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Impacts of Using Sub-Standard Building Materials on Building Collapse

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Abstract

This research was centred on effects of substandard materials usage on building collapse in Nigeria. The study was guarded by three research questions to achieve the aim of the study. Data collected was analysed with statistical tools of mean, percentage and presented with table. Based on the findings of the study, causes for the use of substandard construction materials during construction projects during were analysed that poverty, ignorance, high cost of building materials, inflation of the cost of building materials, greediness of construction workers and lack of good supervision which were verified from the fact that the scores range from 2.50 – 4.00 as established by the cut off mark. The effects of substandard materials on building collapse include among others as comprised constructed building lack standardization, deterioration, cracks, lack of strength to withstand natural disasters,, it makes a building unsafe to inhabit, continuous repairs and checks and building liable to collapse at any time while all the respondents' negative response comprised only building unable to withstand vibration which were verified from the fact that the scores range from 2.50 – 4.00 as established by the cut off mark while the negative responses were also established from the fact that the mean scores were less than 2.50.The study was concluded by giving some recommendations among which was workshops and seminars should be organized through media and physical means for all the construction teams and the general public on the effect of building collapse.

Keywords: *Substandard materials, Building collapse, Effects, Usage, Proper supervision.*

1. Introduction

Structures or shelters known as buildings are made specifically to house people and provide storage for their possessions (Oyenuga, 2010). The kind and function of the structure determines the materials used in its construction. When creating a structure, important variables such the design, the materials and resources to be used, and the prices involved must be taken into account (Adewuyi, 2010). The level and quality of the materials utilised is crucial among these variables.

The quality of buildings in Nigeria is still questioned because of the many instances of unpleasant and unwanted manifestations that occur soon after construction is completed and frequently even during the operating phase. From a technical point of view, a building's service life is the amount of time that it can function as needed to fulfil its intended function. Langston (2011) identifies a number of characteristics that affect a building's service life, including the environment, users' maintenance level, design level, work execution level, and the quality of a building's components, which are dependent on the quality of materials utilized.

However, the materials chosen have a significant impact on how long a building will last technically. The least amount of time that a structure may satisfy user needs and requirements while carrying out its intended duties until it becomes outdated is implied to be its service life. As a result, both structural and non-structural components' integrity can be used to evaluate and quantify it. Building materials is one of the primary variables determining the effective functioning of the Nigerian building sector. It makes a significant contribution since building materials quality affects the calibre of construction undertakings. As a result, a drop in the quality of these materials puts human health, lives, properties and the economy at large as well as the service life of buildings at serious risk.

Building materials that fall short of quality standards and have an unfavourable impact on a building's lifespan are considered substandard. About 52% of architectural faults that appear after a building's post-occupancy period, particularly in residential buildings, can be attributed to the use of inferior materials and poor craftsmanship (Ayodeji, 2011). Moreover, Ajufoh et al. (2014) hypothesis that a 10% causal influence of using subpar building materials is the reason behind building collapses.

According to Akinyemi et al. (2016), 60% of building collapses in Nigeria are attributed to the use of substandard materials and shoddy craftsmanship by quacks. Furthermore, Omenihu et al. (2016) assert that the use of inferior building materials contributes 13.2% of building collapses, with structural failure accounting for the remaining 24.9% of structure collapses. According to Akande et al. (2016), poor quality materials particularly cement, steel sections, and reinforcement rods, may account for as much as 18.4% of a building's collapse. In Nigeria, the number of building collapses has increased recently. Media stories of collapsing buildings in major cities in Nigeria and other parts of the world are not uncommon. A structure may collapse for a variety of causes, including inadequate foundation support, poor quality control, inadequate structural design, inadequate specification compliance, and the use of inferior materials. A few outcomes of this horrible event are the loss of life and property, to name a couple. Based on the information provided by the study's backdrop, it is vital to look at how the usage of inferior materials affects building collapse.

1.1. Objectives of The Research

The aim of the research was to investigate the effects of substandard construction materials on building collapse while the objectives were to:

1. Examine the causes for the use of substandard construction materials during construction projects.
2. Highlight the effects of substandard materials on building collapse.
3. Proffer solution to the effect of substandard materials to reduce high rate of building collapse

2. Literature Review

2.1. Building Collapse

When a building can no longer fulfil its basic purpose of being secure, stable, comfortable, and fulfilling for its occupants, it is said to have collapsed Khitab et al. (2015). Therefore, the building is employed to give its people sufficient shelter and protection without having to worry about it

collapsing. (2016) Kapliński et al. Like all other structures, buildings are made to be able to withstand loads and external forces without deforming excessively. These loads are the weights of the buildings themselves, which are referred to as dead loads, and the weights of people and things, as well as the weight of wind and rain. To ensure that the building can support all of these loads for the duration of its life, all of these loads must be included in the structural design, Kapliński et al. (2016), the design life is usually fifty (50) years for constructions.

