
JOURNAL OF ENVIRONMENTAL TECHNOLOGY AND MANAGEMENT

Volume 4, Number 2, June 2022



ISSN: 3250-0542

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Journal of Environmental Technology and Management, Volume 4, Number 2, June 2022

THE ROLE OF THE ARCHITECT IN THE PREVENTION OF BUILDING COLLAPSE IN NIGERIA

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Abstract

The aim of this paper was to examine the role of architects in the prevention of building collapse in Nigeria. The specific objectives were to identify the causes of building collapse and examine how the architect could help in preventing them. The study employed a survey research design. One hundred (100) architects were interviewed and content analysis, in addition to simple statistical tools like mean, percentage and frequency, was used to analyse the data, obtained. The study found out that the architects were involved in preparation of standard building drawings, ensuring approval by relevant authorities; ensured zero modifications/ alterations of approved building plans without re-approval; engaged in quality control of building materials; ensured that quality assessment of foundation soil was done; assessed every formwork to be used for construction; were involved in hiring and supervision of qualified construction personnel; ensured collaboration with relevant professional bodies for regulation and guidance. Following these findings, some relevant recommendations were made..

1.0 Introduction

1.1 Background to the Study

Ayodeji (2011) and Adedeji (2013) define building collapse as 'a state of complete failure when the structure has given way and most members caved-in or buckled'. Similarly, Olagunju et al. (2013) perceives building collapse as a total or partial failure of one or more components of a building leading to the inability of a building to perform its principal function of stability, safety and comfort. In line with these, building collapse can affect the totality of the building or can partially affect some parts of the building and in this regard, safety and stability must be of utmost concern. Analyses of building collapse cuts across all the geo-political zones

in Nigeria; with the South-east made up of Anambra, Enugu, Ebonyi, Imo and Abia states; South-south made up of Edo, Delta, Bayelsa, Cross-River and Akwa-Ibom States; South-west made up of Lagos, Ogun, Oyo, Osun, Ondo and Ekiti States; North-central made up of Kwara, Kogi, Plateau, Nasarrawa, Benue, Niger States and F.C.T-Abuja; North-east made up of Taraba, Adamawa, Borno, Yobe, Bauchi and Gombe States; and North-west made up of Sokoto, Zamfara, Kebbi, Kaduna, Kano and Jigawa States (Ayeni, 2012). Furthermore, Ede (2010) argues that every structural system is expected to be designed with safety in mind so as to avoid loss of lives, properties and damages to the environment. Building failure, according to Ayininuola & Olalusi (2004), is an unacceptable difference between expected and observed performance of building components. They identified two types of failure in building, which are cosmetic and structural types. Cosmetic failure occurs when something has been added to or subtracted from the building, thus affecting the structures' outlooks. On the other hand, structural failure affects both the outlook and structural stability of the building.

Roddis (1993) considered failure as occurring in building components when they can no longer be relied upon to fulfill their principal functions. He distinguished between defect and failure in buildings. Defect is deflection in a building causing certain amount of cracking or distortion while excessive deflection that results in serious damage to partitions, ceilings and floor finishes is referred to as building failure. A distressed building exhibits defects. These overall defects in the structural stability of buildings, if not checked, result in progressive collapse. Failure, according to Wardhana & Hadipriono (2003), is the incapacity of a constructed facility or its components to perform as specified in the design and construction requirements. Building collapse is therefore the failure of all or a substantial part of a building, where full or partial replacement may be needed. Citing the collapse of the World Trade Centre tower as the most infamous paradigm, Bažant & Verdure (2006) described progressive collapse as a failure mode of great concern for tall building subjected to fire, internal explosions, external blast, impact, earthquake and foundation movements, and also typical of building demolitions. According to Wardhana & Hadipriono (2003), collapse and distress are subsets of failure in a building. In terms of functionality, collapse occurs when the entire or a substantial part of a structure comes down thereby losing the ability to perform its function. Building collapse may be classified as total and partial collapses. Total collapse implies that several primary structural members of a building have fallen down completely while partial collapse suggests a condition where only some of the

primary structural members of the building components have fallen down. Distress is the unserviceability of a structure or its components that may or may not result in a collapse, and refers to a particular condition of the structure which has undergone some deformations without losing the whole structural integration. Incidences of distressed or collapsed buildings are global phenomenon and are not limited to Nigeria. At the international level, a number of building collapses were reported. Globally, building collapse may either be due to natural disasters resulting from earthquakes, hurricanes, floods, landslides, volcanic eruption, rising sea levels, storm surges; or man-made factors, also known as human errors as a result of poor design and construction before, during and or after construction (Natural Environment Research Council, 2005; Amadi et al. 2012). These, in most cases are accompanied by unforgettable memories by affected victims.

