Menace of Building Collapse in Nigeria: Perception of General Public and Professionals

Egbo G. N., Ayoola A. R., Avre K. G., Edom A.

Abstract— A properly constructed building is expected to stand the test of time, at least for a century. In as much as every society has its own challenges, Nigeria as a country is not an exception. In the recent times, incessant buildings collapse in various parts of the country has been giving the various arms of Nigerian government and the general populace nightmares in wake of the enormous loss of huge investments in these properties and that of human lives. One of the challenges on the issue of building collapse is the individual differerences by the populace on whom to be blamed, either the professionals in the building industry or their allied personnel. This study gives the overview of perception of the general public and the professionals in the building industry in relation to incessant collapse of buildings. Data for the study were gathered through the use of structured questionnaires administered to the public, professionals and academia in the construction industry. A total of 240 questionnaires were distributed mainly to the general public, academia, and the professionals in the building industry, out of which 190 were retrieved and used for the analysis. Also, the sample size was selected using a random sampling technique. The collected data were futher analyzed using the frequency table, mean item score, analysis of variance, percentages, aggregate and standard deviation. Historical data of collapsed buildings in the country were also discussed. It was observed from the analysis that causes of building failure centers around engagement of unqualified personnel, inadequate soil investigation, improper supervision, poor materials and workmanship, foundation problems, non-compliance to approved drawings, structural design errors, unethical practices and construction problems. The major effects of failure from the analysis were found to be loss of reputation of professionals in the building industry, loss of lives, waste of resources, time and labor. Remedies according to analysis were adequate supervision, use of standard materials, involving qualified professionals in the construction process, proper soil investigation, and discipline of professionals if proven to be involved. Recommendations were consequently provided to alleviate incessant collapse in Nigeria.

Keywords— Building Collapse, effects, factors, remedies

1.0 INTRODUCTION

The place of buildings to human's existence and priority to survival as he goes about his activities within the space is important. Regardless of this, maintaining the existing housing stock in livable conditions still remains a huge challenge to be solved world over, Nigeria inclusive. Nigeria may not be famous as a country with ravaging natural disasters, however; the country can not be totally excempted from spates of disasters, which are mostly man-made. The precarious state of cities around the world is caused primarily as a result of the upward surge in population growth in these urban areas, while poor housing developments and planning are unbecoming. The frequency of collapse of building structures in Nigeria at an alarming rate in the past few years is worrisome. These have claimed many lives, while properties have been lost to incidence mostly in Abuja, Lagos and Port Harcourt. Many of these property owners, according to Kingsley (2010), have been diagnosed with high blood pressure while some have been sent to early grave. A visit to collapsed building site were as uncovering as they were unfortunate; and one could not yet ask why such structures could have been permitted to stand or to what degree individuals can go to compromise to the detriment of security and regard for lives.

- *Egbo g. N., Researcher, Nigerian Building and Road Research Institue (NBRRI), Ota, Nigeria. E-mail gegbo2020@gmail.com*
- *Ayoola A, R., Researcher, Nigerian Building and Road Research Institue (NBRRI), Ota, Nigeria. E-mail: yomicaxton@gmail.com*
- *Avre K. G., Researcher, Nigerian Building and Road Research Institue (NBRRI), Ota, Nigeria. E-mail: avrekazzi2@gmail.com*
- *Edom A., Researcher, Nigerian Building and Road Research Institue (NBRRI), Ota, Nigeria. E-mail: atomenarc@yahoo.com*

Unfortunately, there are as yet various structures of similar conditions specking the horizon of numerous urban centres in Nigeria. Occurence of building collapse over the years – despite the increase in engineering knowledge – calls for a review in the process of building production developments and control. Building failures could be cosmetic or structural; cosmetic being an addition or subtraction of items on the building, while stucrural affects both the outlook and structural stability of the buildings (Ayininuola and Olalusi, 2004).

Persistent building collapse occurrences in Nigeria have been of utmost concern to all stakeholders; the professionals in the building industry, government, estate developers and occupants. This concern forms the basis of this paper, which is to investigate the major causes and remedies to collapse of buildings in Nigeria. A nice structure will surely attract people's attention and bring about a quest for "who is the builder"? Invariably, occurrence of failure which probably resulted in a collapse, the reaction remains "who is the builder"? Nobody wants to take the blame. Collapses of buildings have resulted to waste financial and human resources, sometimes loss of lives and deterioration in the nation's economy. It dents the confidence of prospective and present investors in the building industry thereby diminishing the image of professionals nationally and internationally. This research work tends to determine the causes and effects of building collapse in Nigeria through questionnaires, thereafter proffering recommendations to save the situation while the objective are to determine the leading causes and effects of building failures and proffer solution to prevent further building collapse.