According to various studies carried out to date, the following are the structural engineering design and construction related reasons for building collapse as listed by building professionals in Nigeria as poor structural design, poor compliance with engineering drawings and specifications, inadequate supervision and poor quality control, illegal conversion and alteration to existing structure, corruption, natural disaster, poor construction, poor maintenance, lack of information about the underlying soil, and use of sub-standard building materials. Building construction industry has experienced a huge boom in the last two decades but not without these ugly occurrences of myriad building collapse in Nigeria. Since the boom in the building industry, it has been one of the main drivers of development in our economy. Therefore, we should make every effort to investigate the causes of building collapses in Nigeria. The need for additional buildings in Nigeria to accommodate the country's population growth has been addressed in both sincere and incorrect ways (Ede, 2010).

The incorrect method has led to the collapse of numerous buildings in Nigeria, including but not limited to the usage of sandcrete blocks as beams, as shear and load-bearing walls, and subpar materials including reinforcement, cement, and bad concrete (Gajzler 2016). As per the collective references provided by Amadi et al. (2012) and Dimuna (2010), building collapse is a global phenomenon primarily driven by two main factors: man-made and nature. The following are examples of natural elements: mudflows, hurricanes and thunderstorms, earthquakes, erosion and flooding, landslides. Man-made variables, on the other hand, are nothing more than simple mistakes committed by humans in the areas of design, construction technique, planning, and building materials.

As a result, trustworthy information regarding the reason of building collapses in Nigeria may be hard to come by. Flaga (2000) claims that despite corruption from all sides of the industry, design flaws, faulty construction methods, and a host of other issues, there doesn't appear to be a decrease in the catastrophic building collapses that occur over time. According to this review's technical analysis, a major factor in building collapses is a lack of materials used during building construction.

In Nigeria, the number of building collapses has increased recently. Media stories of collapsing buildings in major cities in Nigeria and other parts of the world are not uncommon. A building may collapse for a variety of causes, including bad structural design, inadequate adherence to requirements, inadequate quality control, flawed construction techniques, failed foundations, and corruption. Building collapses are also linked to natural disasters. Nigeria has seen a number of building collapse incidents recently, some of which are depicted in the image below. A two-storey building has collapsed on Amusu Street, in the Orile Iganmu area of Lagos State.

Figure 1: Image from the Orile Iganmu building collapse on Monday, October 14th, 2024

3. Methodology

The study adopted a survey research design. It was carried out on the field with the administration of a well-structured questionnaire which was based on the research questions. Fifty (50) questionnaires were distributed for the purpose of achieving the objectives of this effects of sub-standard materials usage on building collapse for collection of data and only forty (40) were received this happened because some of the respondents were not interested in completing the questionnaire and some cannot be retrieved due to the careless act of the respondents. The data was analysed (i.e the mean and standard deviation), using statistical package for social society (SPSS). The statistical tools used for this study include percentage, mean, and relative significance index (RSI) to determine which of the impacts of using sub-standard building materials on building collapse in Nigeria. The relative significance index ranking (RSI) was used for ranking of the factors studied. These methods had been used in construction research by authors such as, (Bakhary, 2005; Elhag and Boussabaine, 1999; Faniran, 1999; Idrus and Newman, 2002; Kangiwa and Olubodun, 2003) among others. This questionnaire was administered and retrieved by the researcher to avoid some error of omission which could come up in the process. The questionnaire was designed with Likert Scale rated between 1 to 4 scales as shown below: "Strongly Agreed" were scored 4, "Agreed" were scored 3, "Disagreed" was scored 2, and "Strongly Disagreed" were scored 1.

The data retrieved was analysed with descriptive statistic of mean. The response categories in the questionnaire were scored using a four-point rating scale as shown in the instrument for data collection above. The frequency of each category of response was multiplied by score value of the response alternative.

$$\text{For average to get decision rule} = \frac{4 + 3 + 2 + 1}{4} = 2.50$$

Decision Rule - All items with mean score less than 2.50 were rejected while every item with mean score above 2.50 and above was accepted.

4. Data Analysis and Results

The data were presented using tables for clarification and better interpretation. The analysis tools included both descriptive and inferential statistics on the effects of substandard materials usage on building project. Among fifty copies of questionnaire distributed only forty copies were retrieved and they were analysed based on the opinion of the respondents.

Respondents Profile

Table 1: Sex

Gender	Frequency	Percentage
Male	28	70
Female	12	30
Total	**40**	**100**

Source: Field survey, 2024

Table 1 revealed data analysis related to the respondents' gender who responded to the instrument distributed. Among 50 copies of questionnaire, only 40 copies were retrieved. It comprised twenty-eight (70%) males and twelve (30%).