Ayuba et al. (2012) noted that the structures, materials and components of any building are very important and must not only meet standard but also aesthetics; short of these could result in building collapse. Conversely, Nwokoye (2012) stated that buildings are designed to support both live loads i.e. weights of people, objects, pressure of wind and rain; as well as dead loads and should not deform excessively. The inability to calculate these loads appropriately and accurately may lead to its failure and eventual collapse. Oyewande (1992) stressed that cases of building collapse are attributed to the following causes; design faults (50%) faults on construction site (40%) and product failure (10%) while Akinpelu, (2002) categorized the following as major causes of structural failures: environmental changes, natural and man-made hazards; improper presentation and interpretation in the design. A lot of role is usually played by the architect during the design and construction of buildings and that is why the communication or language of the architect is very essential. However, this paper dwells on building collapse due to human errors caused by poor architectural practices in design, construction and post-construction stages resulting in the loss of human lives and properties in some cases, in Nigeria.

1.2 Statement of Problem

Like in other countries, Nigeria is experiencing cases of building collapse ranging from one-storey buildings to multi-storey buildings in the different geopolitical zones that make up Nigeria; of which quite a number of factors are responsible. However, recent events in Nigeria in places like Abuja, Lagos, Port Harcourt, Enugu, Abakaliki, Aba and other places in the country

have seen these cases as a growing cause of death, loss of property and left many people injured. There is need, therefore to determine the role of architects in the prevention of such unprecedented occurrence.

1.3 Aim and Objectives of the Study

The aim of this study was to examine the role of the architect in the prevention of building collapse. The specific objectives were to identify the causes of building collapse and examine how the architect could help in preventing them.

2.0 Literature Review

2.1 Causes of Building Collapse

According to Arayela & Adam (2001) the selection of materials, components and structures that will meet the expected building standards and aesthetic value is paramount. But if there is a non-occurrence, non-performance, breaking down and sick syndrome in the building, failure can be said to have occurred which can lead to building collapse. Quite a number of factors are responsible for this incessant collapse of buildings in Nigeria. Yussuf (2006) classified 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 factor. Hall (1984) ascribed faulty design, faulty execution of work, and use of faulty materials as major causes of structural failures; while Merritt & Ambrose (1989) were of the opinion that overturning of structures due to heavy wind loads, sliding of structures due to high wind, roof uplift or sliding, and building sway due to lateral loads were major factors of failures in buildings.

Oyewande (1992) identified additional factors responsible for building collapses in Nigeria; these are design faults, faults on construction site and product failure, with design fault contributing most significantly to such collapses. Other studies by Akinpelu (2002), and Richards (2002) found that structural failures, environmental changes, natural and human-induced hazards, improper presentation and interpretation in design, deterioration of reinforced concrete occurring as a result of corrosion of reinforcement caused by carbonation and chloride ingress, cracking caused by overloading, subsidence or basic design faults, and construction

defects are causes of building collapses. The collapse of buildings occurs from several factors beyond the direct participation of the architect. The architect conceives the space and hands over to the engineer to put in place the design solutions to carry the structure. The engineer may recommend changes to the design to bring the final solution within an acceptable budget. The architect must have basic knowledge of structural design to appreciate the engineering solution and may have to make certain amendments to the initial design.

However while these communication moves between architect and engineer, the client may appoint a contractor who may not have qualified personnel who will be able to interpret the design solutions. This is where the first danger signals could occur. There are cases where clients repeat projects using designs for different sites on new sites without reference to the architect. Different soil conditions could put the new building at risk. Again clients tend to alter projects mid-stream on the advice of ill-informed friends and associates. This can lead to building collapse. In addition, Ahmad (2004) found additional causes different from earlier studies: these are fungus stain and harmful growth, erosion of mortar joints, defective plastered rendering, cracking and leaning of walls, defective rainwater goods, decayed floor boards, insect or termite attack, dampness and penetration through walls, and unstable foundations.

