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Evaluation of Compliance of Concreting Materials to Standards in Building Projects in Lagos State, Nigeria

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Abstract

The incessant collapse of high-rise buildings has necessitated research into the compliance of materials — structural components and elements — to standards. This study evaluated compliance of concreting materials with standards in building project delivery. It examined the factors that influence compliance with standards of materials used for producing concrete elements. A quantitative approach was adopted in the study where structured questionnaires were administered to designers and constructors (such as architects, engineers/site supervisors and quantity surveyors) in consulting and contracting organisations in Lagos State, Nigeria. The data were analysed using frequency distribution, mean score, standard deviation, factor analysis and Kruskal Wallis test. Factors affecting compliance of materials with standards were categorised into construction site-based and procurement-based. These are technical, regulation, procurement, capacity, performance, and skill. The study provides implications for quality building production through improved compliance of concreting materials to standards. It also found the neglect of the use of structural engineers' services and limited standards observance on site. These lead to substandard components and elements production. It therefore, recommends efficient regulatory policies, enforcement mechanisms, improved training and instilling ethical standards among project stakeholders.

Keywords: Building projects, Compliance, Concreting materials, National standards, Project delivery.

1. Introduction

Construction materials are significant inputs in building project delivery. Performances in a building project are measured using the criteria, time, budget, and quality (Opawole, 2016). The quality component is consequently defined to a greater extent by the specification of materials and components. The number of large-scale building construction project failures and accidents in Nigeria in the recent past has raised the need for probing into several issues relating to the standards of materials for concrete component production. The products, mainly in the informal sector, often exhibit quality compromise. Recently, the Nigerian construction industry has faced many challenges, of which defects and collapse of buildings are inclusive. Most building defects and collapses ensued mainly due to non-compliance of the construction industry's professionals to the national standard on selected construction materials (Windapo and Rotimi, 2012; Adewoleet al., 2014). According to Adenike (2006), Grema (2006), and Bamisile (2004), compromise in building quality is mainly attributed to materials and workmanship. Akinyemi et al. (2016) grouped the causes of building collapse into three: types and quality of materials used and operational and personal problems. Where the cause of the collapse is traced to concrete quality, the fault is usually associated with poor aggregates and substandard cement grade (Olanitori, 2011; Adewole et al., 2014). Akinyemi et al. (2016) pointed out that poor concrete mix can lead to building collapse.

The issue of compliance with national standards in building projects is now a concern in the Nigerian building industry. Over the years, most collapsed buildings across the 36 States of Nigeria have been linked to poor quality materials and neglect of services of

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qualified professionals (Olanitori, 2011). Studies have shown that the Nigerian building construction industry is dominated by informal construction activities, in which operations are not professionally monitored. As a result, quality breaches in the building industry abound, with structural failures leading ultimately to building collapse (Akinyemi et al., 2016; Adewoleet al., 2014). The evaluation of some facets of the building industry in Nigeria reveals that the acknowledgment of compliance management strategies to national standards is at its low ebb. For example, Oludare and Oluseye (2016) found that the overall quality management system is the supervision of operatives and work processes. Hence, the degree of compliance with selected concreting material national standards in building projects attained is solely dependent on the mastery of the supervisor. This situation is commonly counter-productive, notably when the supervisor lacks knowledge and skills. The non-compliance with selected concreting materials to national standards in Nigeria has assumed an uncontrollable dimension. This attribute exhibited in the construction industry largely contributed to the bad image of the construction industry in Nigeria and thus suggested multidisciplinary investigations. Therefore, this study aims at evaluating compliance with concreting materials standards in building projects by assessing the factors influencing compliance with concreting materials, national standards and factors affecting compliance with national standards; also examining compliance with concreting materials to national standards and the effects of non-compliance on project delivery to enhance construction project delivery.

2. Component Standards Compliances Factors and Effects

According to Penn State University Libraries (2022), building codes specify minimum standards for the construction of buildings. They are not legally binding. They serve, instead, as "models" for legal jurisdictions to utilise when developing statutes and regulations. Building code becomes the law of a particular jurisdiction when formally enacted by the appropriate governmental or private authority. Ruya et al. (2017) opined that regulation is synonymous with law, and regulations are rules or norms adopted by the government and backed up by some threat or consequences, usually negative ones in the form of penalties. Designing Buildings (2022) stated that standards typically refer to published documents that are intended to define the common specifications, methods and procedures that are to be used, while building regulations establish minimum standards to be achieved in the construction of buildings. The National Building Code (NBC) is designed to be the master source of national standards in relation to the design and construction of buildings in Nigeria (Anigbogu and Anunike, 2014).

Building materials are materials or components used purposely to construct buildings (Omotehinshe et al., 2015). The two main categories of building materials are natural materials such as stone/granite/gravel or coarse aggregates, sand and the like or fine aggregates, and manufactured materials such as cement, reinforcement, irons, metals, tiles, blocks or bricks, concrete, and so forth. Building materials constitute the highest percentage of inputs in terms of volume and cost in building construction (Elkhalifa & Shaddad, 2018). Hamma-Adama and Kouider (2017) concluded that sub-standard building materials are one of the leading causes of building collapse. According to Twidale (1982), the final product of the crushing of rocks is simply granite chippings. Coarse aggregate (stones) is composed of quartz, feldspar, and mica. Biotite and muscovite are contained in mica, which are agents of oxidisation and might make concrete strength lesser or weaken over time (Bamigboyeet al., 2019). Since granite is good in strength, appearance and resistance to weathering, it should be void of excessive crystals of mica-biotite and muscovite.

