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Analysis of Safety and Failure Tracing In High-Rise Building Collapse in Selected States of Nigeria

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***Abstract*-Housing is one of the most essential human needs for living in this world even before food. The construction industry is the provider of physical infrastructure essential for human sustenance and economic development. Over the years, Nigeria has been experiencing collapse of multi-story buildings. To analyze the safety and failure tracing in high rise building collapse in selected states of Nigeria, extant literatures was reviewed. A self-developed structured checklist questionnaire was randomly distributed to a population of four hundred (400), of which three hundred and eight four (384) successful responses were retrieved from nine (9) construction companies across Abuja, Lagos State, Rivers State and Enugu for analysis. Data collated was analyzed with basic descriptive statistics tools. The result reveals that the frequency of building collapse in Nigeria is at an alarming rate and the impact is moderately major. The identified major causes of building collapse were Design/Engineering faults 8.6%, lack of compliance with an approved design specification 3.9%, compromise with materials specification 22.4%, combination of design/Engineering faults, lack of compliance with approved design specification and compromise with materials specification accounts for 64.3% represented 247 out of 384 of the population studied. While 0.8% represented 3 out of 384 of the population studied stated that lack of compliance with an approved design specification and compromise with materials specification accounts for building collapse. The study also established major contributors to building collapse as: Client/developers 12.2%, approval authority /agency 25.35%, building control agency 37.25%, and Ministry of Environment control team 25.3 % respectively represented the 384-population studied. A fishbone analysis diagram formulated. This study recommends implementation of regulatory framework, improve risk assessment and management, adoption of proven technology, joint professional monitoring and assessment process for building construction incident prevention.**

***Index Terms*—Analysis, Safety, Failure tracing, Checklist, and Building collapse Control and prevention.**

I. INTRODUCTION

The Construction industry is one of the rickets industries with vital contributions to national economic development through strategic planning, design, and transforming various production processes into constructed facilities (Isa, Jimoh, and Achuenu, 2013). Nigeria has the highest number of collapse building in Africa according to SON DG dated 26th April 2023..The Nigerian Institution of builders in facilities management (NIBIFM) tasks leaders on the preventive maintenance ,infrastructure decay Director General Standards Organisation of Nigeria(SON),Farouk Salim said in 26th April,2023,that Nigeria had witnessed a disturbing increase in cases of building collapse over the years. He noted that statistics have shown that there are over 221 cases and over five hundred fatalities with the period under review in Nigeria making it the topmost country in African with the highest number of building collapse. The building collapse prevention Guid (BCPG), stated that about 61 building collapsed within 2022.The guild stated that 541 buildings incidents were recorded between October 1978 and November2022, a 48-year time frame. These statistics are very disturbing; hence this study will greatly contribute to narrowing and reducing the frequency of building collapse.

These building collapse incidents could be prevented with the collaboration of every relevant authority including the design, Engineering, building approval authorities, Use of suitable materials per specifications, Clients and developers support, and synergy with Professional associations. Strict enforcement of statutory requirements, effective monitoring of building process from verification of required test from foundation to completion,holding result oriented meetings with all stakeholders', necessary awareness of building specifications and consequences to the use of qualified professionals at the initiation and execution of the building projects

This is very important as noncompliance has been increasingly popular among the major causes of accidents in the industry (Wang et al.2017, Kvalheim and Dahl,2016, Mat and Ismail,2012, Alpher and Karsh,2009). All incidents are caused by certain factors. These factors can be drawn from the incident causation theory (Cooper,2002; Reason 1997; Heinrich, Peterson and Roos 1980). Non compliance with specifications and building requirements also informed the decision of this research.

Housing is one of the most essential human needs for living in this world even before food. The construction industry is the provider of physical infrastructure essential for human sustenance and economic development. Buildings are intellectual works of civil Engineering structures, designed and constructed in various forms and styles, usually made with different materials and for different purposes. Basically, it is for the provision of shelter for lives and other valuable assets or properties. The constructions of buildings are anchored on seasoned considerations for Safety, Health

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of the occupants, the Environment, Economy, and Serviceability (Ede 2010).

The fundamental principle of building design is that a building should be designed and constructed to meet its owner's requirements and also satisfy public health, welfare and safety requirement. No part of such building should pose a hazard to its occupants, Fredrick et al., (1989).