According to Ozerdem (1999) and Global Corruption Report (2005), corruption has been identified as one factor that has caused high cost of building materials and reduction in standard of construction works in developing economy. They stated that corruption may be at different stages, namely, at contract award, planning and design stage, construction stage, and when the building is completed. It may take different forms like bribery, deception and collusion the end products of which are lowering of construction standard, increasing cost of repair and maintenance, defects in building that may not be discovered until eventually collapse. The following are major causes of building failure and collapse in Nigeria:

2.1.1 Quality of concrete used

Concrete is a very versatile material that can be cast in place with or without reinforcement to achieve any required strength. It is used for construction of foundation footings, mass concrete slabs, beams, floor slabs, columns, lintels and decking. It composes of cement, sand and stones, when iron rods are introduced into it, it becomes reinforced concrete.

(Oyewande, 1992) observed that the strength of reinforced concrete depends on the proportion of cement, sand, stones and iron rods. These constituents are always used in the design of high- rise structures. The structural analysis is done by a structural engineer who calculates the weight of the building, number and sizes of iron rods that will be put into the beams and columns to strengthen them for carrying the weight. Most times in the building industry, this structural analysis is not properly carried out which may result into trial and error methods by the contractor without using the needed number and sizes of iron rods. Some contractors even fail to use the correct mix design for the concrete. When these errors accumulate over time, may lead to building failure and subsequent collapse of building.

2.1.2 Poor compaction and consolidation of foundation soil

In the building industry, a building could collapse if it lacks adequate compaction of the soil inside the foundation before placing hardcore and placing the over site concrete slab. If the soil is not well compacted before the over site concrete slab is cast, settlements may occur causing cracks on the wall and over site concrete slab leading to structural failure (Philip, 2002).

2.1.3 Low quality sandcrete blocks on structural wall

Sand Crete blocks are composite units made up of mixture of sand, cement and water in specified proportion. The quality of sand Crete block used in the construction of walls play a very significant role in the total strength of the wall. The quality of any sand Crete block is largely determined by it properties which include strength, durability, thermal conductivity, fire resistance, density, efflorescence and dimensional charges. However, these properties greatly depend on the type and proportioning of the constituent materials, mix ratio, mode of compaction and duration of curing. These constituent materials are first mixed and then compacted in moulds to form pre-cast units. On setting and hardening, the blocks attain sufficient strength and can be used as walling units (Oyewande, 1992).

The quality of block used in Nigerian building industries is a factor in building failure. For instance, the 225mm hollow blocks used for the construction of external walls of a building are to support the weight of the decking and other floors above it in conjunction with column Since 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 hig

demands in the building industry, the block industries in Nigeria have equally increased the quantity thereby compromising the quality 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 (Ayininula, & Olalusi, 2004). A lot of these blocks even break in the process of conveying them to the site. Most block industries in Nigeria do not meet the standard requirements specified by the Standard Organization of Nigeria (SON). The Nigeria Industrial Standard (NIS 87:2000) requires that a certain degree of quality for sand Crete blocks be produced. The basic requirements stipulate that sand Crete blocks should have the required crushing strengths, the required dimensional tolerances and the desired appearance; only blocks that are sound and true in shape, free from holes, cracks and any other flaws shall be considered good for use in the building industry.

2.1.4 Improper concrete curing and bracing of form work

Curing is probably the most abused aspect of the concrete construction process. Concrete requires an adequate time to cure at a proper temperature and humidity; if not it may not develop the characteristics that are expected to provide necessary durability (Akinpelu, 2002). He opined that when formworks are not properly aligned, premature removal of formwork, improper mixing inadequate design and improper concrete placement can lead to discontinuity in the surfaces of concrete which could break resulting into building failure. Poor construction and negligence of concrete placement and curing process have caused collapse of buildings in Nigeria.