Care should be taken to select suitable quality materials for building construction (Anthony, 2012). It is essential to carry out tests on the water to be used, sieve analysis on aggregates, tensile strength on reinforcement and also ensure there is a design mix to follow during construction (Bamigboyeet al., 2019). The key physical parameter used to classify and compare Portland cement includes bulk density, relative density (specific gravity), fineness, setting time, strength, soundness, the heat of hydration, and loss on ignition (Nwankwojike et al., 2014). In accordance with the specifications of the Bureau of Indian Standards (BIS) and European Standard EN 197-1, Portland cement used for intensive load-bearing superstructures is expected to exhibit a minimum of 3.1 specific gravity, maximum of 10% fineness, consistency range of 26 to 33% and initial/final setting time of not less than 30 minutes/not more than 600 minutes respectively.

2.1 Compliance with National Standards in the Construction Industry

The Nigerian construction industry has relied majorly on British and American Standards and Codes for construction materials and components. Professionals that specify materials (architects, engineers, and quantity surveyors), sometimes lack adequate knowledge of the function and performance of the materials and components they recommend (Adafin et al., 2011; Folorunsho and Ahmad, 2013). Several studies have been carried out on standards relating to construction materials. These studies include Voskresenskaya and Vorona-Slibinskaya (2018), focusing on the development of national standards pertaining to the safety and security of high-rise buildings in Russia; Angelino (2019), focusing on developing better design standards for the construction industry in the UK and Ndongo et al. (2020) concentrating on the current situation on the use of building construction standards in Congo-Brazzaville. In the last decades, much has not been done on the national standards relating to construction materials in the Nigerian construction industry as obtained in other countries (Anigbogu and Anunike, 2014).

Past studies on compliance with national standards include factors influencing compliance with safety standards guidelines in public secondary schools in Kitui Central Sub County, Kitui County (Muthiani, 2016); contextual, structural, and behavioural factors influencing the adoption of industrialised building system (Zakaria et al., 2018); analysis of some factors driving ecological sustainability in construction firms (Bamgbade et al., 2019). Also, there has been a lot of research evaluating compliance in various fields. Among these research works are sharia compliance in the construction industry (Annabi et al., 2017); an assessment of quality compliance using concrete test mechanism in Saudi Arabia (Al-Ghamdi, 2020); research on the construction of ecosystem in compliance risk management of foreign trade enterprises in Fujian Province (Hu, 2020); and Oludare and Oluseye (2016) focusing on quality management practices among construction firms. It is noteworthy to emphasise the impacts of non-compliance with national standards in the construction industry. These impacts are usually expected to affect products' quality negatively. Previous studies have also been conducted relative to the effects of non-compliance but not specifically on the impact of non-compliance with national standards. These studies include assessing the effects of non-compliance and enforcement of building safety regulations on construction sites in the Assin North Municipality (Dei, 2016), challenges facing building code compliance in New Zealand (Nwadike & Wilkinson, 2020) and antecedents and consequences of public procurement non-compliance behaviour (Tukamuhabwa, 2012).

The Nigerian construction industry is dominated by informal activities which often do not follow laid down procedures (Ezema and Olatunji, 2018). The industry's activities cannot be fully monitored due to the informality of their operations. As a result, quality breaches in the materials standards abound, with several structural failures leading ultimately to building collapse. A recurring theme is that lives are lost during simple, routine work. In many cases, an apparent lack of planning and compliance of construction materials with standards contributed to the tragedy (Ruya et al., 2017). Safety and safeguarding of life have been lacking in the Nigerian construction industry (Ndirangu, 2009). An underlying belief is that many accidents are not caused by careless workers but by poor adherence to materials standards and control, which ultimately is the responsibility of management (Ruya et al., 2017). Often collapses are attributed to several factors, including poor quality of materials and construction processes. In this respect, concrete, as an important structural component, deserves research attention if the challenges posed by building collapse (Ezema and Olatunji, 2018) are to be comprehensively addressed.

2.2 Concrete materials' standards: components, types, grades, and strength

Arayela and Adam (2001) stated that the first thing to question whenever any civil structure fails is the quality/strength of the concrete in it. The strength of any building component made of concrete depends on its two major components, reinforcing steel bars and concrete (Nwankwojike et al., 2014). Concrete is a composite material mostly used in building projects (Arum, 2008). It is a manufactured building material comprising cement, fine aggregates, coarse aggregates, and water with optional additives for improving performance. Concrete is the most versatile structural material that offers the flexibility of form not found in other structural materials (Ezema and Olatunji, 2018). It is composed of coarse granular material implanted in a hard matrix of material (cement or binder) that fills the space among the aggregates and binds them together (Gashemi, 2017; Arum, 2008). Alternatively, concrete can be said to be a compound material that consists of a binding medium, entrenched particles or fragments of aggregates. When freshly mixed, concrete tends to be flexible, therefore, can be used to form any shape.

