

Assessment of Compliance with Preliminary Environmental Investigations for Erecting Sustainable Building Structure in Abuja Metropolis, Nigeria

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Abstract: The continuous collapse of structures which is usually accompanied by great loss of lives and properties, the conscientious construction activities in the country has a direct or indirect impingement on the environment by displacing settlements, hampering farming activities and the destruction of beneficial plants. This pose threats to the continuous existence of man and the sustenance of natural vegetation. Based on the foregoing, the study was designed to assess compliance with preliminary environmental investigations for erecting sustainable building structures in Abuja Metropolis. Two research questions and two null hypotheses guided the study. The research was carried out in Abuja Metropolis Nigeria. Descriptive survey research design was used for the study. The targeted population for the study was 148 subjects comprising of 72 builders and 76 engineers. Since the population was manageable no sampling was done. A structured questionnaire was used for data collection. Cronbach's alpha statistical tool was used to determine the internal consistency of the instrument and was found to be 0.80. Data collected for the study was analyzed using mean, standard deviation and z-test. Mean was used to analyze the research questions while z-test was used to test the hypotheses at 0.05 level of significance. The findings of the study revealed that builders and engineers are aware of all the necessary preliminary investigations that should be conducted before erecting building structures. The findings also showed that despite the fact that builders and engineers are aware of the necessary preliminary environmental investigations to be conducted before erecting building structures, they still fail to execute the investigations of the building which aren't environmentally friendly. Based on the findings of the study, it is recommended that all the preliminary investigations identified in this study should be made a requirement for approving any building plans and construction and also government should enact laws to punish violators of preliminary investigations in Nigeria.

Keywords: Building structures, Compliance, Investigation, Nigeria, Preliminary investigations, Sustainability

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1. Introduction

The building industry is an important aspect of any economy which has a substantial effect on the environment. Building construction is one of the largest consumers of energy and material resources, and also a producer of pollutants to the environment. To tackle these effects, there is a general agreement among bodies committed to environmental performance targets that

appropriate strategies and actions are needed to make building structures more sustainable (Abidin, 2010). With respect to such significant influence of the building industry, the sustainable building approach has a high capability to make a valuable contribution to sustainable development. Sustainability is a wide and complex concept, which has grown to be one of the major issues in the building industry. The concept of sustainability involves improving the quality of life, which will allow people to inhabit a healthy environment, with improved

social, economic and environmental conditions (Ortiz et al., 2009). A sustainable project is designed, built, renovated, operated or reused in an ecological and resource efficient manner (Ortiz et al., 2010).

There is no state in Nigeria and the Federal Capital Territory (FCT) that building collapse has not affected in recent years. Mathebula et al., (2017), cited the case of Reigners Bible church in Akwa Ibom State Nigeria that collapsed killing about one hundred (100) worshippers. In the same vein a seven (7) storey building at Woji road in Rivers State Portharcourt Nigeria collapsed killing about five persons respectively (Odeyemi et al., 2019). Also On the 13th of March, 2019 a three (3) storey building located at Ita-Faji area of Lagos State Nigeria collapsed killing about twenty persons (20) and injuring scores (Odeyemi et al., 2019), on the 6th of October 2021 a two storey building under construction located behind Citec estate along airport road Jabi Abuja collapsed killing one occupant ("Breaking '1 dead as building collapses in Abuja'", 2021). Finally on the 19th of October 2021 a two storey building in Ikorodu area of Lagos killing one person and trapping many (Toromade, 2021).

As highlighted above hundreds of lives and properties worth millions of naira has been lost in recent years due to building collapse. What may actually be the cause of the increase in building failure? Probably negligence on the part of building owners to carry out preliminary environmental investigation before erecting building structures. Also these collapses are always associated with serious environmental problems such as air pollution, dust, noise disturbances, waste disposal problems and attending loss of life and properties. This has always given the government and stakeholders serious headaches over the years.