2.1.5 Weak soil

Weak soil has also contributed to building failure as a result of the geologic nature. In most cases some layers of soil are not strong enough to carry the weight of the building particularly the top most layer. According to Sunday (2006), most buildings are erected without carrying out soil test by the engineers. If this factor is not considered from the unset, could lead to differential settlement of the building caused by cracking of walls and decking. In some areas, due to weak nature of the soil, building might just sink.

2.1.6 Modification in the use of a building

Modification in the use of a building refers to the situation where by the use of a building is modified, other than that which it was originally intended for. Ayininula, & Olalusi, (2004) observed that even though majority of the clients seek for approval before commencement of projects in Nigeria, further alterations during construction are not made known to the authority where the approvals were sought from. For instance a storey building designed to carry only two floors approved and constructed, if given an additional weight without due consideration for foundation, column and slab will eventually fail as a result of structural inefficiency due to excessive loading of area after remodelling, improper binding of units and un equal distribution of load.

2.1.7 Collapse of buildings induced by fire

Fire is said to be a process of burning that produces light and heat as well as smoke and flame. Over the ages, man has used fire to solve basic problems such as the provision of heat energy for residential use, commercial and for individual use. However, the misuse of it has always resulted in consequential adverse effect which leads to burning down of so many things like buildings, vehicles and other utilities. In the building industry, adequate attention has not been paid to fire as a causative factor that is responsible for building collapse in Nigeria. Taiwo, (2002) opined that when fire occurs in buildings, the structural members such as walling materials, foundation and other structural members get weaken. After sometimes, the walls begin to crack which may lead to total collapse of building.

2.1.8 Use of non-professionals in building construction

Due to high cost of some building materials in Nigeria, use of substandard materials, incompetent adoption of untested local construction methods are employed, with non-existent or lack of enforcement of building regulation, by- laws and construction health and safety regulations such as placement of structural beams and columns. Lack of experience on the part of the contractor and the consultant could result in poor workmanship and low standard of construction. This could result in high running cost and in some cases failure of some part or the whole building. These non-professional other wise known as quacks have over taken up the

services of architects, engineer and other allied professionals in the building industry (Oyewande,1992).

2.1.9 The role of professionals and other participants in the building industry

The involvement and input of professionals in the building industry from the design to the construction of the buildings; including the supervision at every stage is vital if standards are to be maintained. As observed by Windapo & Rotimi (2012) the absence of these, results into failed projects and poor functional performance; as buildings that meet desired performance requirements add value to national asset stock. However, in some cases, these standards are not adhered to and services of non-qualified professionals are employed thereby constituting problems of building collapse. Tomori (2010) noted that every aspect of building planning process from the architectural designs through to the mechanical, electrical, structural engineering, construction and maintenance require proper supervision and quality input by professionals and stakeholders in the building industry . Nevertheless, in some cases, building projects are not executed in accordance with the set down rules and consequently results in collapse.

The factors to be observed in building industry should include adequate stability to prevent its failure or discomfort to the users, durability, resistance to weather, fire outbreak and other forms of accidents. As new materials are being constantly discovered, so also is the style of building construction changing in the building industry.

Building drawings that are prepared by an Architect who probably does not carry out proper site investigation, soil test, inadequate working drawings and details, wrong specifications, non-adherence to buildings bye laws, regulations and acts that obtain at the Federal, State or Local Government levels, neglect of building orientation and location with reference to weather conditions are sources of collapse of our building. Structural drawings without sufficient information on the design of beams, columns, deformation, shrinkage, structural engineering details calculation error overtly or covertly contributes to building failure (Aluko & Adedeji, 2010). Hence, various professional are to ensure that their professional inputs are diligently and accurately carried out. In the same vein, construction, when in progress ought to be supervised and monitored so as to point out to the contractor areas of deficiency, which

could be in terms of workmanship and materials. The aftermath of not doing the above is what anybody can think of. Other causes from consultants are outright negligence, greed and mismanagement. The contractor is charged with the responsibility of physical erection of the building. All the participants involved in the construction of buildings are contributors to building failures in one way or the other. Onyemachi & Uji, (2005) observed that architects contribute to building collapse by not involving engineers at all stages of construction. Today, architects are seen undertaking buildings all alone without the consultation of engineers.