The most common types of concrete in building projects are plain and lightweight concrete, which consists of natural minerals like pumice and Scotia and artificial minerals like expanded shales and clay with a density of less than 1920kg/m3 (Adewole et al. 2015). Others are high-density concrete, also called heavy-weight concrete and ranges in density between 3000 - 4000kg/m3. It is prepared using reinforcement and high-density crushed rocks as coarse aggregates (Ezema and Olatunji, 2018). This is also called Reinforced Cement Concrete (RCC). Steel in various forms is used as reinforcement to give varying high tensile strengths, and precast concrete refers to numerous shapes cast into moulds in a factory or at the site (Adewole et al. 2014). After placement, concrete gains strength quickly, particularly within the first seven days, which is crucial for achieving the needed strength. For determining the strength of concrete, the compressive strength at 28 days is usually considered (Arum, 2008). Ezema and Olatunji (2018) also stated that the strength of concrete primarily depends on the quality of constituent materials, namely cement, aggregates, and water.

Portland cement is one of the most common building materials on the building site. As stated earlier, cement acts as a binding agent in concrete (Odigure, 2009). Cement grade is a significant factor that contributes to concrete quality (Olanitori, 2011). It is essential in determining the compressive strength of concrete. The cement grades used generally for concrete production in Nigeria are grades 32.5, 42.5 and 52.5 (Kashim, 2014). The Standards Organisation of Nigeria (SON) approves grade 32.5 for plastering work and grade 42.5 for general concrete works, while the 52.5 grade is for special projects (Ezema & Olatunji, 2018). Adewole et al. (2014) investigated the effects of these cement grades on concrete compressive strength. The investigation indicated that the compressive strength of concrete produced with cement grade 42.5 is typically higher than that produced with grade 32.5. If the standard 1:2:4 concrete mix is to be utilised, the least cement grade would be 42.5. Adewole et al. (2014) noted that surveys supervised by the Standard Organization of Nigeria (SON) found that, during the construction of most privately-owned buildings, where concrete trial mixes were not conducted, the standard 1:2:4 mix ratio was used irrespective of the cement grade/strength class. The survey further disclosed that when concrete cubes were made with Portland cement grade 32.5 using 1:2:4 and 1:1.5:3 mix ratios, the compressive strengths were less than the 25 megapascals (MPa) and 30MPa cube strengths which are generally recommended for building superstructures and foundations respectively.

Anigbogu and Anunike (2014) discovered that ordinary Portland cement packaged in 50kg bags was found to vary from 35kg to 45kg in 53% of the shops surveyed. This wide variation in the weight of cement bags may contribute to the poor strength of work items where such cement bags are used. Nwankwojike et al. (2014) analysed different cement samples using methods of physical tests and conformity criteria for hydraulic cement specified by Indian Standards (IS 4031:1988), British Standards (BS 4550-3.4:1978) and European Standard (EN 197-1 2011). The results revealed that the respective fineness of the cement samples conforms with the standard specification of 10% maximum. However, the average specific gravity of the cement samples investigated was below the standard value of 3.1 minimum.

Contrary to general expectations, the 32.5 grade of some cement samples meant for lightweight construction exhibited higher concrete strength than the 42.5 grade of other cement samples designed to construct load-bearing superstructures. This is unexpected because the Standard Organization of Nigeria alleged that the two major grades of Portland cement used in Nigeria (32.5N/mm 2 and 42.5N/mm 2) are only being misapplied in some instances (Etim, 2014). In line with Enno and Mohsin (2001), the study concluded that all the five brands of Portland cement samples used for the study are short of international standards, and substandard 42.5-grade cement constitutes one of the major causes of the high rate of storey-buildings collapse in Nigeria (Nwankwojike et al., 2014).

Water is the main element of the concrete mix and plays a vital role in the chemical reaction of cement and aggregates (Roy, 2015). The quality and quantity of water used in concrete are also important. Roy (2015) asserts that the quality of hardened concrete is strongly impacted by the proportion of water used in concrete, as it influences compressive and flexural strength, permeability, and workability of concrete, as well as the bond between concrete and reinforcement. Odusote & Adeleke (2012) found that from the test carried out on reinforcement bars collected from collapsed buildings, the brittleness of reinforcement caused by the presence of high concentrations of sulphur and phosphorous with Iron (II) sulfide (FeS) and Iron phosphide (Fe_3P) present (harmful materials) may have been responsible for many collapses of buildings in Nigeria. In a similar study, Bamigboye et al. (2019) discovered that the material's inherent flexibility had been significantly altered and compromised, which invariably aided the collapse of the buildings. Fine aggregates serve the purpose of filling the open spaces in between the coarse particles by reducing the porosity of the final mass. In some cases, granite quarry dust is often partially traded for sand in varying percentages to achieve satisfactory concrete strengths. This helps to reduce the intensity of sand mining which has adverse environmental implications (Ezema and Olatunji, 2018).