Mosley et al (1985), posited that the design of an engineering structure must ensure that:1. Under the worst loading the structure is safe.2. During normal working conditions the deformation of the members does not detract from the appearance, durability or performance of the structure. Despite the difficulty in assessing the precise loading and variations in the strength of the concrete steel these requirements have to be met.Three basic methods using factors of safety to achieve safe, workable structures have been developed for engineering designs, Mosley et al.,(1985),identified them as: The Permissible stress method in which ultimate strengths of materials are divided by a factor of safety to provide design stresses which are usually within the elastic range and when a structure is rendered unfit for use, it is said to have attained a limit state. The code listed the limit states as ultimate limit state collapse, Serviceability limit state defection, cracking and vibration. others include durability.

The components of a building include the foundation (soil test must be investigated following the design requirements), Columnsare usually strutting and therefore very strong element of the structure.Beams are most susceptible to all kinds of stress than other structural elements such stresses include that due to bending, shear, slabs, cantilevers and torsion other failure includes deflection, bond and anchorage

Dimuna 2010 established the following as the causes of frequent high-rise building collapse to include: IDeficient structural are based on false assumptions of soil strength, they can also collapse as a result of faulty structural details Oyewale (1992) identified design faults accounting for 50% of collapse of engineering facilities in Nigeria.2.Absence of proper supervision. Even where a structural design is not deficient, absence of proper supervision on the site by qualified personnel can lead to building failure.3. Alteration of approved drawings-Cutting corners and alterations of approved deisgns.4. Building without approved building drawings. Building without approved drawings and in some cases no drawings at all, can result in the collapse of the building more so when the drawings were not vetted by qualified professionals or relevant authorities before the buildings are erected without drawings, all construction is based on guess work.5. Approval of technically deficient drawings. Town planning authorities at times approve technically deficient drawings. This may be as a result of ignorance on the part of Town planning personnel who vet and approved these drawings or as a result of outright corruption on their part.6. illegal alteration to existing buildings. Client at times, on their own, alter existing structures.7. Absence of town planning inspection or monitoring of sites.8. Clients penchant to cut corners.9. Use of substandard materials.10. Inefficient workmanship (labour).11.Use of acidic and salty water. 12.Th activities of quacks.13. Clients over reliance on contractors for decisionmaking on site. Also, Divid (2009)'identified the following (as causes of building collapse, they are as follows:14.Bad design.15. Faulty construction.16. Faulty or failing foundation:17. Extraordinary loads.18. Unexpected failure modes:.19. Incompetence of contractors or craftsmen.20.Unapproved plan or self-help method.21. Corruption and greed.22. Natural disasters:23.High cost of building materials:24.Lack of maintenance

Building collapse has many effects on the economy of nations as a whole lives and properties and as a result, the following have been identified as the effect of building collapse;waste of lives,waste of properties,discouragement of property development,scarcity of property,

Measures for prevention and solutions to building collapse were identified.The need to prevent building from collapsing requires serious attention, Stella (2010) stated that the need for a functional building code that is enforced against all odds has always been canvassed for at the end of the occurrence et after a while the clamor dies until another one occurs.Windapo and Rotimi (2012), further listed structural failure, poor workmanship, carelessness, excessive loading, illegal conversion, hasty construction, obstruction of water course as other causes. Fakere, Fadairo and Fakere (2012) also identified different causes of building failure. These include inadequate preliminary works, adoption of wrong foundation, poor concrete mix ratio, improper walling. lack of approved structural design, poor building material specification, ineffective supervision, lack of quality maintenance, fire disaster, illegal conversion and climate or natural phenomenon.

Adewunmi (2009) added that building collapse in Nigeria are man. made and not natural (disasters, therefore they are avoidable.Therefore,the following will help to prevent incessant building collapse if implemented.; Use of professional engineers, Compliance with applicable statutory requirements, building plan approval, Lubrication /soil test Regular maintenance culture, use of quality materials according to specifications, good designs, regular monitoring and inspection ,Involvement of professionals(Architects, builders, surveyors, estimators, Engineers and town planners, and estate surveyors and valuers).

II. RESEARCH METHODOLOGY

A. Research Design

The descriptive research method was adopted for this study. The purpose of a descriptive study is to provide picture of a situation, person or event or show how things are related to each other and as it naturally occurs (Blumberg, Cooper and Schindler, 2014).