Table 2: Marital Status

Gender	Frequency	Percentage
Single	30	75
Married	10	25
Total	**40**	**100**

Source: Field survey, 2024

Table 2 revealed data analysis related to the respondents' marital status who responded to the instrument distributed. Among fifty copies of questionnaire, only forty copies were retrieved. It comprised thirty singles which represented 75% and ten married represented 25%.

Table 3: Population distribution

Questionnaire administered	No. of respondents	Percentage (%)
Questionnaire retrieved	40	80
Un-retrieved questionnaire	10	20
Total	**50**	**100**

Source: Field survey, 2024

Table 3 showed the population distribution of the respondents. It showed that fifty percent (80%) are questionnaires retrieved, and twenty percent (20%) are un-retrieved questionnaires. The result shows the representation of genders in the construction industry in the study area.

Table 4: Respondents' year of experience

Years	Midpoint (x)	Frequency (f)	Fx	Percentage
1-5	12	24	288	60.00
6-10	6	12	72	30.00
11-15	1	2	2	5.00
16-20	1	2	2	5.00
above 21	0	0	0	0.00
Total		**40**	**364**	**100.00**

Mean = $\sum fx/\sum f$= 364/40 = 9.10

Source: Field survey, 2024

Table 4 shows the respondents mean years of working experience estimated at approximately ten years (10years), while there were no respondents with experience above 21 years. With this average working experience of ten years, respondents are deemed experienced enough to supply reliable data for the research.

Table 5: Academic qualifications of the Respondents

Educational Qualification	Frequency	Percentage (%)
National Diploma/NCE	5	12. 50
HND/BSc	30	75.00
MEng/MSc/MTech	3	7.50
PhD	2	5.00
Total	**40**	**100**

Source: Field survey, 2024

Table 5 represents the academic/educational qualification obtained by the respondents. 12. 50% is with National Diploma/NCE, while 75% is with HND/BSc, while 7.50% is with MEng/MSc/MTech, and 5% is with PhD certificates. The result shows that all respondents possess academic qualifications from the various schools as from elementary to tertiary education to acquire training and knowledge to supply reliable data for the study.

Table 6: Professional qualification

Educational Qualification	Frequency	Percentage (%)
NIOB	15	37.50
NIQS	10	25.00
NIA	11	27.50
NSE	3	7.50
Others	1	2.50
Total	**40**	**100.00**

Source: Field survey, 2024

Table 6 represents the professional qualifications obtained by the respondents. 37.50% is registered with NIOB, while 25% is registered with NIQS, 7.50% is registered with NIA, and 2.50% is with other professional bodies. The result shows that all respondents possess registration of their various professional bodies in Nigeria and adequate professional training to supply reliable data for the study.

Table 7: Causes of the use of substandard materials during construction projects

S/N	Factors	Mean	Remarks
1	Poverty	3.2	Agreed
2	Ignorance	3.05	Agreed
3	Favouritism of workers	2.2	Disagreed
4	Lack of knowledge	2.95	Agreed
5	High cost of building materials	3.15	Agreed
6	Inflation of the cost of building materials	3.35	Agreed
7	Desperation to own a building	1.8	Disagreed
8	Greediness of construction workers	3.35	Agreed
9	Lack of good supervision	3.15	Agreed
10	Unable to comply to building rules and codes	2.15	Disagreed

Source: Field survey, 2024

Table 7 showed the mean response of respondents to the reasons for the use of substandard construction materials during construction projects. The respondents agreed with items 1, 3, 4, 5, 6, 8 and 9 which were poverty, ignorance, lack of knowledge, high cost of building materials, inflation of the cost of building materials, greediness of construction workers and lack of good supervision respectively but disagreed with only items 3, 7 and 10 which included favoritism of workers, desperation to own a building and unable to comply to building rules and codes. Their positive responses were verified from the fact that the scores range from 2.50 – 4.00 as established by the cut off mark while the negative responses were also established from the fact that the mean scores were less than 2.50.

Table 8: Effects of substandard materials on building collapse

SN	Effects	Mean	Remarks
1	Constructed building lacks standardization	3.05	Agreed
2	Deterioration	2.85	Agreed
3	Cracks	2.55	Agreed
4	Lack of strength to withstand natural disasters	3.00	Agreed
5	Building unable to carry loads intended for	2.42	Agreed
6	Building is generally weak	3.05	Agreed
7	Building unable to withstand vibration	2.12	Disagreed
8	It makes a building unsafe to inhabit	3.10	Agreed
9	Continuous repairs and checks	2.7	Agreed
10	Building liable to collapse at any time	2.75	Agreed

Source: Field survey, 2024

Table 8 showed the mean response of respondent to the effects of substandard materials on building collapse. The respondent agreed with items 1, 2, 3, 5, 6, 8, 9 and 10 respectively. These

positive responses were verified from the fact that the scores were fallen between 2.50 to 4.00. Nevertheless, the respondents disagreed with only item 7 as this negative response was also established from the fact that the mean scores was less than 2.50. Also the positive response among others comprised constructed building lack standardization, with deterioration, cracks, lack of strength to withstand natural disasters, building unable to carry loads intended for with building is generally weak, it makes a building unsafe to inhabit, continuous repairs and checks and building liable to collapse at any time while all the respondents' negative response comprised only building unable to withstand vibration.