Based on the foregoing, the study was designed to assess compliance with preliminary environmental investigations for erecting sustainable building structures in Abuja metropolis.

2. Relevant Literatures

2.1. Building structures

A building is an edifice that is firmly attached to the ground which provides complete shelter for human, conducting of human of activities, storage of human properties, machines, processing equipment, or any combination of these. A building is constructed to offer shelter and to carry out day to day activities for mankind. Mankind has advanced in providing safe and more conducive shelter for continuous human existence (Mansur & Tahar, 2017). Building structures has evolved through centuries, from caves to skyscrapers and recently to intelligent structures that can smartly respond to stimuli in its environment (Ede, 2017). Since buildings cannot be overlooked as long as man lives on planet earth it is therefore important to accord every stage of building construction utmost importance.

Building construction is the process of bringing together materials to form a building. It is generally performed by labourers and craftsmen engaged for the purpose by an individual or a company called a contractor. The contractor signs an agreement or contract with the building owner or client under which the contractor agrees to construct a specific building on a specified site and the client agrees to pay for the materials and services provided. Construction practice has also undergone a great deal of development in response to the dynamic nature of human needs and infrastructure (Anumba et al., 2008). The building construction process is grouped into three major phases: the conception or design stage, construction phase and operation or use phase. Building design is the process of providing all information necessary for construction of a building that will meet its owner's requirements and also satisfy public health, welfare, safety requirement and sustain the environment. The design stage is the planning and feasibility studies stage in which some professionals may assist the owner to evaluate the technical, economic and environmental options available and then realize the design. The design consists of the creation of the architectural form, identification of the loads, selection of materials, and proportioning of the sections. During this stage, the basic requirements of safety, aesthetic, economy, and constructability must be considered, irrespective of the client's brief (Davison & Owens, 2003). Building design may be legally carried out only by persons deemed competent to do so by the state in which the building is to be constructed. Competency is determined on the basis of education, experience and the ability to execute a sustainable structure.

2.2. Sustainable building structure

A sustainable building structure is one which has all the various components of sustainability (environmental, economic, social, and cultural) put into consideration. The various sustainability issues are connected, and the interaction of a building with its surroundings is also important. The environmental issues share, in common, concerns which involve the reduction of the use of non-renewable materials and water, and the reduction of emissions, wastes, and pollutants (Luis et al., 2010). The following goals can be found in several building sustainability assessment methods: optimization of site potential, preservation of regional and cultural identity, minimization of energy consumption, protection and conservation of water resources, use of environmentally friendly materials and products, a healthy and convenient indoor climate, and optimized operational and maintenance practices.

The purpose of sustainability assessments is to gather and report information for decision-making during different phases of the construction, design, and use of a building. The sustainability scores or profiles, based on indicators, result from a process in which the relevant phenomena are identified, analyzed, and valued. Two extreme trends can be recognized at the moment: on one

hand, the complexity and diversity of indicators from different operators, and on the other hand, the evolution towards better usability through a common understanding and simplicity.

2.3. Environmental investigations / preliminary investigations

The importance of preliminary investigations to every building owners before erecting any building cannot be over emphasised. This is because information obtained in the investigation will help guide proper and adequate construction of the building that will satisfy the taste of time without damage. Preliminary investigation works are operations carried out to figure out the suitability of the site for for the proposed structure. It consist the investigation of site topography, soil strata, load-bearing capacity of the soil on site, propensity of the site to flooding and information about previously existing building structures (Oladunjoye et al., 2017). The nature of the sub-surface soil on every construction sites is of great concern to builders and engineers because it determines the suitability of the site for construction project and it also determines modifications to be made on such subsoil if the need arises (Oyedele et al., 2015). This make the environmental investigations/ preliminary investigations an inherent part of every construction project.