The study precisely depicted the characteristics of the situation, the present work proposed to evaluate. Per Kothari (2004); This methodology was meticulously selected because it is widely applied by other literature reviewed in the area of study (Wang et al., 2017.Hu et al., (2016), Walala , (2016),Adebola,(2014),Dhal,(2013)

The descriptive research approach has been proven successful in similar studies across many fields and industries. (Liang et al.,2018, Kvalheim and Dhal,2016, Adebola ,2014, Dhal,2013, Aliyu and Saidu,2011, Alpher and Harsh 2009). Descriptive studies are aimed at finding out "what is, "so observational and survey methods are frequently used to collect descriptive data (Borg and Gall, 1989).The main aim of descriptive design approach is portrayal of the situation as it exists at present. As indicated by Orodho (2003, 2012), the descriptive survey design is powerful, and simple to carry out and it likewise guarantees ease in getting access to data.

The study was based on 'Analysis of Safety and failure tracing in High rise building collapse in selected states of Nigeria'. To achieve this, primary data was collected.

B. Study Area

The study area covered include Abuja, Lagos, Rivers State and Enugu State. Abuja is located in the center of Nigeria and has a land area of 7,315 square Kilometers according to 2006 population census. It is bounded on the north by Kaduna state, on the west by Niger.Lagos, the most populous, largest metropolitan area and urbanized State in Nigeria (World Population Review, 2021) has a landmass of approximately 3,577sqkm.Rivers State covers an area of 11,077 square kilometers. It has a population of 5,198,716 (2006 census) 7,303,924 (2016 forecast) and a population density of 469.

Enugu, a city that emerged as a result of the discovery of coal deposit by 1915 is situated between latitude 06°21°N and 06°30°N and longitude 07°26° E and 07°37°E (see figure 1) within an estimated land area covering a total of 215mi 2 equivalent to 556 km 2 [9] and fondly called the coal city was named after "EnugwuNgwo

C. Data Collection

This research involved collection and analyzing of qualitative data, through a semi-structured interview and observation.

Semi-structured interview offers a balance between a formal interview's focus and the flexibility of an unstructured interview.The sampling techniques adopted in this study shall was multi-stage. The sampling method employed and adopted stratified proportionate, simple random by balloting, convenient and purposive sample (Nwaogazie,2011, Creswell,2009).

D. Nature/Sources of data

The sources of data collection included the primary and secondary sources of data. The primary sources of data were collected with the use of questionnaire. The sources of secondary data are the documents obtained from published sources like magazines, newspapers, articles, textbooks, journals and the internet.

A checklist was established and deployed effectively

E.Study instrument /Validity/reliability of instrument

The methods of data collection and instruments for this study was selected to suit the research needs and ensurethat the stated research objectives are met. Content validity and expert judgment was applied. Reliability of the instrument is concerned with the measurement consistency. The rate at which the research instrument measures repeatedly the same thing, in the same way, any time it is used, at the same condition and subject is reliability (Chismall, 1981). Reliability is the level of consistency that the instrument or system shows (Best and Kahn 2006). Dependability of an instrument likewise concerns how much a specific estimating method gives comparative outcomes over various repeated tests (Orodho, 2012). As it were, it is how much an estimation system can be depended upon to verify predictable outcomes upon repeated application. In the present work, it was accomplished by estimating steady outcomes from the respondents. Reliability of data was guaranteed through data gathered from pertinent respondents with explicit thoughtfulness regarding proper wording of instructions, coherent game plan of inquiries that were posed.

E. Study instrument/Checklist /FMEA/Fishbone model

The study instrument was the data collection tools. Checklist/failure mode effect analysis and fishbone model were applied. The first was the self-developed checklist. The second shall have two sets of questionnaires, semi -structure self-administered questionnaires for both general employees and process heads. This instrument is a sensitive one and will help people to express their mind and what they practice when reporting anonymously (Wang et al.,2017, Dhal2013).

The questions generated in the questionnaires were both open ended questions and closed ended question, with dichotomous and multiple-choice options. The mixed questionnaires shall be adapted from those found in related research, safety management standards and HSE guidelines (IOGP,2018, ISO 45001:2018. Wang et al. ,2017, Dhal,2013, Vinodkumar and Bhasi,2010).