2.0 LITERATURE REVIEW

The high frequency of building collapse in Nigeria has become a major concern in Nigerian housing sector. It is required that buildings be conducive and safe for varying human activities as it constitute one of the basic human need which is shelter, and also recognized imperative for life sustainance and survival (Adenuga, 1999). The Nigerian Building and Road Research Institute in conjunction with some major stakeholders in the construction industry held a national technical workshop on Challenges of Building Collapses in Nigeria. Some of the reasons highlighted for being responsible for the frequent collapse of buildings range from the use of poor quality materials, improper foundations and lack of subsoil investigation (Matawal, 2012). Overall inadequate design structure, lack of site supervision, unwholesome roles of artisans, craftsmen, and construction workers were also enumerated. In Nigeria, the cases of building collapse occur mostly in major cities like Abuja, Lagos, Port Harcourt etc., from the statistics obtained by Building Research department in Ota of building collapse in 2012, Abuja has 75% occurrences with 117 deaths, Lagos has 37.5% occurrences with 21 deaths, Port-Harcourt has 37.5% occurrences with 9 deaths, Enugu has 12.5% occurrences with 5 deaths, Ilorin has 12.5% occurrences with 37 deaths, Dutse has 12.5% occurrences with 3 deaths, Kano has 12.5% occurrences with 22 deaths and Imo has 12.5% occurrences with only 1 death, although there are some recorded cases in rural areas as well. According to Augustine (2012), building collapse in Nigeria can be traced to the use of substandard materials, prevalence of unqualified operators (quacks) and sharp practices to maximize profit. He emphasized that the unfortunate proclivity of some government officials to collude with clients to outwit standard town planning regulatory provisions cannot be overlooked as a cause of building collapse. In addition to these, paying little or no attention to some parameters such as the soil type, design type, wind load, choice of materials, estimated load and proper factor of safety lead to building failure.

Building collapse can be defined as the failure in all or a substantial part of a building, where complete or partial replacement may be required, according to Agele (2012) include: Poor structural design, faulty construction, poor workmanship, foundation failure, lack of detailed geotechnical investigation and extraordinary loads as a result of natural phenomenon such as earthquake. The frequency of building collapse in Nigeria is due to uncommon factors that are not obtainable in most developing countries. These peculiar factors includes, and are not limited to lack of proper supervision, corruption, bad governance, abuse and misuse of authority, deficient quality control and standards, inadequate sanctions of erring professionals and investors, lawlessness and the presumptions that any professional in built industry can assume varying forms of responsibility in the building process without the required basic skills. Other causative factors are inappropriate conversion of building use, non-adherence to approval regulations, improper interpretation of site conditions, lack of soil investigation and unethical dealings with planning authorities by project promoters, non-involvement of certified professionals in varying stages of the project, sharp construction practices, greed, low quality workmanship, corner cutting by investors and contractors (Agele, 2012).

Both the professionals and the government owe it as a duty to educate the public on proper building construction. According to Simire (2008), who itirated on the "impact of standards in the construction industry", he charged professionals to make use of standards in building sector to introduce sanity in the building industry; thus enabling Builders to source for materials without compromising the quality. Ochshorn (2006) is of the opinion that excessive deflection led to extension crack propagation in a collapsed building. Inexperienced or unskilled workers may not fully understand the implication due to his pursuit for capital gains which may further increase the stress and strains on the building until its eventual collapse. It is also important to educate the general public of te fundamental requirements in building construction, as this would prevent them from patronizing quacks and unskilled construction workers.

Buildings are known to have four types of life spans and a building that collapses after the expiration of its lifespan has technically not caused any economic loss. In economic sense, the cost of replacing a collapsed building must be greater than its residual economic value which depends on the stage of its life cycle.

3.0 RESEARCH METHODOLOGY

The adopted technique for the study was survey research. The professionals working in different building construction companies in the six (6) geo-political zones of Nigeria, the Landlord, Tenants, Artisans and public view were considered in this research. This ensures adequate coverage of the population to get an insight of the possible causes of building collapse in various locations of Nigeria, since some factors that cause building collapse vary with different climatic conditions and locations. The sample sizes were selected using a random sampling method and a well-structured self-administered questionnaire given to the respondents. The secondary data were sourced from a careful search of different texts in the library, NBRRI newsletter, journals, eBooks, and different magazines with related subject matters on the study. The structure of the questionnaire involves reasons for failures, season of the year with rampant building collapse, effects of collapse and remedies of collapse which are to be filled using strongly agree, agree, undecided, disagree and strongly disagree scale. The following are the factors that guided the development of the questionnaire: the Geo-political Zones in Nigeria, Gender rate, working experiences, professionals, academia, the public and qualifications. The questionnaires were administered by the authors on one-on-one basis through the Geo-political Zones in Nigeria. The methods were analyzed using frequency table, mean item score, analysis of variance, aggregate and standard deviation. A sample of the questionnaire is in Appendix 1.

4.0 DATA PRESENTATION AND ANALYSIS

TABLE I: Response rate of the Respondents

Questionnaire administered	240
Questionnaire recovered	190
Percentage rate of response	79%

Source: Author's survey (2017)

Table I indicates that 240 questionnaires were administered, out of which 190 were recovered. This represents a response rate of 79.2%, and also an indication of acceptable response from respondents.