2.3 Factors influencing compliance with concreting materials national standards

Compliance with national standards in the construction industry is influenced by factors that may be intrinsic or extrinsic (DiMaggio and Powell, 1983). Tabish and Jha (2015) identified common factors influencing compliance: familiarity, monitoring, professionalism, sanctions, perceived inefficiency, and contractors' resistance. Mwelu et al. (2018) observed that non-compliance is induced by; self-interest, weak enforcement mechanisms, inefficient regulatory frameworks, and unprofessional conduct. Zadawa et al. (2015) concluded that misconceptions and unfamiliarity with procurement policies relatively undermined compliance in the Nigerian construction industry. Where building laws and regulations exist to achieve effective development control (Ezema and Olatunji, 2018), construction implementations still fall short of expectations because of unethical contract practices coupled with a weak regulatory framework (Longtau et al., 2016; Fernandez, 2014).

Another major challenge of the industry is the preponderance of informal activities. According to the International Labour Organisation (ILO), the informal sector in Sub-Saharan Africa, of which Nigeria is prominent, is globally regarded as the largest concentration of informality (ILO, 2002). The implication is that many industry activities are not completely captured in national economic accounting. This situation presents a considerable challenge to public programme planning and implementation. In Nigeria, this informality translates to a lack of regulations and is also primarily responsible for the high rate of building collapse (Ezema and Olatunji, 2018). Windapo and Rotimi (2012) had earlier attributed the major factors of building collapse to structural failure, poor supervision, workmanship, and use of substandard materials. Such factors characterise the Nigerian informal building and infrastructure procurement systems, eventually influencing non-compliance with standards. However, it is pertinent to note that most collapsed buildings are residential, procured in the unregulated system, calling on governments and professional bodies to act promptly for the safety of lives and property.

2.4 Effects of Non-compliance with National Standards on Building Projects Delivery

The effects of non-compliance with national standards have significantly depleted the effectiveness of the Nigerian construction industry. Lind and Brunes (2014) reported that non-compliance of construction materials and processes to standards in the public sector leads to extra cost and waste of time in procurement. Dei (2016) identified the effects of non-compliance with national standards on building project delivery to include accidents on site, loss of lives, decrease in productivity, project delay, and excess expenditure in the form of compensation. Building project research shows that Nigeria has experienced consistent building failures and collapses owing to non-compliance with prescribed standards. For example, 64 buildings collapsed between 1974 and 2011. These collapsed buildings reported include a guesthouse at Ikotun-Egbe, Lagos State, on 12th September 2014 and a three-storey building housing a school at Ita-Faaji, Lagos-Island, Lagos State. It is noteworthy that faulty designs and improper supervision, the leading cause of non-compliance of the approved construction materials to standards, predominantly caused these collapsed buildings in Lagos State. Incidences of collapsed buildings in Nigeria are only moderately recorded in literature; there has been persistent collapse of buildings in all parts of the country, but more in the civic areas in large numbers. This is why more failures have been recorded in Lagos State than in any other part of the federation (Windapo and Rotimi, 2012; Ebehikhalu and Dawam, 2014).

3. Research Methodology

3.1 Study Area

Lagos State in South-western Nigeria is the country's commercial nerve centre, which hosts many reputable consultancy and construction companies. As mentioned, the State has witnessed more building collapses than any other part of Nigeria (Ebehikhalu and Dawam, 2014). This study describes respondents' opinions on compliance with national standards regarding concreting materials forming the load-carrying elements in buildings.

3.2 Questionnaire design

A quantitative research strategy based on primary data considered suitable for the study was adopted (Cloete, 2002). According to Quinlan (2011), quantitative research usually involves gathering numeric data systematically. On that note, a structured questionnaire, an effective data collection instrument for measuring respondents' opinions and attitudes, was used (Van Laerhoven et al., 2004). The survey questionnaire was close-ended, which offers easy and relatively quick analysis (Kothari and Gary, 2004).

The questionnaire was developed based on the literature review's constructs and divided into two parts. Part 1 was designed to gather data on the respondents' academic and professional profiles, as well as respondents' experience in the construction industry. Part 2, used in collecting data on the study's objectives, was divided into three sections. Section one examined compliance with concreting materials national standards. Section two assessed construction site-based factors influencing compliance with standards of concreting materials and procurement-based factors affecting compliance with national standards. Section three sourced data on the effects of non-compliance with national standards on building project delivery. According to Leedy and Ormrod (2014), Likert-type or frequency scales use fixed-choice response formats designed to measure opinions. For compliance with concreting materials national standards, the assessment was such that 1= Very low, 2= Low, 3= Moderate, 4= High and 5= Very high. For construction site-based factors influencing compliance with standards of concreting materials and procurement-based factors affecting compliance with national standards, 1= Very insignificant, 2= Not significant, 3= Significant, 4= More significant and 5= most significant. For effects of non-compliance with national standards on building project delivery, 1= Very insignificant, 2= Not significant, 3= Significant, 4= More significant and 5= Most significant.