Preliminary investigations involve exploring the ground conditions and sampling of strata likely to be affected by the structural load, it is a prerequisite for the successful and economic design of engineering structures (Enahoro & Ogbonnaya, 2015). Preliminary investigations are normally carried out to determine the specific properties of soil and materials needed for a specific project at hand. (Frigga, 2006) noted that preliminary investigation is simply the process of determining the condition of the soil beneath the ground where building is to be constructed. Also, preliminary investigation is the overall process for the collection of information, appraisal of data, assessment and reporting of data without which the hazard beneath the land cannot be known (Sadanandam & Anupaju, 2017). From the foregoing preliminary investigations are conducted in order to enable a geotechnical and geo-environmental assessment of the ground conditions and analysis of the engineering and environmental considerations related to the proposed building site.

Building sites are construction site that need to be investigated to determine the type and nature of foundation to be dug on such site, the nature and extent of the preliminary work that would be needed. Amadi et al., (2012) revealed that most of the foundations in Nigeria are designed without considering the soil type on which the building will rest upon, adding that it is vital that adequate soil investigation be carried out before designing a foundation in-order to have a suitable design to suit the local geology of the area. Thus, the nature of the soil and its probable load-bearing capacities are important areas to be investigated. The past history of the site is to be investigated with particular reference to the former

existence of trees, water level, borehole log, underneath soil strata and waste dumps (Seeley in Ibrahim & Abdul 2019). Preliminary investigation before erecting any building structures is considered important because it provides the client with the necessary information about the soil condition and the materials to be used (Dimuna, 2010).

This explains why building regulatory bodies such as the Nigeria Institute of Building (NIOB), Council of Registered Builders of Nigeria (CORBON), and the Council for Regulation of Engineering in Nigeria (COREN) and all related agencies at all levels are trying hard to enforce compliance with standard building regulations and practices among the building owners in Nigeria (Ibrahim & Kagara 2018). Building structure may be residential, office, commercial complex, hospitals or shops. However, all buildings erected should be made to satisfy the test of time and to provide reasonable comfort for safe use. To actualize this dream, building owners particularly the residential building owners must conduct preliminary investigations to obtain the necessary information before erecting building structures in order to avoid incessant building collapse.

3. Materials and methods

The study was conducted in the Federal Capital Territory (FCT) Abuja Nigeria. Abuja is the Federal capital of Nigeria situated at the geographical Center of Nigeria on Latitude of 9° 03'28.26"N and longitude 7° 29' 42.29" East (Abubakar, 2014). Abuja is bordered by the states of Niger to the west and Northwest, Kaduna to the Northeast, Nassarawa to the east and south and Kogi to the Southwest. Abuja was chosen as the study area because it is one of the fastest growing cities in Africa (Abubakar, 2014). Moreover the city is currently facing building constructions at a geometric rate to cope with it ever growing population, the targeted population for the study was 148 subjects comprising of 72 builders and 76 engineers, Cronbach's alpha Statistical tool was used to determine the internal consistency of the instrument and was found to be 0.80. Data collected for the study was analyzed using mean, standard deviation and z-test. Mean was used to answer the research questions while z-test was used to test the hypotheses at 0.05 level of significance.

4. Results

Table 1 shows responses of the respondents on the 19 items that should be subjected to Preliminary investigations before erecting building structures in Abuja Metropolis with the mean ranging from 2.81 to 3.61 and a grand mean of 3.25. This signifies that all the items should be investigate before erecting building structures in Abuja Metropolis. The deviations of the items ranges from 0.44 to 1.81. The deviations showed that the respondents were not too far from the mean and were closed to one another

in their responses. This closeness of the responses added value to the reliability of the item.

Furthermore Table 3 shows the z-test analysis of differences in the mean responses of Builders and Engineers as regards the preliminary investigations to be conducted before erecting building structures. The Table revealed the probability value obtained to be 0.004 which is less than the probability value of 0.05 in comparison. The null hypothesis was therefore rejected. Therefore, there is significant difference between the mean responses of Builders and Engineers as regards the preliminary investigations to be conducted before erecting building structures in Abuja Metropolis.