TABLE II: Work Experiences of the Respondents

Work Experiences	Frequency	Percentage
Less than 10 years	39	20.53%
10 – 19 years	60	31.58%
20 – 29 years	70	36.84%
30 – 39 years	21	11.05%
TOTAL	190	100%

Source: Author's survey (2017)

Table II indicates that 20.53% of the respondents, most of who are professionals in the built environment have less than 10 years of work experience and 31.58% have between 10 and 19 years work experience. Furthermore, 36.84% of the Respondents have 20 to 29 years of work experience, while 11.05% has 30 to 39 years of experience. This indicates that 79.47% of the respondents who are mainly professionals in the built environment have more than 10 years of work experience; which means that they possess adequate years of cognate experience.

TABLE III: Response rate of Professionals

Professions	Frequency	Percentage
Architects	15	16.67%
Builders	28	31.11%
Electrical Engineer	6	6.67%
Civil Engineer	10	11.11%
Mechanical Engineer	4	4.44%
Quantity Surveyor	17	18.89%
Town Planner	7	7.78%
Others	3	3.33%
TOTAL	90	100%

Source: Author's survey (2017)

Table III indicates that 16.67% of the respondents were Architects, 6.67% were Electrical engineers, 31.11% were Builders, 4.44% were Mechanical engineers, 11.11% were Civil engineers, 18.89% were Quantity surveyors, 7.78% were Town planners and 3.33% were other profession related to the built environment. Thus, the respondents are capable of providing information for this study based on professional point of view.

TABLE IV: Qualifications of Professional respondents

Qualification	Frequency	Percentage
MNIA	23	18.40%
MNIQS	23	18.40%
MNIOB	40	32.00%
MNSE	28	22.40%
Others	11	8.80%
TOTAL	125	100%

Source: Author's survey (2017)

Table IV, indicating 18.40% of the respondents were registered architects, 18.40% were registered quantity surveyors, 32.00% were registered builders, 22.40% were registered engineers and 8.80% were other professionals related to the built environment. This is an indication that the response centers primarily on registered professionals who are expected to be better informed on the menace of building collapse in Nigeria.

TABLE V: Gender rate of the Respondents

Gender	Frequency	Percentage
Male	135	71.05%
Female	55	28.95%
TOTAL	190	100%

Source: Author's survey (2017)

Table V indicates that 71.05% of the respondents were male, while 28.95% of the respondents were female. This indicates that the male respondents are about two and a half times the female respondents.

TABLE VI: Response rate from Geo-Political Zones

Geo-Political Zone	Frequency	Percentage
North – East	15	7.89%
North – Central	40	21.05%
North – West	15	7.89%
South – West	50	26.32%
South – South	20	10.53%
South – East	50	26.32%
TOTAL	190	100%

Source: Author's survey (2017)

Table VI indicates that the respondents from North–East, North–Central and North–West were 7.89%, 21.05%, and 7.89% respectfully, South–West were 26.32%, South–South were 10.53% and South–East were 26.32%, indicating that North–Central, South–West and South–South have more respondents.

TABLE VII: Distribution of Questionnaires

Respondents	Frequency	Percentage
Professionals	90	47.37%
Academia	60	31.58%
Public	40	21.05%
TOTAL	190	100%

Source: Author's survey (2017)

Table VII indicates that questionnaires were distributed more to the Professionals and Academia. The distribution shows that the professionals and academia have greater contributions in this study than the public.

Analysis of the Distribution of the Factors of Building Collapse by Respondents

The variables used for the analysis are the percentages of agreement, variance, standard deviation, mean and aggregates.

Percentage of agreement is obtained by dividing each value of agreement by the total number and multiplying by 100. For example, from table 8 the engagement of unqualified builders have strongly agree = 135 out of 190, therefore the percentage of strongly agree = (135/190) x 100 = 71.1%. The percentages obtained were used to determine the variances.

Variance helps to determine how far each factor varies from others and how closely related they are in the built environment. It is a measure of how far each value in the data set is from the mean, and also expressed mathematically as the sum of the squared distances of each term in the distribution from the mean divided by the number of terms in the distribution.

Standard deviation is obtained from the variance. Standard deviation is the positive square root of the variance. It also does the work of variance

Aggregate is obtained using weighted values with strongly agree = 2, agree = 1, undecided = 0, disagree = -1, strongly disagree = -2. These values are multiplied by their respective agreement responses and then add together. The mean is simply aggregate divided by total respondents.

Table VIII shows the general analysis of responses receive as the causes of building collapse with percentage of agreement, variance, standard deviation, mean and aggregates.

TABLE VIII a: Variance values against their factors

Variance values	Factors	% due to the ranges
0 – 999	Political/Social Violence, Mismanagement Of Buildings By Occupants	5.4
1000 – 1999	Economic Pressures, Poor Choice Of Structural Element, Faulty Construction Sequence, Lack Of Effective Policies, Poor Town Planning /Development Monitoring Process, Owner-Contractor Disorder, Natural Disaster, Wide Gap Between Designers And Site Operators, Internal Vibration, Poor Work Ethics, Artificial Disaster, Unauthorized Change Of Use Of Building, Bribery And Corruption, Education Standard, Aged Buildings, Inadequate Knowledge And Materials For Construction, Lack Of Continuing Professional, No Appropriate Penalty Or Sanction For Offenders,	48.6
2000 – 2999	Non-Compliance With Specifications/Standards By Contractors, Structural Design Errors, Construction Challenges, Unskilled Contractors, Faulty Construction Methodology, Incompetent Conversion, Non-Compliance/Possession Of Approved Drawings, Social Influence, Lack Of Field Training, Unclear Specification And Contract Agreement, Poor Maintenance, Inadequate Funds.	29.7
3000 – 3999	Use Of Substandard Materials, Unpleasant Practice Of Professionals,	5.4
4000 – 4999	Lack Of Soil Investigation, Inappropriate Supervision,	5.4
5000 – 5999	Engagement of Unqualified Builders, Inferior Equipment And Workmanship, Foundation Problems,	8.1