Table 1.1: Checklist for safety analysis and failure tracing in high -rise building Collapse in Selected States of Nigeria (Safetyculture, 2018)

S/No.	Checklist questions	Responses (Yes/No/ comments)	Remarks

Table.1.2 failure mode and effect analysis (FMEA) a2:m26

Process/product name: _____Prepared by: _____

Responsible; _____FMEA date(original)_____Rev_____

PROCESS STEP/INPUTS	POTENTIAL FAILURE MODE	POTENTIAL FAILURE EFFECT	SEVERITY (1-10)	POTENTIAL CAUSES	CONSEQUENCES (1-10)	CURRENT CONTROLS	DETECTION (1-10)	RPN	ACTION RECOMMENDED	RESPONSIBLE	ACTION TAKENS	SEVERITY (1-10)	OCCURRENCE (1-10)	DETECTION (1-10)	RPN
What isthe process steps/features under investigation?	In what way could the step or feature go wrong?	What is the impact on the customer if the failure mode is not prevented or correct?		What causes the step to go wrong (ie how could the failure mode occur)		What are the existing controls that either prevent the failure mode from occurring or detect it should it occur		Risk Priority number. The overall risk score of an event .it is calculated by multiplying the score for severity occurrence and detection. An event with a high RPN demands immediately attention while events lower RPNs are less risky	What are the actions for reducing the occurrence of the cause or for improving its detection? Provide actions on all high RPN and on severity ratings of 9 0r 10.	Who is responsible for making sure the actions are completed	What actions were taken, (and when), with respect to RPN				

G.Source of Data Collection

The source of data collection in this study was primary, using the Checklist adapted from safety culture, 2018.

The Checklists were distributed to 400population(purposive sampling) in four states.The survey was conducted on 400 respondents (150 in Lagos, 178 in Rivers, 42 in Enugu, and 30 in Abuja), out of the 400 copies of the questionnaires distributed, the questionnaires that was returned from Lagos state were 148, 166 was returned from Rivers State, 40 was returned from Enugu, and 30 was return from Abuja representing 96% and 16 (4%) was missing from three states (2 in Lagos State, 12 in Rivers State, and 2 in Enugu).

H. Data Analysis

Different risk tools assessment was used in order to effectively analyze data which have given rise to critical issues in the building construction industry. these risk assessment tools include:

1. Probability rating (from 1 to 10)
2. Severity rating (from 1 to 10)
3. Detection rate (1-10)
4. Strongly agreed
5. Strongly disagreed
6. Agreed
7. Not agreed
8. Neutral

The three factors of severity, occurrence, and detectability are multiplied together to calculate the risk priority number (RPN): RPN = S × O × D.The critical failure modes are identified based on RPN rankings.

III. RESULTS

The survey was conducted on 400 respondents (150 in Lagos, 178 in Rivers, 42 in Enugu, and 30 in Abuja), out of the 400 copies of the questionnaires distributed, the questionnaires that was returned from Lagos state were 148, 166 was returned from Rivers State, 40 was returned from Enugu, and 30 was return from Abuja representing 96% and 16 (4%) was missing from three states (2 in Lagos State, 12 in Rivers State, and 2 in Enugu).

The frequency distribution of the demographics based on gender shows that of three hundred and eighty-four (384) respondents, 160 (41.7%) were male, while 224 (58.3%) were female. Hence, we have more female respondents than male in the study

The frequency distribution of the demographics based on the nature of business is shows the responses of three hundred and eighty-four (384) respondents. There are 54 (14.1%) operating in the building construction business, 93 (24.2%) in the road construction business, and 237 (61.7%) in the general construction business. This implies that most respondents operate in the general construction business.

The frequency distribution of the demographics based on the number of years worked in the form is displayed shows the responses of three hundred and eighty-four (384) respondents. In addition, among the 384 respondents, 61 (15.9%) have worked for their firm for 1–5 years, 58 (15.1%) have worked for their firm for 6–10 years, 76 (19.8%) have worked for their firm for 11–15 years, and 189 (49.2%) have worked for their firm for 16 years and above. According to this analysis, most respondents have worked for their firm for more than 16 years.

The frequency distribution of the demographics based on the roles of the participants was established. Out of the 384 respondents, 158 (41.1%) work as a site engineer, 58 (15.1%) work as a project manager, 44 (11.5%) work as a site supervisor, and 124 (32.3%) work as an operator. The analysis for this is that most respondents work as site engineers.

The frequency distribution of the demographics based on age was established. In addition, among the respondents, 96 (25%) are of age 18 to 25 years, 223 (58.2%) are between 26 and 35 years, 49 (12.8%) are between 36 and 45 years, and 16 (4.2%) are above 46 years. According to this analysis, most respondents are between 26 and 35 years old.