Structural engineers are also involved in carrying out structural analysis without site inspection, possessing inadequate soil knowledge and geological formation of the site. Clients contribute to building failure by erection of structures on unapproved land, additions of extra floors on existing buildings without any consultations with the structural engineers, altering a structure's purposes, and lack of maintenance culture. Clients are also involved in cutting corners, monetary delays, involvement of non-competent professionals and building without building plans. Consultants should always provide specialized knowledge and skills to supplement those of the architect. They should be hired directly by and responsible to the architect. The architect must then coordinate and control all aspects of the design process. As part of their duty to safe guard public health, welfare and safety, building officials should administer building codes that establish minimum standards for construction. Their primary responsibility is to ensure that buildings meet health, and safety requirements, particularly those related to structural and fire safety, as well as local zoning or land use.

3.0 Methodology

This study employed a survey research design. One hundred (100) architects were interviewed and content analysis, in addition to simple statistical tools like mean, percentage and frequency, was used to analyse the data, obtained.

4.0 Results and Discussion

Table 1: Observed Role of Architects in Preventing Building Collapse (Trend Analysis) (N = 120)

S/N	Role	Frequency	Percentage	Rank
1	Preparation of standard building drawings and ensuring approval by relevant authorities	116	96.67	1

2	Ensuring zero modifications/ alterations of approved building plans without re-approval	86	71.67	4
3	Quality control of building materials	105	87.50	2
4	Quality assessment of foundation soil	83	69.17	5
5	Assessment of formworks	97	80.83	3
6	Hiring and supervision of qualified construction personnel	81	67.50	6
7	Collaboration with relevant professional bodies for regulation and guidance.	52	43.33	7

From Table 1, 96.67% of the architects were involved in preparation of standard building drawings and ensuring approval by relevant authorities (Rank = 1). 71.67% ensured zero modifications/ alterations of approved building plans without re-approval (Rank = 4). 87.50% engaged in quality control of building materials (Rank = 2). 69.17% ensured that quality assessment of foundation soil was done (Rank = 5). 80.83% assessed every formwork to be used for construction (Rank = 3). 67.50% were involved in hiring and supervision of qualified construction personnel (Rank = 6). 43.33% of the architects ensured collaboration with relevant professional bodies for regulation and guidance (Rank = 7).

5.0 Conclusion and Recommendations

5.1 Conclusion

The need to provide shelter to man and his daily activities has always been an utmost priority. Buildings are constructed to serve as shelter for man, his properties and other activities therefore; they must be properly planned, designed and erected to obtain desired satisfaction from environment. A nation's development is usually measured by the strength of the building and construction sector of its economy

The leadership of building construction industry is in the hands of the architect, who co-ordinates the operations of all stakeholders and allied professions in the building industry to ensure that the end product is what is desired by the employer or the client. Therefore, there is the need for the use of high quality materials, labour and skilled professionals. Hence, an architect as the master planner should always recommend competent professionals to the client and contractors but most times, the architect has a lot of challenges which make them drift from their professional responsibilities. However, with the introduction of building code now in place,

the building experts otherwise called professionals will be put on their toes in rendering qualitative work as well as impeding clients from the use of quacks in property development.

Legislation should be put in place to register every building designed by an architect along with the profile of all consultants responsible for the execution. There must be a responsibility clause to bind the architect to the project until completion and certification for use issued. This will give the impetus for architects to hold maximum control on their projects until completion and under these circumstances failure will then lie squarely on the architect for he will have powers to hire and fire any of the actors in the construction process. But under the situation where construction is an all comers affair with persons who have never gone to school claiming to know more engineering than fully qualified structural engineers, buildings will continue to fall and unfortunately lives may be lost. Every building that collapses is a clarion call to Government to take action, call the professionals to take responsibility and put a stop to this once and for all. Where Government lacks the act of will, professionals can do very little.

Various regulatory bodies such as Nigerian Institute of Architects, Architects Registration Council of Nigeria, Nigerian Society of Engineers, Council of Registered Engineers in Nigeria, Nigerian Institute of Builders, Nigeria Institute of Quantity Surveying and others in the building sector to beam their search light in making sure that defaulting builders are not only apprehended but also prosecuted. Government on its own part should put sufficient legislations to ensure that buildings do not collapse again in the country. It is only when the rules and regulations of development control are implemented that the issue of collapsed buildings in Nigeria, remains unabated in the country.