Source: Author's survey (2017)

Table VIIIa indicates how the factors are closely related as a result of their variance values. For example, variance values between 0 – 999 for political/social violence and mismanagement of buildings by occupants are closely related according to the analysis. It also gives the percentages of the factors as they occur in each variance group. The percentages are not evenly distributed which is an indication that some factors are more significant than others. It is important to note that standard deviation also follow the same pattern like that of variance since standard deviation is the square–root of variance.

TABLE VIII b: Aggregate range against their factors

Aggregate range	Factors
200 – 350	Lack Of Soil Investigation, Inappropriate Supervision, Inferior Equipment And Workmanship ,Use Of Substandard Materials, Foundation Problems, Structural Design Errors, Non-Compliance with Specifications/Standards By Contractors
100 – 199	Unpleasant Practice Of Professionals, Construction Challenges, Unskilled Contractors, Faulty Construction Methodology, Incompetent Conversion Non-Compliance/Possession Of Approved Drawings, Economic Pressures, Social Influence, Poor Choice Of Structural Element, Lack Of Field Training
0 – 99	Unclear Specification And Contract Agreement, Faulty Construction Sequence, Poor Maintenance Culture, Lack Of Effective Policies, Poor Town Planning /Development Monitoring Process, Owner- Contractor Disorder, Inadequate Funds
Below 0	Natural Disaster, Wide Gap Between Designers and Site Operators, Internal Vibration, Poor Work Ethics, Artificial Disaster, Unauthorized Change of use of Building, Bribery and Corruption, Education Standard, Mismanagement of Buildings by Occupants, Aged Buildings, Inadequate knowledge and Materials for Construction, Inadequate Knowledge and Materials for Construction, Political/Social Violence, Lack of Continuing Professional, No Appropriate Penalty or Sanction for Offenders.

Source: Author's survey (2017)

Table VIIIb gives the aggregate range of the factors of building failures. It is important to note that the higher the

aggregate value the higher the rank in terms of leading factors. Aggregate values

Between 200 and 350 form the leading factors of building collapse while aggregate values below 0 form the secondary factors according to the analysis. The mean is the aggregate divided by total number of respondents which gives the same ranking as the aggregate.

TABLE VIII c: Factors of Building Collapse by Respondents

Factors	SA*	A*	U*	D*	SD*	% SA*	% A*	% U*	% D*	% SD*
Engagement of unqualified builders	135	55	0	0	0	71.1	28.9	0	0	0
Lack of Soil Investigation	130	50	4	6	0	68.4	26.3	2.1	3.2	0
Inappropriate Supervision	128	48	5	5	0	67.4	25.3	2.6	2.6	0
Inferior Equipment and Workmanship	140	28	4	14	4	73.7	14.7	2.1	7.4	2.1
Use of Substandard Materials	114	57	19	0	0	60.0	30.0	10.0	0	0
Foundation Problems	140	26	6	14	4	73.7	13.7	3.2	7.4	2.1
Non-Compliance with Specifications/Standards by Contractors	80	80	15	10	5	42.1	42.1	7.9	5.3	2.6
Structural Design Errors	96	48	16	20	10	50.5	25.3	8.4	10.5	5.3
Unpleasant Practice of Professionals	44	116	15	15	0	23.2	61.1	7.9	7.9	0
Construction Challenges	64	96	8	6	16	33.7	50.5	4.2	3.2	8.4
Unskilled Contractors	102	32	15	16	25	53.7	16.8	7.9	8.4	13.2
Faulty Construction Methodology	50	75	45	15	5	26.3	39.5	23.7	7.9	2.6
Incompetent Conversion	70	42	56	8	14	36.8	22.1	29.5	4.2	7.4
Non-Compliance /Possession of Approved Drawings	28	112	28	12	10	14.7	58.9	14.7	6.3	5.3
Economic Pressures	75	45	15	15	30	39.5	23.7	7.9	7.9	15.8
Social Influence	34	102	17	20	17	17.9	53.7	8.9	10.5	8.9
Poor Choice of Structural Element	39	65	52	26	8	20.5	34.2	27.4	13.7	4.2
Lack of Field Training	40	80	20	40	10	21.1	42.2	10.5	21.1	5.3
Unclear Specification and Contract Agreement	8	80	64	16	2	4.2	42.1	33.7	8.4	1.1
Faulty Construction Sequence	35	64	48	20	23	18.4	33.7	25.3	10.5	12.1
Poor Maintenance Culture	28	42	84	20	16	14.7	22.1	44.2	10.5	8.4
Lack of Effective Policies	34	51	51	34	20	17.9	26.8	26.8	17.9	10.5
Poor Town Planning /Development Monitoring Process	18	72	52	18	30	9.5	37.9	27.4	9.5	15.8
Owner-Contractor Disorder	34	34	68	34	20	17.9	17.9	35.8	17.9	10.5
Inadequate Funds	20	68	16	72	14	10.5	35.8	8.4	37.9	7.4
Natural Disaster	36	44	22	55	33	18.9	23.2	11.6	28.9	17.4
Wide Gap between Designers and Site Operators	20	64	26	50	30	10.5	33.7	13.7	26.3	15.8
Internal Vibration	40	30	10	58	52	21.1	15.8	5.3	30.5	27.4
Poor Work Ethics	47	23	10	46	64	24.7	12.1	5.3	24.2	33.7
Artificial Disaster	35	25	20	62	48	18.4	13.2	10.5	32.6	25.3
Unauthorized Change of use of Building	14	42	28	70	36	7.4	22.1	14.7	36.8	18.9
Bribery and Corruption	24	36	10	69	51	12.6	18.9	5.3	36.3	26.8
Education Standard	29	33	8	55	65	15.3	17.4	4.2	28.9	34.2
Mismanagement of Buildings by Occupants	28	30	12	48	72	14.7	15.8	6.3	25.3	37.9
Aged Buildings	18	42	4	56	70	9.5	22.1	2.1	29.5	36.8
Inadequate Knowledge and Materials for Construction	20	25	15	70	60	10.5	13.2	7.9	36.8	31.6
Political/Social Violence	16	28	20	56	70	8.4	14.7	10.5	29.5	36.8
Lack Of Continuing Professional	26	14	10	71	69	13.7	7.4	5.3	37.4	36.3
No Appropriate Penalty/Sanction for Offenders	10	35	15	59	71	5.3	18.4	7.9	31.1	37.4