The frequency distribution of the demographics based on familiarity with construction safety was established . Out of the 384, 50 are not familiar with construction safety (13.0%), 203 are not quite familiar with construction safety (52.9%), and 131 are very familiar with construction safety (34.1%). This implies that most respondents are not quite familiar with construction safety

Table 2.1Respondents' answers based on report of near-mises/incidents

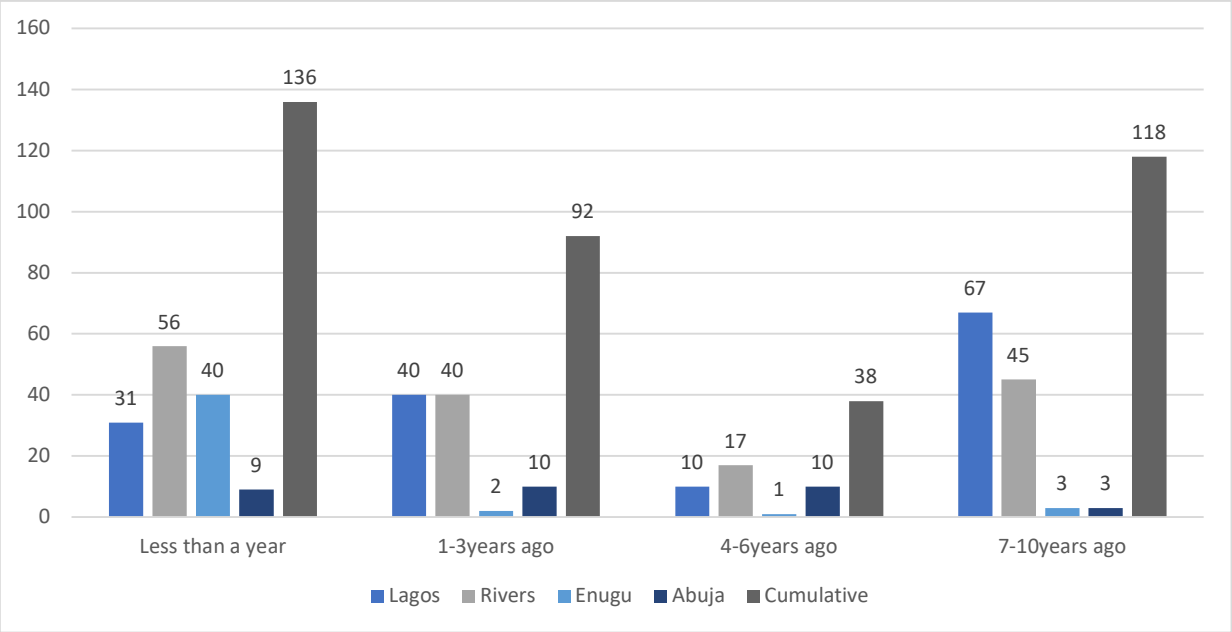
		Frequency	Percent	Cumulative Percent
Report	Always	292	76.0	76.0
	Not always	86	22.4	98.4
	As situation demands	6	1.6	100.0
	Mean	128	33.3	

Table 2.2 Respondents' answers based on building collapse

Building Collapse	Frequency	Percentage

Less than a year	136	35.4%
1-3years ago	92	23.1%
4-6years ago	38	9.9%
7-10years ago	118	30.7%
Total	384	100%
Mean	96	25

Fig 1.1Bar Chart showing respondents' answers based on building collapse according to the four States.