5.2 Recommendations

5.2.1 1 Various regulatory bodies such as Nigerian Institute of Architects (NIA), Architects Registration Council of Nigeria (ARCON), Nigerian Society of Engineers (NSE), Council of Regulation of Engineers in Nigeria (COREN), should ensure that there are some kinds of multiple responsibilities between the architects and the engineers in the design and construction of high-rise buildings in Nigeria. Nigerian institute of architects, Architects Registration Council of Nigeria, should ensure that architects do not work alone in the design and construction of high-rise buildings without engineers.

5.2.1.2 The Nigerian Institute of Town Planners (NITP) in collaboration with organization responsible for approval of building plans should live up to their expectation by monitoring buildings that are not approved, unauthorized addition of extra floors, on existing buildings without due consultations with the structural engineers. Only buildings with ARCON, and COREN seals should be approved.

5.2.1.3 Standard Organization of Nigeria (SON) should ensure that a well packed bag of cement with sharp river sand can be used to produce about 45 pieces of block. Anything above 45 pieces of block from a bag of 50kg will not produce the desired quality and quantity of blocks. Therefore, there should be a regular check of block industries to ensure that blocks are of good quality and highly vibrated.

5.2.1.4 The building code introduced should define emphatically how a building will be erected, the type of materials to be used to reflect the required standard, and to be in good maintenance. The code should spell out among other things how to assemble materials to use for what project and other details or actions to be taken in the building process.

5.2.1.5 All professionals involved in the building industry supervising projects should ensure the following; a. Building foundations are properly back-filled and well consolidated before the mass concrete slab is cast. If this is done it will prevent secondary settlement and cracking of walls. Blocks used for the building come from block industry certified by standard organization of Nigeria. Correct number and sizes of iron specified for columns, slabs and beams are used to carry the much needed weight. d. Contractors using correct mixing ratio of concrete at site, and site execution management be handled by professional builders with architects and engineers certifying buildings. There should therefore be a periodic inspection of existing buildings to ensure their fitness and planning authority to remove such buildings. e. Foundation design plans be it bungalow or high-rise as yardstick for granting certificates of fitness by relevant government agencies in charge of planning development. f. Buildings that are partially or wholly engulfed by fire should always be inspected by building officials to ensure the safety of the occupants. If the buildings are found to be unfit, they should be pulled down immediately, to avoid total collapse.

5.2.1.6 Government should come up with professional policy outlawing indiscriminate building construction by non-professionals and all the regulatory bodies in the building industry to comply strictly with their professional ethics. Stable policy on building approvals should be enforced.

5.2.1.7 Architects should discourage the alterations of building plans after approval and after the structural drawings are completed. All alterations must be done at the design stages. There are cases where one storey buildings are changed to two storeys by the client and unqualified contractors without seeking the advice from the architect and other professionals. Due approval must be obtained from the Local Planning Authority before alteration is effected on any existing building.

5.2.1.8 Another role the architect needs to play in mitigating building collapse is to ensure that all drawings are duly approved by appropriate authorities before the commencement of the construction work.

5.2.1.9 Architects should discourage clients building without all necessary approvals. Also, professional bodies like Nigeria Institute of Architects (NIA), Nigeria Institute of Quantity Surveyors (NIQS), Nigeria Society of Engineers (NSE), have not been able to effectively monitor the activities of their members as most of their jobs have been taken over by the quacks. Designs made by the quacks are brought to the registered professionals to seal after a sum of money has changed hands without putting the integrity of the profession at heart. These have contributed to the persistent building failures. Architects should have it in mind that his job does not end on the drawing board but to oversee the entire process through to the construction stage until the project is completed. In that way, the architect is able to advice the client and sees that the design is actualised. Added to the activities of the architects in the mitigating collapse of buildings, other key players in the building industry like the clients, consultants, contractors and government agents are vital to solving this menace.

5.2.1.10 Architectural Education must be employed in Mitigating Building Collapse in Nigeria The analyses above supports earlier researches by Tanko, Ilesanmi & Bala (2013, that quackery is a principal culprit in building failures in Nigeria, hence, building

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