***SA=Strongly Agree, A=Agree, U=Undecided, D=Disagree, SD=Strongly Disagree**

Source: Author's survey (2017)

TABLE VIII d: Factors against its Distribution Variables

Factors	Aggregate	Mean	Variance	Standard Deviation
Engagement of unqualified builders	325.0	1.7	5084.0	71.3
Lack of Soil Investigation	304.0	1.6	4663.9	68.3
Inappropriate Supervision	299.0	1.6	4498.3	67.1
Inferior Equipment and Workmanship	286.0	1.5	5051.0	71.1
Use of Substandard Materials	285.0	1.5	3893.5	62.4
Foundation Problems	284.0	1.5	5034.4	71.0
Non-Compliance with Specifications/Standards by Contractors	220.0	1.2	2875.7	53.6
Structural Design Errors	200.0	1.1	2849.8	53.4
Unpleasant Practice of Professionals	189.0	1.0	3191.8	56.5
Construction Challenges	186.0	1.0	2829.0	53.2
Unskilled Contractors	170.0	0.9	2880.7	53.7
Faulty Construction Methodology	150.0	0.8	2147.4	46.3
Incompetent Conversion	146.0	0.8	2179.4	46.7
Non-Compliance /Possession of Approved Drawings	136.0	0.7	2839.4	53.3
Economic Pressures	120.0	0.6	1884.2	43.4
Social Influence	116.0	0.6	2467.6	49.7
Poor Choice of Structural Element	101.0	0.5	1866.7	43.2
Lack of Field Training	100.0	0.5	2046.6	45.2
Unclear Specification and Contract Agreement	76.0	0.4	2139.4	46.3
Faulty Construction Sequence	68.0	0.4	1646.5	40.6
Poor Maintenance Culture	46.0	0.2	2026.0	45.0
Lack of Effective Policies	45.0	0.2	1549.1	39.4
Poor Town Planning / Development Monitoring Process	30.0	0.2	1714.5	41.4
Owner-Contractor Disorder	28.0	0.1	1671.4	40.9
Inadequate Funds	8.0	0.0	2111.8	46.0
Natural Disaster	-5.0	0.0	1421.9	37.7
Wide Gap between Designers and Site Operators	-6.0	0.0	1558.7	39.5
Internal Vibration	-52.0	-0.3	1298.9	36.0
Poor Work Ethics	-57.0	-0.3	1131.4	33.6
Artificial Disaster	-63.0	-0.3	1308.1	36.2
Unauthorized Change of use of Building	-72.0	-0.4	1564.3	39.6
Bribery and Corruption	-87.0	-0.5	1406.5	37.5
Education Standard	-94.0	-0.5	1078.4	32.8
Mismanagement of Buildings by Occupants	-106.0	-0.6	899.8	30.0
Aged Buildings	-118.0	-0.6	1098.5	33.1
Inadequate Knowledge and Materials for Construction	-125.0	-0.7	1289.6	35.9
Political/Social Violence	-136.0	-0.7	966.7	31.1
Lack Of Continuing Professional	-143.0	-0.8	1281.2	35.8
No Appropriate Penalty/Sanction for Offenders	-146.0	-0.8	1050.5	32.4

Source: Author's survey (2017)