3.3 Questionnaire administration and response rate

The study's target populations were construction professionals in consultancy and contracting organisations in Lagos State. Mouton and Prozensky (2001) indicated that the availability of data, population size, and balance between cost and the desired accuracy could significantly influence the sampling frame. For this reason, randomisation was employed to ensure an unbiased sample. Sixty randomly selected construction professionals comprising practising architects, engineers/site supervisors, and quantity surveyors formed the sample size. Each respondent was chosen entirely by chance, not biased systematically, and each member of the population had the same chance of being included in the sample (Kothari and Gary, 2004). Sixty structured questionnaires were self-administered on the randomly selected practising architects, engineers, and quantity surveyors. Forty (40) valid copies, which represent a response rate of 66.67%, were returned and considered adequate for analysis since Idrus and Newman (2002) recommend a minimum of 30.0% rate for construction management studies.

Cronbach Alpha was used to test the reliability of the responses provided for the study objectives. Since the Likert scale was adopted for the study, it was imperative to calculate and report Cronbach's Alpha coefficient for internal consistency and reliability of the scales. Cronbach's Alpha ranges between 0 and 1. The closer the coefficient is to 1 the higher the internal consistency of the items in the Likert scale. Bonett and Wright (2015) stated that Cronbach's Alpha (α) > 0.6 is adequate. The Cronbach's Alpha for compliance of concreting materials to national standards, construction site-based factors influencing compliance with standards of concreting materials, procurement-based factors influencing compliance with national standards, and effects of non-compliance with national standards on building projects delivery are 0.878, 0.632, 0.875, and 0.803 respectively. This implies that the responses provided are reliable for carrying out this research.

3.4 Factor analysis

Factor analysis is typically used to explore the underlying structure of the set of variables as the influence factors in this research. The study used the technique to reduce the factors to manageable components. There are three main steps in conducting factor analysis – step (i) assessment of the suitability of the data for factor analysis. The data was first assessed for suitability of use of factor analysis. It includes the Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy and Bartlett's test of sphericity. The KMO index ranges from 0 to 1, with 0 .6 suggested as the minimum value for a good factor analysis (Tabachnick and Fidell, 2007; Oboirien, 2019). The value of the KMO (0.672) test is shown in Table 1, indicating the data obtained were sufficient for factor analysis, and Bartlett's test of sphericity (0.000) was very significant.

Table 1: KMO and Bartlett's Test for Factors Influencing Compliance with National Standards

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.672
Bartlett's Test of Sphericity	Approx. Chi-Square	412.825
	Df	190
	Sig.	.000

Step (ii) factor extraction involves determining the smallest number of factors that best represent the interrelationships among the set of variables. There are a variety of approaches that can be used to identify (extract) the number of underlying factors or dimensions. The most commonly available extraction technique is principal components. According to Field (2005), for factor analysis to yield precise and reliable results and to proceed to the factor extraction stage, only factors with an eigenvalue of 1.0 or more are retained for further investigation. Eigenvalues greater than 1.0 was the criterion on which factor extraction was based.

Step (iii) factor rotation and interpretation. Once the number of factors has been determined, the next step is to try to interpret them. To assist in this process, the factors were 'rotated'. This does not change the underlying solution. Instead, it presents the pattern of loadings in a manner that is easier to interpret—the rotation shows which variables clump together. From the content of the variables, component interpretations were proposed. The 20 procurement factors influencing compliance with standards were reduced to six principal components. The cumulative percentage of variance, as explained by the six components, accounted for 75.99%. This shows that six components can account for 75.99% of the common variance shared by the 20 variables. The obliquely rotated components matrixes of the six major components with their nomenclature and loading factors are presented in Table 5. SPSS version 20 was used in the analysis.

3.5 Kruskal-Wallis's test

Kruskal-Wallis's test is used to determine the difference in the opinions of the groups of respondents. The Kruskal-Wallis H test (sometimes also called the "one-way ANOVA on ranks") is a rank-based nonparametric test that can be used to determine if there are statistically significant differences between two or more groups of an independent variable on a continuous scale or ordinal dependent variable (Ostertagova et al., 2014). It is considered the nonparametric alternative to the one-way ANOVA and an extension of the Mann-Whitney U test to allow the comparison of more than two independent groups. Kruskal-Wallis's influences, effects, factors' ranks, and response opinions are shown in Tables 3, 4, 5, and 7. SPSS version 20 was used in the analysis.

4. Data Analysis

4.1 Profile of the respondents

The results of the analysis are presented in Table 2. The profiles of the respondents comprise their organisations, highest academic qualifications, professional affiliations, years of experience, and several projects participated in in the last five years. Most respondents (70.0%) work in contracting firms, while (30.0%) work in consultancy. On the highest academic qualifications of the respondents, about (75.0%) were First degree holders, (22.5%) were Higher National Diploma (HND) holders while (and 2.5%) had other academic qualifications. Of the profession, engineers/ site supervisors had the highest representation (45.0%), followed by quantity surveyors (40.0%). However, the least proportion of respondents were architects (15.0%). Professionally, 45.0% of the respondents were registered with the Nigerian Society of Engineers (NSE), about (40.0%) with the Nigerian Institute of Quantity Surveyors (NIQS), and (15.0%) with the Nigerian Institute of Architects (NIA). More than half of the respondents (55.0%) had more than ten years of experience in the construction industry. Respondents' years of experience in the industry fall into a modal class of 10-15 years on an average of 8 projects. It can be seen from the above analysis of respondents' profiles that they possessed adequate qualifications and experience to supply reliable data for this research.