The results in Table 2 revealed that the respondents agreed with eight items (2, 3, 5, 7, 11, 13, 16 and 18) on the extent of compliance with preliminary investigations before erecting building structures in Abuja Metropolis as moderately complied. Also, the respondents agreed that eleven items (1, 4, 6, 8, 9, 10, 12, 14, 15, 17 and 19) are not being complied before erecting building structures in Abuja Metropolis. With a mean score that ranges from

1.06 to 1.95 and a grand mean of 1.52. This signifies that the respondents agreed generally that reports of preliminary investigations are not complied with before erecting building structures in Abuja Metropolis. The standard deviations of the items ranged from 0.25 to 0.96, showing that the respondents were not too far from the mean and were close to one another in their responses.

Furthermore Table 4 shows the z-test analysis of differences in the mean responses of Builders and Engineers as regards the level of compliance with preliminary investigations before erecting building structures. The Table revealed the probability value obtained to be approximately 0.3 which is greater than the probability value of 0.05 in comparison. The null hypothesis was therefore accepted. Therefore, there was no significant difference in the mean responses of Builders and Engineers as regards the level of compliance with preliminary investigations before erecting building structures in Abuja Metropolis.

Table 1: Mean and standard deviation of respondents on the preliminary investigations that should be conducted before erecting sustainable building structures in Abuja Metropolis

S/N	Items	\bar{x}_T	SD _T	Remark
Present practices				
1	Specific gravity test for cement to be used throughout the structure.	2.81	0.90	Agreed
2	Investigating the propensity of the site to flooding.	3.30	0.64	Agreed
3	Slump cone test to determine the consistency and workability in the mix.	2.86	0.98	Agreed
4	Specific gravity test of plaster sand to be used	3.61	0.61	Strongly Agreed
5	Investigating the topography of the sites.	3.16	1.81	Agreed
6	Conducting cube test for the concrete mix.	3.18	0.40	Agreed
7	Physical inspection of the materials.	3.15	0.44	Agreed
8	Specific gravity test for granite to be used	3.24	0.46	Agreed
9	Information about previously existing building structures	3.31	0.49	Agreed
10	Investigating the potential impact of the project on nearby structures	3.32	0.57	Agreed
11	Investigating the wood to be used for construction.	3.25	0.62	Agreed
12	Determining the foundation depth.	3.37	0.60	Agreed
13	Information about the local terrain before building construction	3.25	0.46	Agreed
14	Determining the strengths of blocks before erecting any building structure	3.23	0.70	Agreed
15	Determine a good mix design	3.43	0.50	Agreed
16	Investigating the load bearing capacity of the soil.	3.50	0.50	Strongly Agreed
17	Investigating the soil strata of the site before erecting structures.	3.20	0.90	Agreed
18	Specific gravity test of sharp sand to be used	3.40	0.50	Agreed
19	Materials such as aggregates, mortar, concrete, cement, sand and water conform to standard building regulations.	3.30	0.58	Agreed
	Grand Mean/SD	3.25	0.66	

Key: N_T = Number of respondents, \bar{x}_T = Total, SD_T = Average Standard Deviation.

N_T=143

Table 2: Mean response and standard deviation of respondents on the extent of compliance with preliminary investigations before erecting building structures in Abuja Metropolis.