TABLE IX: Remedies to Building Collapse by Respondents

Remedies of Collapse	SA*	A*	U*	D*	SD*	% SA*	% A*	% U*	% D*	% SD*
Good and Adequate Supervision	171	0	19	0	0	90.0	0	10.0	0	0
Use of Standard Materials	140	30	10	8	2	73.7	15.8	5.3	4.2	1.1
Involvement of Professional Builders in the Construction Process	114	57	19	0	0	60.0	30.0	10.0	0	0
Soil Investigation	80	80	15	10	5	42.1	42.1	7.9	5.3	2.6
Discipline of Professionals Proven to be Involved in Failures	92	68	10	5	15	48.4	35.8	5.3	2.6	7.9
Promulgation of Appropriate Legislation against Building Failure	37	143	0	5	5	19.5	75.3	0	2.6	2.6
Compliance to Approved Drawings	96	48	16	20	10	50.5	25.3	8.4	10.5	5.3
Proper Check of Detailing by Builder and Designer	96	48	16	14	16	50.5	25.3	8.4	7.4	8.4
Correct use and Installation of Fittings	70	90	5	10	15	36.8	47.4	2.6	5.3	7.9
Provision of a detailed design	64	96	8	6	16	33.7	50.5	4.2	3.2	8.4
Involvement of Professionals in the Composition of Building Regulation	102	32	15	16	25	53.7	16.8	7.9	8.4	13.2
Adequate and firm Inspections	80	60	10	25	15	42.1	31.6	5.3	13.2	7.9
Strict Compliance to data available and Geotechnical Properties of the Soil	96	36	14	24	20	50.5	18.9	7.4	12.6	10.5
Prompt and necessary measure towards Deterioration and Defect	50	75	45	15	5	26.3	39.5	23.7	7.9	2.6

Adequate Site Investigation	84	36	20	30	20	44.2	18.9	10.5	15.8	10.5
Publicity of the Consequences of Illegal Buildings	75	45	15	15	30	39.5	23.7	7.9	7.9	15.8
Education of the Occupiers of the Building	20	68	16	72	14	10.5	35.8	8.4	37.9	7.4
Adequate and Planned Maintenance	40	30	10	58	52	21.1	15.8	5.3	30.5	27.4
Enforcement of Insurance of Buildings Against Failures	47	23	10	46	64	24.7	12.1	5.3	24.2	33.7

***SA=Strongly Agree, A=Agree, U=Undecided, D=Disagree, SD=Strongly Disagree**

Source: Author's survey (2017)

TABLE IX a: Remedies against its Distribution Variables

Remedies of Collapse	Aggregate	Mean	Variance	Standard Deviation
Good and Adequate Supervision	342.0	1.8	7342.0	85.7
Use of Standard Materials	298.0	1.6	5057.0	71.1
Involvement of Professional Builders in the Construction Process	285.0	1.5	3893.5	62.4
Soil Investigation	220.0	1.2	2875.7	53.6
Discipline of Professionals Proven to be Involved in Failures	217.0	1.1	3010.8	54.9
Promulgation of Appropriate Legislation against Building Failure	202.0	1.1	4358.6	66.0
Compliance to Approved Drawings	200.0	1.1	2849.8	53.4
Proper Check of Detailing by Builder and Designer	194.0	1.0	2814.3	53.1
Correct use and Installation of Fittings	190.0	1.0	2812.7	53.0
Provision of a detailed design	186.0	1.0	2829.0	53.2
Involvement of Professionals in Building Regulation Composition	170.0	0.9	2880.7	53.7
Adequate and firm Inspections	165.0	0.9	2424.9	49.2
Strict Compliance to data available and Soil Geotechnical Properties	164.0	0.9	2692.0	51.9
Prompt and necessary measure towards Deterioration and Defect	150.0	0.8	2147.4	46.3
Adequate Site Investigation	134.0	0.7	2261.4	47.6
Publicity of the Consequences of Illegal Buildings	120.0	0.6	1884.2	43.4
Education of the Occupiers of the Building	8.0	0.0	2111.8	46.0
Adequate Planned Maintenance	-52.0	-0.3	1298.9	36.0
Enforcement of Insurance of Buildings Against Failures	-57.0	-0.3	1131.4	33.6

Source: Author's survey (2017)

Tables IX and IXa shows the general analysis of responses receive as the remedies of building collapse with percentage of agreement, variance, standard deviation, mean and aggregates.

TABLE IX b: Variance values against Remedies

Variance values	Remedies	% due to the ranges
0 – 1999	Publicity Of The Consequences Of Illegal Buildings, Education Of The Occupiers Of The Building, Education Of The Occupiers Of The Building, Adequate And Planned Maintenance And Enforcement Of Insurance Of Buildings Against Failures,	10.5
2000 – 4999	Involvement Of Professional Builders In The Construction Process, Soil Investigation, Discipline Of Professionals, If Proven They Are Involved In Failures, Promulgation Of Appropriate Legislation Against Building Failure, Compliance To Approved Drawings, Proper Check Of Detailing By Builder And Designer, Correct Use And Installation Of Fittings, Involvement Of Professional Builders In The Composition Of Building Regulation, Adequate And Firm Inspections ,Strict Compliance To Data Available And Geotechnical Properties Of The Soil, Prompt And Necessary Measure Towards Deterioration & Defect, Adequate Site Investigation.	63.2
5000 – 8000	Good And Adequate Supervision And Use Of Standard Materials	26.3

Source: Author's survey (2017)

Table IXb shows how the remedies are closely related as a result of their variance values. For example, variance values between 5000 and 8000 are for good and adequate supervision and use of standard materials are closely related according to the analysis. It also gives the percentages of the remedies as they occur in each variance group. The percentages are not evenly distributed which is an indication that some factors are more significant than others.