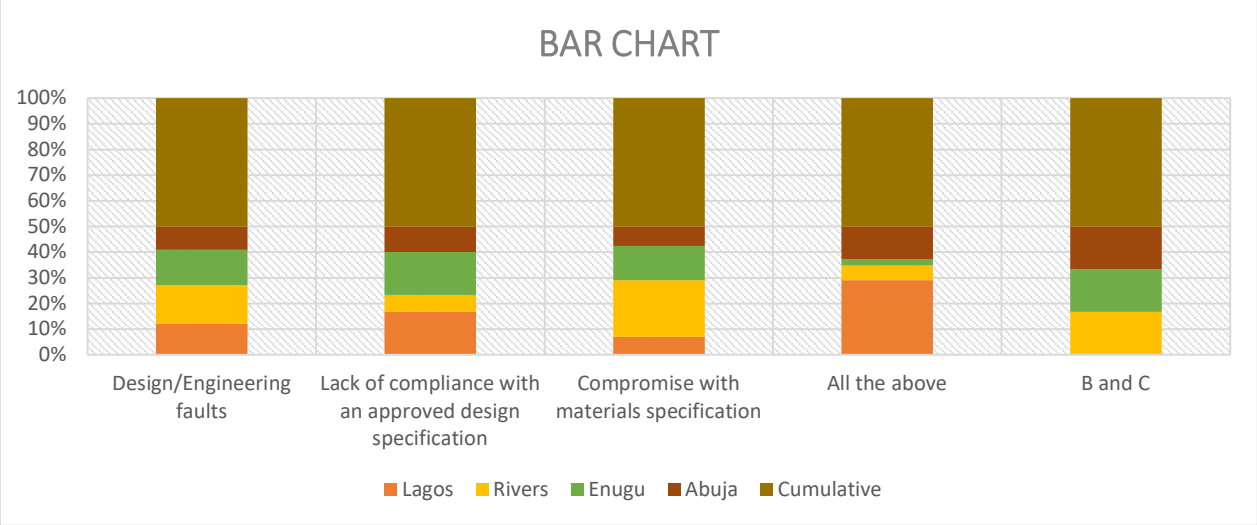


2.3 Respondents' answers based on major cause of the building collapse

Causes	Frequency	Percentage
Design/Engineering faults	33	8.6%
Lack of compliance with an approved design specification	15	3.9%
Compromise with materials specification	86	22.4%
All the above	247	64.3%
B and C	3	0.8%
Total	384	100%

Mean	76.8	20

Fig 1.2 Bar Chart showing respondents based on major cause of the building collapse according to the Four States



2.4 Respondents' answers based on the major contributors to building collapse

Level of Income		
Client/Developers supervision team	47	12.2%
Building plan-approving authority or agency	97	25.3%
Building control agency	143	37.2%
Ministry of Environment control team	97	25.3%
Total	384	100%
Mean	96	25

Table 2.5: Descriptive Statistics of respondents

	N	Minimum	Maximum	Mean	Std. Deviation

Safety Awareness	384	4.20	12.60	5.8849	1.81556
Top management commitment	384	4.20	12.60	5.9099	2.14174
Building construction standards	384	4.20	12.60	5.6354	1.71888
Valid N (listwise)	384				

Table 2.6Scatter Plot of Perceived Building Construction Standards and Safety Management System Compliance