SN	Items	\bar{X}_T	SD ₁	Remark
Extent of compliance				
1	Specific gravity test for cement to be used throughout the structure.	1.25	0.43	Not complied
2	Investigating the propensity of the site to flooding.	1.78	0.53	Moderately Complied
3	Slump cone test to determine the consistency and workability in the mix.	1.55	0.56	Moderately Complied
4	Specific gravity test of plaster sand to be used	1.11	0.31	Not complied
5	Investigating the topography of the sites.	1.96	0.40	Moderately Complied
6	Conducting cube test for the concrete mix.	1.41	0.53	Not complied
7	Physical inspection of the materials.	1.56	0.64	Moderately complied
8	Specific gravity test for granite to be used	1.45	0.49	Not complied
9	Information about previously existing building structures	1.39	0.50	Not complied
10	Investigating the potential impact of the project on nearby structures	1.10	0.32	Not complied
11	Investigating the wood to be used for construction.	1.94	0.42	Moderately complied
12	Determining the foundation depth.	1.37	0.52	Not complied
13	Information about the local terrain before building construction	1.93	0.25	Moderately complied
14	Determining the strengths of blocks before erecting any building structure	1.39	0.49	Not complied
15	Determine a good mix design	1.48	0.96	Not complied
16	Investigating the load bearing capacity of the soil.	1.93	0.25	Moderately complied
17	Investigating the soil strata of the site before erecting structures.	1.06	0.25	Not complied
18	Specific gravity test of sharp sand to be used	1.97	0.36	Moderately complied
19	Materials such as aggregates, mortar, concrete, cement, sand and water conform to standard building regulations.	1.41	0.53	Not complied
Grand Mean/SD		1.52	0.46	

Key: N_T = Numbers of respondents, \bar{X}_T = Total, S_{DT} = Average standard deviation.

Table 3: Z-test analysis of significant difference in the mean responses of the respondents as regards the preliminary investigations to be conducted before erecting building structures in Abuja Metropolis.

Building professionals	N	Mean	S.D	Df	Z	P-Value
Builders	69	3.21	0.12	141	-2.97	0.004
Engineers	74	3.29	0.18			

Table 4: Z-test analysis of significant difference in the mean responses of the respondents as regards the extent of compliance with preliminary investigations for erecting sustainable building structures in Abuja Metropolis

Building Professionals	N	Mean	S.D	Df	Z	P-value
Builders	69	1.49	0.14	141	-2.42	0.27
Engineers	74	1.56	0.18			

5. Discussion

The Findings on the preliminary investigations to be conducted revealed that the respondents agreed to all nineteen items posed as the necessary preliminary investigations to be conducted before erecting building structures. This signifies that all the nineteen items are necessary information that must be sought before erecting building structures in Abuja Metropolis. This finding is in line with the view of (Oladunjoye et al., 2017) who identified investigation of site topography, soil strata, load-bearing capacity of the soil on site, propensity of the site to flooding and information about previously existing building structures as operations carried out to ascertain the suitability of the site for the purpose of construction. Similarly (Enahoro and Ogbonnaya, 2015) observed that the prerequisite for the successful erection of engineering structures and earthworks involves investigating and exploring the ground conditions and sampling of strata likely to be significantly affected by the structural load.

The Findings in Table 2 relating to research question 2 showed that preliminary investigations such as investigating the site to determine its propensity to flooding, conducting slump cone test, determining the topography of the site, physical inspection of materials before being used for construction purpose to mention but few were moderately complied with while preliminary investigations such as specific gravity test for cement to be used throughout the structure before being used for construction purpose, conducting cube test, information about previously existing buildings, specific gravity test of sharp sand to be used, determining the strength of blocks before being used for construction were not conducted before erecting building structures. The findings are in consonance with the findings of Ibrahim and Kagara (2019) whose study found out that residential building owners do not sought and conduct preliminary investigations. According to Amadi et al., (2012) building failures are as a result of poorly structured, planned and executed preliminary investigations, or even the total neglect of the investigations. (Amadi et al., 2012) further revealed that most of the foundations in Nigeria are designed without considering the soil type on which they rest upon.

6. Conclusion

Based on the findings of the study, the following conclusions were made. The findings of the study revealed that Builders and engineers are aware of all the necessary preliminary investigations that should be conducted before erecting building structures. It was also concluded that prospective building owners in Abuja metropolis do not conduct preliminary investigations before erecting building structures this practice has led to the continuous building collapse resulting in the degrading of the environment and loss of lives and properties worth billions of naira.

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