It is important to note that standard deviation also follow the same pattern like that of variance since standard deviation is the square-root of variance.

TABLE IX c: Aggregate values against Remedies

Aggregate	Remedies
200 – 350	Good And Adequate Supervision ,Use Of Standard Materials, Involvement Of Professional Builders In The Construction Process, Soil Investigation, Discipline Of Professionals, If Proven They Are Involved In Failures, Promulgation Of Appropriate Legislation Against Building Failure And Compliance To Approved Drawings
120 – 194	Proper Check Of Detailing By Builder And De-

	signer, Correct Use And Installation Of Fittings, Provision Of A Detailed Design, Involvement Of Professional Builders In The Composition Of Building Regulation, Adequate And Firm Inspections, Strict Compliance To Data Available And Geotechnical Properties Of The Soil, Prompt And Necessary Measure Towards Deterioration & Defect, Adequate Site Investigation And Publicity Of The Consequences Of Illegal Buildings.
Below 8	Education Of The Occupiers Of The Building, Adequate And Planned Maintenance And Enforcement Of Insurance Of Buildings Against Failures.

Source: Author's survey (2017)

Table IXc gives the aggregate range of the remedies of building failures. It is important to note that the higher the aggregate value the higher the rank in terms of leading factors. Aggregate values between 200 and 350 form the leading remedies of building collapse while aggregate values below 8 form the secondary factors according to the analysis. The mean is the aggregate divided by total number of respondents which gives the same ranking as the aggregate.

TABLE X: Effects of Building Collapse by Respondents

Effect of Collapse	SA*	A*	U*	D*	SD*	% SA*	% A*	% U*	% D*	% SD*
Loss Of Reputation	140	30	5	15	0	73.7	15.8	2.6	7.9	0.0
Loss Of Lives	130	36	14	10	0	68.4	18.9	7.4	5.3	0.0
Waste of Resources, Time and Labor	74	86	7	18	5	38.9	45.3	3.7	9.5	2.6
Degrading Environment	51	79	20	35	5	26.8	41.6	10.5	18.4	2.6
Increase of Maintenance Cost	35	85	30	25	15	18.4	44.7	15.8	13.2	7.9
Structural Effects / Defects on Surrounding Buildings	33	87	10	32	28	17.4	45.8	5.3	16.8	14.7
Shortage of Manpower	30	60	52	38	10	15.8	31.6	27.4	20.0	5.3
Loss of Aesthetic Values	35	65	10	70	10	18.4	34.2	5.3	36.8	5.3
Loss Of Investment	15	80	15	60	20	7.9	42.1	7.9	31.6	10.5
Psychological Effects on Citizens	28	22	10	83	37	14.7	11.6	5.3	43.7	19.5

***SA=Strongly Agree, A=Agree, U=Undecided, D=Disagree, SD=Strongly Disagree**

Source: Author's survey (2017)

TABLE X a: Effects against its Distribution Variables

Effects of Collapse	Aggregate	Mean	Variance	Standard Deviation
Loss Of Reputation	295.0	1.6	5074.5	71.2
Loss Of Lives	286.0	1.5	4481.4	66.9
Waste of Resources, Time and Labor	206.0	1.1	2856.4	53.4
Degrading Environment	136.0	0.7	2177.4	46.7
Increase of Maintenance Cost	100.0	0.5	2022.4	45.0
Structural Effects / Defects on Surrounding Buildings	65.0	0.3	1992.3	44.6
Shortage of Manpower	62.0	0.3	1754.0	41.9
Loss of Aesthetic Values	45.0	0.2	2139.1	46.3
Loss Of Investment	10.0	0.1	2098.7	45.8
Psychological Effects on Citizens	-79.0	-0.4	1721.2	41.5

Source: Author's survey (2017)

Tables X and Xa shows according to the aggregates obtained that loss of reputation; loss of lives, waste of resources; time and labor form the leading effects while psychological effect on citizens and loss of investment are the least on the table.

TABLE XI: Season of the Year with Rampant Collapse by Respondents

Season of the Year with Rampant Collapse	SA*	A*	U*	D*	SD*	% SA*	% A*	% U*	% D*	% SD*
January–March	10	28	100	42	20	5.3	14.7	52.6	22.1	10.5
April–June	30	76	64	20	0	15.8	40.0	33.7	10.5	0.0
July–September	120	28	18	22	2	63.2	14.7	9.5	11.6	1.1
October–December	6	35	100	35	14	3.2	18.4	52.6	18.4	7.4

***SA=Strongly Agree, A=Agree, U=Undecided, D=Disagree, SD=Strongly Disagree**

Source: Author's survey (2017)

TABLE XI a: Effects against its Distribution Variables

Effects of Collapse	Aggregate	Mean	Variance	Standard Deviation
January – March	-34.0	-0.2	2548.4	50.5
April – June	116.0	0.6	2234.4	47.3
July – September	242.0	1.3	3869.8	62.2

Source: Author's survey (2017)

Tables XI and XIa gives the analysis of season of the year with rampant collapse of buildings and July–September seems to have taken the lead. This period has an aggregate of 242 points which surpasses other months.