4.2 Findings and discussions

4.2.1 Compliance of concreting materials to national standards

Results of the evaluation of compliance with concreting materials' national standards are presented in Table 3. Five of the identified factors have mean scores (MS) ranging from 3.50 and 4.30. Highest compliance is reported on a 0.45:0.60 water/cement ratio with 4.30 MS. This is followed by cement grade (42.5) with an MS of 3.65, reinforcement grade 3.60 MS, aggregates grading 3.53 MS and reinforcement grade 40 for concreting with an MS of 3.50.

The significant compliance of the water/cement ratio could be due to the concrete placement mode (usually by head pan) and satisfactory workability. Good water/cement ratio concretes are easier to place in formwork and workable. When concrete complies with the water-cement ratio standard, it prevents seepages through joints in the formwork. This result agrees with Roy (2015), who opined that the water/cement ratio is the ratio of the mass of water to the mass of cement added to concrete and found that the quality of hardened concrete is strongly impacted by the proportion of water used in the concrete; as it influences compressive and flexural strengths, permeability, workability and the bond between concrete and reinforcement. As posited by Adewole et al. (2014) and Ezema and Olatunji (2018), the Standards Organisation of Nigeria (SON) approves grade 32.5 for plastering, grade 42.5 for general concretes and grade 52.5 for special projects. Cement grade also ranks high, probably due to varied grades of cement and manufacturers' specifications.

Table 2: Profile of the Respondents

Respondents' Profile	Frequency	%
Nature of the organisation		
Contracting firms	28	70.0
Consultancy firms	12	30.0
Total	40	100.0
Highest academic qualification of respondents		
OND/HND	9	22.5
B.Sc/B.Tech	30	75.0
Others	1	2.5
Total	40	100.0
Professional affiliation of respondents		
NIA	6	15.0
NEWS	16	40.0
NSE	18	45.0
Total	40	100.0
Years of experience the respondent in the construction industry		
0-5	6	15.0
5-10	12	30.0
10-15	5	12.5
15-20	4	10.0
Above 20	13	32.5
Total	40	100.0
Mean= 13.75 years		
Number of projects involved within the last five years		
1-5	10	25.0
5-10	11	27.5
10-15	3	7.5
15-20	3	7.5
Above 20	13	32.5
Total	40	100.0
Mean= 13 projects		

This result concurs with Adewole et al. (2014), who concluded that the compressive strength of concrete produced with grade 42.5 is typically higher than that of cement grade 32.5. The ranks of grade 60 reinforcement for concreting, aggregates grades and grade 40 reinforcement for concreting should be due to their importance in structural stability. Structural failures are difficult and expensive to correct; hence engineers avoid them in construction (Ruya et al. 2017).

Five materials whose compliances rank low are 12mm HY reinforcement bar for slabs 3.27 MS, 12mm HY reinforcement bar for concrete in foundation 3.17 MS, superplasticisers as concrete admixtures 3.13 MS, 16mm high yield (HY) reinforcement for beams and 8mm HY reinforcement as stirrups 2.92 MS and cement types (Ordinary Portland Cement) with 2.82 MS. The insignificant compliances of 12mm HY reinforcement bars for slabs and 12mm HY reinforcement bars for concrete in the foundation could be explained by the usual substitution of 12mm bars with 10mm bars by contractors who see little or no difference in the strength impact of the two sizes. This is usually among quacks that rely on experiences from previous similar projects where stability was achieved and sustained. This finding aligns with Olanitori (2011), who linked building collapse to the inappropriate placement of steel reinforcement. Many professionals in the industry rarely use admixtures except in extreme situations; this could account for using superplasticisers as concrete admixtures. Kruskal Wallis test was used to assess the difference in the opinion expressed by respondents on concreting materials compliance with national standards. The result shows no significant difference ($p \geq 0.05$) in their opinion.

4.3 Assessment of construction site-based factors influencing compliance with standards of concreting materials

The ranking and Kruskal Wallis test of construction site-based factors influencing compliance of concreting materials to standards are shown in Table 4. The overall ranking of 12 factors out of the identified 16 have mean scores ranging from 3.50 to 4.88. This implies that these 12 factors were more significant in influencing compliance with standards of concreting materials. However, the topmost five significant factors that influence compliance with standards in the materials are site quality control 4.88 MS, non-adherence to concrete mix ratio 4.82 MS, supervision by local authorities 3.83 MS, use of low cement grade 3.82 MS, and use of uncertified construction supervisors 3.78 MS ranking 1st, 2nd, 3rd, 4th, and 5th respectively. The least five significant factors are non-compliance with aggregate size 3.5 MS, non-compliance with reinforcement grade 3.45 MS, use of poor-quality materials 3.35 MS, polluted and unclean water 3.35 MS, artisans-based supervisions only