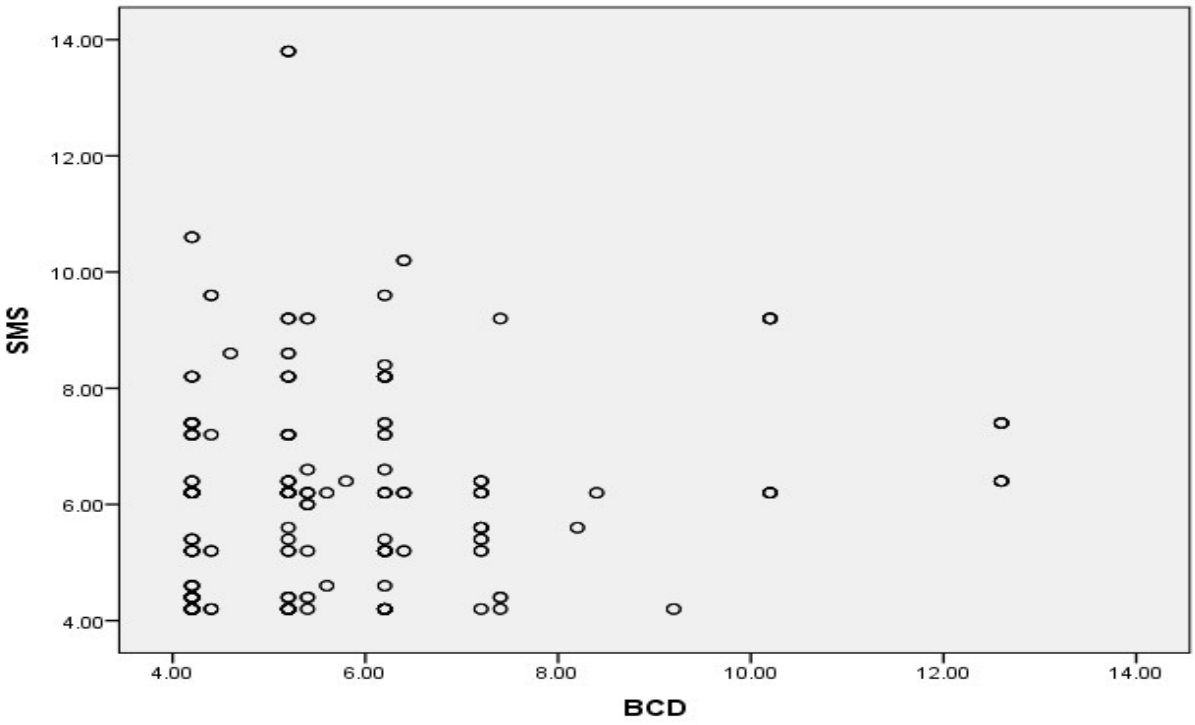


Table 2.7

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	38.003	1	38.003	12.402	.000[b]
	Residual	1170.530	382	3.064		
	Total	1208.533	383			

a. Dependent Variable: safety management system compliance

b. Predictors: (Constant), safety awareness

Test of Hypothesis

In testing the null hypotheses, the ANOVA test Analysis was adopted to ascertain the significance of the variables. All

null hypotheses were tested at a 0.05 level of significance

Hypothesis one and two

a) There is no association between specific factors and high-rise building collapse in the selected states.

b) The frequency of high-rise building collapse is consistent across the selected states

Table 2.8 Analysis of variance

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	38.003	1	38.003	12.402	.000[b]
	Residual	1170.530	382	3.064		
	Total	1208.533	383			

a. Dependent Variable: safety management system compliance

b. Predictors: (Constant), safety awareness

Table 2.9 Coefficient

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	5.137	.303		16.934	.000
	safety awareness	.173	.049	.177	3.522	.000

a. Dependent Variable: SMS

IV. Discussion

The purpose of this study was to analyze safety and failure tracing in high rise building collapse in selected states of Nigeria. The study was guided by the specific objectives, research questions and three null hypotheses. Specifically, the study was directed to analysis safety and trace out the causes of failure in high rise building collapses in selected states of Nigeria. The study sampled four (4) States (Abuja, Lagos, Rivers, and Enugu) using multi-stage sampling technique, while targeting the building construction workers in both states. The study was underpinned by theory of human failures, and failure training to identify major causes of building collapse. From the study findings, the following were noted:

I. There is no association between specific factors and high-rise building collapse in the selected states.

II. The frequency of high-rise building collapse is

consistent across the selected states.

III. There is no significant difference in the frequency of high-rise building collapse between any pair of selected states.

IV. The existing regulations applicable to high-rise building construction are equally effective across all selected states

V. There is no relationship between implemented controls and the prevention of future collapse of high-rise buildings.

VI. The failure tracing and risk assessment methods in high-rise building construction yield similar results across the selected states

The executive conclusions followed the outcome of this research work;

1. The selected organizations across the four states had the recommended building construction safety statutory requirements, specifications, standards and codes in place. It was revealed that awareness of the existing construction safety standards 52.9% represented 203 of 384 of the population interviewed was not quite aware. This calls for increase in creation of awareness of the existing building construction requirements to all relevant parties within the organisation, and make them understand their roles including the consequences of non fulfilment of the requirements.

2. The study also revealed that a good number of workers across the four states of the population studied were not aware of building collapse incident. the data obtained, showed that 47.7% represented 183 out of 384 population interviewed were not aware of building collapse incident within the area.

3. The study established that near misses /incidents were not reported as required. The data 22.4% represented as 86 of 384 do not report near misses. It's a requirement that all hazards, near misses and incidents must be determined, investigated and reported for continual improvement. ISO 45001;2018(clause 6:1). The Heinrich theory of accident causation pyramid as postulated by Bert William Heinrich (1931) laid premium on the identification and appropriation action against hazards/near-misses, unsafe acts and unsafe conditions (Herbert William Heinrich 1931., ABD El-Rahman ABD EL-Hafez, May 26,2023).

4. Several factors were identified to have contributed as major causes of building collapse .As shown on table (4.12),Design/Engineering faults 8.6%,lack of compliance with an approved design specification 3.9%,compromise with materials specification 22.4%,combination of design/Engineering faults, lack of compliance with approved design specification and compromise with materials specification accounts for 64.3% represented 247 out of 384 of the population studied. While 0.8% represented 3 out of 384 of the population studied stated that lack of compliance with an approved design specification and compromise with materials specification accounts for building collapse.