TABLE XII: Comparison of the Leading Factors from Literature with that of this study

Literature	This Study
Poor Quality Materials	Use of sub-standard Mateials
Improper Foundation and Lack of Sub-soil Investigation	Improper Sub-soil Investigation
Inadequate Design of Structure	Structural Design Errors
Lack of Site Supervision	Inappropriate Supervision

Unwholesome Roles of Artisan, Craftsmen and Construction Workers	Unpleasant Practice of Professionals
Faulty Construction Squence	Construction Challenges

Table XII shows that the leading factors from paper presented by Matawal (2012) totally agree with the ones obtained from this study.

4.0 CONCLUSION

The study carried out made it evident that building collapse is not caused by a solitary factor but different elements, the greater part of which are human variables. The building industry nowadays has been hjacked by quacks and inexperienced contractors who would rather enrich their pockets and erect substandard buildings without regards to the lives of the intending owners and occupants. The significant explanation behind building collapse originates from the engagement of unqualified builders, lack of soil investigation, inappropriate supervision, inferior equipment and workmanship, use of substandard materials, foundation problems, noncompliance with standards and specifications by contractors, unpleasant practice of professionals, structural design errors, construction challenges and so on. Also pertinent on the side of the builders and site engineers is poor management and leadership.

5.0 RECOMMENDATIONS

In order to curtail and eliminate the menace of building collapses, and also the need to prevent the re-occurrence of such ugly situations that ensues such cases, the following recommendations are proffered:

- Building designs and other allied documents should be handled by appropriately certified professionals
- Only professionally qualified Architects, Builders, and Engineers should be allowed to be in control of the supervision of buildings construction
- Adequate monitoring of Building contractors is of importance in order to guarantee the use of good quality materials
- The authority's saddles with the building approval planning, development and control should be properly organized, and empowered to enforce all building bye-laws and regulations
- The Standard Organization of Nigeria should rid the society of substandard materials by dynamically going after such components involved in the production or importation of substandard building materials. Also, the Ministries of Housing and Urban Development should use the zoning approach expediently to restrain the type of development in areas suspected to have weak or non-load bearing soil, and at the same time specifying the proper foundation type
- At the State Government level, the process of granting building plan approval should be streamlined through the appropriate department with a view to on-time approvals
- Adequate investigations should be carried out prior any design work so as to enable the design of a suitable foundation type
- Relevant authorities saddled with the check of building materials standard should strictly comply and enforce same
- Enforcing the ethical Code of conduct for erring building professionals by the concerned bodies in order to prevent ethical abuse by the players in the industry.

References

[1] Adenuga O. A. (1999): Building Maintenance in Nigeria: Structural Deterioration, Ignition, and Diagnosis of causes and Remedies. Shelter Watch Vol. 001 June–July, pp5-25

[2] Agele A. J. (2012): The Challenges of Building Collapse in Nigeria. NBRRI newsletter Vol. 1, No.7, June, pp13
.

[3] Akinpelu, J. A. (2002): The need for code of conduct, building regulations and by-laws for the building industry in Nigeria. The Professional Builder, Nigeria Institute of Building, pp11-14

[4] Augustine C. I. (2012): Case histories of building collapse in Nigeria. NBRRI newsletter Vol. 1, No.7, June, pp10

[5] Ayininuola, G.M. and Olalusi, O.O. (2004): "Assessment of building failure in Nigeria" African Journal of Science and Technology, Science and Engineering Series, Vol. 5, No 1.

[6] Matawal, D. S. (2012): The Challenges of Building collapse in Nigeria. NBRRI newsletter Vol. 1, No.7, June, pp8

[7] Iyagba, R. O. A. (2005): The Menace of Sick Buildings – A Challenge to all for its Prevention and Treatment. An Inaugural lecture delivered at University of Lagos, Lagos.

[8] Kingsley O. D. (2010): Incessant Incidents of Building Collapse in Nigeria: A Challenge to Stakeholders, Global Journal of Researches in Engineering Vol.10 Issue 4 (Version 1.0)

[10] Ochshorn J. (2006): "Designing Building Failures" An essay presented at the Building Technology Educators Symposium, University of Maryland, and College Park

[11] Olagunju R. E. (2013): Incessant Collapse of Buildings in Nigeria: An Architect View, Journal of Civil and Environmental Research Vol.3, no.4, pp

[12] Olajumoke, A.M., Oke, I .A. Fajobi, A.B. and Ogedengbe, M.O, (2006), "Technical Assessment and Remediation of a failed Building in Osun State of Nigeria" Journal of Applied Science Research, 2(8): 462-465, 2006.

[13] Oni, A. O. (2010), "Analysis of Incidences of Collapsed Buildings in Lagos Metropolis, Nigeria" International Journal of Strategic Property Management 2(8): 62-65

[14] Simire, M. (2008): "Why Buildings Experience Structural Failure" Daily Independent Newspaper (18th Jan., 2008)