3.03 MS whose ranks are 12th, 13th, 14th, 15th, and 16th respectively.

Site quality control ranks high among the factors because actual executions occur on-site. Using standard-based specifications notwithstanding, if site production falls below the design, product quality becomes low. Poor product quality control has been identified in the informal construction sector. Previous research has drawn a relationship between the informal procurement routes and building collapse in Nigeria (Ebehikhalu & Dawam, 2014; Fagbenle and Oluwunmi, 2010). Although the construction industry differs from manufacturing, quality control is primarily used in manufacturing. Due to the free market nature of the Nigerian construction industry and the myriad of informal building and infrastructure procurement activities, construction sites using unskilled labour as quality controllers or officers are prevalent. This finding agrees with Ezema and Olatunji (2018) and Ruya et al. (2017), who identified the preponderance of informal activities in the construction industry as a significant factor and contributor to quality compromise.

Non-adherence to the specified concrete mix also ranked high, reflecting quality compromise, poor workmanship and lack of adequate technical expertise prevalent in most Nigerian construction sites. Many private clients and contractors usually do not engage professionals in construction projects. As an important constructional element, the type of concrete and the compressive or tensile strengths required determine the mix ratio and cement grade specified by the structural engineer. This finding agrees with Akinyemi et al. (2016), who observed that poor concrete mixes during construction result in weak load-bearing elements, eventually leading to collapses.

The use of low-grade cement and uncertified construction supervisors also rank high, reflecting the disposition of both clients and contractors to tow the paths of least resistance and embark on corner cuttings. Many clients are unwilling to purchase the right quality and quantities of the needed construction materials. Several contractors engaged in such unprofessional acts by cutting corners for profit maximisation. Ezema and Olatunji (2018) noted that the strength of concrete primarily depends on the quality of the constituent materials, namely; cement, aggregates, and water for mixing. Local authorities must uphold the public's interest and ensure compliance with statutory requirements.

In this study, the extent of supervision by local authorities again ranks high. This could be because of the state of the construction's public service, which is plagued by inefficiency, corruption, and kickbacks exhibited by members of the tendering board, contractors and their employees. This is corroborated by Longtau et al. (2016), who opined that construction implementation falls short of expectations due to unethical practices and weak regulatory frameworks.

As stated in the methodology, Kruskal Wallis was used in testing the difference in the opinions of groups of respondents. The result shows that 15 of the 16 identified factors had p-values greater than 0.05, implying that the respondents' opinions on the fifteen factors were not significantly different. However, there was a significant difference (p-value = 0.010) in the respondents' opinion regarding one of the factors, which was 'the use of uncertified construction supervisors.

4.4 Procurement-based factors influencing compliance with national standards

The results of the assessment of the procurement factors influencing compliance of the concreting materials to national standards are presented in Table 5. The overall ranking of the identified 20 factors has mean scores of between 3.12 and 3.72. The topmost five significant factors are procurement policies 3.72 MS, construction methodology 3.72 MS, professionalism 3.63 MS, inefficient regulatory framework 3.62 MS, and networking 3.62 MS. The least five significant factors are inadequate funding 3.26 MS, procurement stakeholders' training 3.26 MS, labour skills 3.20MS, supervision 3.13 MS and familiarity with regulatory framework 3.12 MS.

Procurement policies comprising ignorance, misconceptions, and unfamiliarity are rife in the informal procurement routes in the Nigerian building industry. This means that several building site participants are not conversant with the procurement policy. Hence, compliance becomes an arduous task. This could explain why procurement policy ignorance ranks highest among the most significant influence factors. This concurs with Zadawa et al. (2015), DiMaggio and Powell (2015), and Tabish and Jha (2015), who identified procurement policies as a significant factor influencing compliance with the standard of materials.

Construction methodology ranks high because it is a vital part of the method statement and an important document to the contractor. Project success hinges on the adopted construction methodology; unfortunately, many contractors skip the preparation and use of construction methodology. Construction methodology is vital for meeting compliance with materials standards because it considers risks, constraints, opportunities, and legal and contractual requirements.

Professionalism ranks high as it greatly influences compliance with standards. It comprises codes of conduct and professional ethics, which observance is mandatory for various professionals. Moreover, the status, methods, characters and standards expected of professionals align with national standards. Embracing professionalism by construction professionals enhances their production compliance with standards. This agrees with the findings of Hemström et al. (2017), who noted professionalism as a significant factor influencing compliance with standards.

Also, ranking high is an inefficient regulatory framework (system of regulations and means of work enforcement that are inefficient). This results from weak enforcement by the appropriate authority (Ruyaet al., 2017). The current regulatory framework in Nigeria results in professional supremacies (conflicts) due to inadequacy in the boundary specifications of the various professionals’ responsibilities (Grimshaw, 2001). Ruya et al. (2017) and Mwelu et al. (2018) noted that self-interest, weak enforcement mechanisms, inefficient regulatory framework, and unprofessional conduct induce non-compliance.

Kruskal Wallis test was used to assess whether there is a statistically significant difference in the respondents' opinions. The result shows that the twenty factors had p-values greater than 0.05, which implies that the respondents are unanimous in their opinion.