5. The study also established that there were cast list of building collapse. Client/developers 12.2% represented 47 out of 384 of the population studied, approval authority /agency 25.35 represented 97 out of the 384-population studied, building control agency 37.25 represented 143 out of the 384-population studied, and Ministry of Environment control team 25.3 % represented 97 out of the 384-population studied ,having a mean of 96 representing 25% as shown in table 4.13.

6. The study also shown the test for homoscedasticity and linearity of the relationship between dependent variable (i.e., safety management system compliance) and independent variables (i.e. safety awareness, top management commitment, and building construction standards). There appear to be a positive correlation among the variables. Respondents that have high level of safety awareness, top management commitment, and building construction standards exhibits high level of safety management system compliance. On the other hand, respondents that do not have high level safety awareness, top management commitment, and building construction standards does not exhibit high level of safety management system compliance.

7. As shown in table4.14, difference hypothesis was made. There is no association between specific factors and high-rise building collapse in the selected states. The frequency of high-rise building collapse is consistent across the selected states. More so, there is no significant difference in the frequency of high-rise building collapse between any pair of selected states.

The existing regulations applicable to high-rise building construction are equally effective across all selected states, as shown in table 4.16. Furthermore, there is no relationship between implemented controls and the prevention of future collapse of high-rise buildings. The failure tracing and risk assessment methods in high-rise building construction yield similar results across the selected states.

8. The fishbone analysis diagram formulated model representedis a veritable tool for building construction workplace safety management. It is a reference guide in optimizing the necessity of standards operating system's as a critical layers or barriers tool to prevent building collapse incident and increase safe work practices.

9. The data from the analysis of the survey carried out show the need for government agencies responsible for building construction in Nigeria to enforce Quality Safety assurance on every project. Thorough examinations and checks must be carried out during designs and building construction by duly certified professionals. Lastly, awareness should be carried out to educate investors and owners of buildings about possible building collapse from over interference in the building construction process.

V. RECOMMENDATIONS

Following the outcome of the study and findings from this study, the following recommendations if implemented will be highly beneficial and helpful to the clients/ developers, Approval authority /agency, building control agency, management of facility, Government regulatory agency, Trade unions, Government monitoring and Enforcement agencies. These recommendations will greatly improve safety performance and engender high compliance with building requirements, thereby leading to incident prevention. The following recommendations were borne out of this research work.

1 Reinforce Regulatory Framework: The regulatory

authorities in Nigeria should enforce strict building codes and safety standards. Regular inspections and audits should be conducted to ensure compliance with these standards. Additionally, there should be consequences for non-compliance to create a culture of accountability.

2 Advance Construction Practices: Construction companies in Enugu State should prioritize the use of high-quality materials, proper construction techniques, and adherence to industry best practices. Training programs should be provided to workers to enhance their skills and knowledge regarding safety protocols.

3 Improve Risk Assessment and Management: Implementing robust risk assessment methodologies, such as fishbone and Failure Mode Effects Analysis (FMEA), can help identify potential hazards and develop preventive measures. Construction companies in Lagos, Rivers and Enugu should proactively identify and mitigate risks at every stage of the project.

4 Promote Safety Culture: Foster a culture of safety within the construction industry by promoting the importance of safety at all levels of the organization. This can be achieved through regular safety training, toolbox talks, safety committees, and recognition of safe practices. Communication channels should be established for workers in the construction companies for the three states to effectively report safety concerns without fear of reprisal.

5 Adoption of proven Technology: Leverage technology to enhance safety in construction projects. This can include the use of Building Information Modeling (BIM) for better planning and visualization, Internet of Things (IoT) devices for real-time monitoring of safety parameters, and drones for site inspections and monitoring, which can be implemented in the construction companies that involve both the three states (Lagos, Rivers, and Enugu).

6 Collaboration and Knowledge Sharing: Building Construction companies in Abuja, Lagos, Rivers and Enugu should encourage collaboration and knowledge sharing among industry associations, and regulatory bodies. Establish platforms for sharing lessons learned, best practices, and case studies to promote continuous improvement in safety performance.

7 Constant Monitoring and Assessment: Each state (Abuja, Lagos, Rivers and Enugu) should Implement a system for constant monitoring and assessment of safety performance in building construction projects. This includes regular inspections, incident reporting and analysis, and feedback mechanisms to identify areas for improvement and implement corrective actions.

8 Public Awareness and Education: Educate the general public about the importance of safety in construction projects. This can be done through awareness campaigns, public seminars, and media outreach to create a sense of shared responsibility towards safety.

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