Table 9: Solution to minimize high rate of building collapse

SN	Solutions	Mean	Remarks
1	Engage the service of competent building team	3.60	Agreed
2	Carry out soil test before construction	3.25	Agreed
3	Use right consumables for the jobs	3.30	Agreed
4	Use suitable foundation for the construction	3.60	Agreed
5	Proper supervision	2.95	Agreed
6	Compliance to all the consultants' specifications	3.30	Agreed
7	Compliance with building regulations and codes	3.30	Agreed
8	Use the right tools for the construction	3.60	Agreed
9	Inform government before the construction	2.30	Disagreed
10	Ensure all construction drawings are completed	1.92	Disagreed

Source: Field survey, 2024

Table 9 showed the mean response of respondents to the ways to minimize high rate of building collapse. The respondents agreed with items 1-8 respectively as these positive responses were verified from the fact that the scores were fallen between 2.50 to 4.00 as established by the cut off marks while the respondents disagreed with item 9 and 10 as this negative response was also established from the fact that the mean scores were less than 2.50. The respondents' positive response among others comprised engage the service of competent building team, carry out soil test before construction, use right consumables for the jobs, use suitable foundation for the construction, proper supervision, compliance to all the consultants' specifications, compliance with building regulations and codes together with the use of right tools for the construction. The respondents' negative responses included to inform the right government before the construction and ensure all construction drawings are completed

5. Findings and Discussions

Table 7 displays the respondent's various points, including strongly agreed, agreed, disagreed, and strongly disagreed, about the reasons for the usage of subpar building materials throughout construction projects. The main causes of building collapses, according to the respondents, were poverty, ignorance, lack of knowledge, high costs for building materials, inflation of those costs, greed of construction workers, and inadequate supervision. These responses were also supported by Ezeagu et al. (2015), who contended that corruption and the nation's poverty, which results in financial constraints, are among the causal factors that encourage the involvement of incompetent professionals and the use of substandard materials for the construction of foundations and other building elements.

Furthermore, table 8's respondents concurred that, among other things, subpar materials' effects on building collapse included lack of standards, deterioration, cracks, a building's inability to withstand natural disasters, its inability to support the loads intended for it, weakness, ongoing checks and repairs, and building collapse at any time. The assertions made by Akinyemi et al. (2016) that the usage of inferior materials was a contributing factor in 60% of building failures in Nigeria corroborated these replies. Furthermore, Omenihu et al. (2016) assert that the use of inferior building materials contributes 13.2% of building collapses, with structural failure accounting for the remaining 24.9% of building collapses. According to Akinyemi et al. (2016), poor quality materials, particularly cement, steel sections, and reinforcement rods, may account for as much as 18.4% of a building's collapse.

Finally, table 8 responders provided suggestions for reducing the high rate of building collapse. Among other things, their response included hiring a qualified construction team, testing the soil prior to starting work, using the appropriate tools for the job, choosing a suitable foundation, providing adequate supervision, adhering to all consultant specifications, and using the appropriate tools for the job. These responses were in line with the findings of Dimuna (2010) and Ede (2010), among others, who noted that using standard construction materials, conducting feasibility studies, employing qualified professionals, hiring professionals with education and awareness, involving structural engineers in projects involving more than one floor, and supervising construction projects by professionals are important ways to reduce the high rate of building collapse.

6. Conclusion

Many lives and properties are lost to building failure every year. Despite the enormous sums of money invested in building projects. If suitable measures are not adopted at the appropriate moment, which can mean the difference between an industrial success and failure, these losses will keep happening. According to the study's conclusions, it is imperative that the construction industry, governments, stakeholders, clients, construction teams, and a host of other parties accept their unwavering obligation to stop the bad things from happening, improve the economy, and add more labour.

6.1. Recommendations

The following suggestions were made after carefully analysing the study's findings:

1. Any construction team involved in any activity that could cause a structure to collapse should be subject to strict legal penalties.
2. All relevant authorities shall supervise and inspect construction projects properly before, during, and after they are completed.
3. To educate all construction teams and the general public on the effects of building collapse, workshops and seminars should be arranged through the media and physical means.
4. To determine whether compliance has improved, a study akin to this one should be conducted in a different setting within the construction industry

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