4.5 Variables reduction

The total variances explained by the 20 variables evaluated are shown in Table 6. An eigenvalue greater than 1.0 was the criterion on which the factor analysis was based. Procurement factors influencing compliance with standards were reduced to six (6) principal components. The cumulative percentage of variance, as explained by the six components, accounted for 75.99%. This shows that six components can account for 75.99% of the common variance shared by the 20 variables. The rotated components matrixes of the six major components with their nomenclature and loading factors are presented in Table 6. As shown in Figure 1, the scree plots revealed the variables with an Eigenvalue of 6.196%, which accounted for 30.981% of the observed variance.

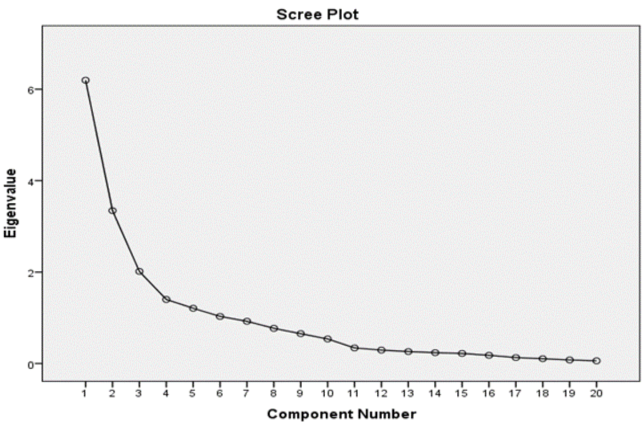

Figure 1: Scree Plot of Factors Influencing Compliance with National Standards

Technical-related factors explained 30.98% of the overall variance. The component is clustered with "faulty design" (0.538), "construction methodology" (0.775), "contractor's resistance" (0.882), "nature of the material" (0.661) and "ambiguity" (0.817). The significance of "contractor's resistance" explained to a greater extent the horrible experience that occurred when regulatory rules were not strictly adhered to. Deviations from structural engineering drawings and specifications as provided expose the client to financial risk and could cause major defects in the building project. The finding on "contractor's resistance" agrees with DiMaggio and Powell (1983), who identified contractor's resistance as a common factor affecting compliance in different fields. The ambiguity, which described the inability of the contractor or the supervisor to clearly understand what regulatory policies and contract documents stipulate before embarking on the project, agrees with Mwelu et al. (2018) that the regulatory framework should be written in plain language for clear translation.

Regulation-related factors explained 16.72% of the overall variance, and it consists of "familiarity with the regulatory framework" (0.782), "inefficient regulatory framework" (0.741), "monitoring" (0.847) and "professionalism" (0.709). The finding concurs with Mwelu et al. (2018) that non-compliance is induced by; inefficient regulatory framework and unprofessional conduct. Olayiwola and Adeleye (2005) also found the non-availability of an efficient regulatory framework and lack of a long-term policy plan for infrastructure development as key factors to non-compliance with standards. The Nigerian building industry faces an inefficient regulatory framework that undermines compliance with national standards.

Procurement-related factors explained 10.08% of the overall variance. The component is clustered with "misconception" (0.717), "procurement policies" (0.882), "weak enforcement mechanisms" (0.662), "self-interest" (0.702) and "inadequate funding" (0.559). The significance of "procurement policies" explains the extent of procurement policies made by the government to harmonise other existing government rules and strategies by regulating standards and formulating the legal framework guiding compliance. Consistency of government in regulations change in Nigeria almost with changes in administrations is supported by the results of Opawole et al. (2016). Thus, deliberate changes in procurement policies affect professionals' compliance with national standards. This finding concurs with Zadawa et al. (2015), which concluded that in Nigeria's public construction sector, misconception and unfamiliarity with procurement policies critically undermined compliance. Also, Mwelu et al. (2018) observed that non-compliance is significantly induced by self-interest and weak enforcement mechanisms. Forsythe (2015) and Isaac and Navon (2014) observed that continuous monitoring of construction projects enhances output by taking corrective actions that will boost compliance in procurement systems.

Capacity-related factors explained 7.10% of the overall variance. This comprises networking (0.695), supervision (0.741) and procurement stakeholder's training (0.854). The extent of supervision of building projects determines the efficiency of output. The study reveals that lack of supervision at the construction site is the cause of poor building project delivery, which couldalso lead to variations in the project cost. This finding agrees with the Public Procurement and Disposal of Public Assets Authority (PPDAAuthority, 2016), which suggested that training and instilling ethical standards among procurement stakeholders boost professionalism. This could be achieved via academic qualifications, skills, and networking.

Table 3: Compliance of concreting materials to national standards

S/N	Factors	Overall			Contracting firm group			Architectural and Quantity Surveying consulting group			Engineering consulting firm group			KW Sig.
		Mean (MS)	SD	Rk	Mean	SD	Rk	Mean	SD	Rk	Mean	SD	Rk	
1	Water/Cement ratio (0.45:0.60	4.30	1.60	1	4.06	1.31	1	4.00	0.89	2	4.94	7.31	1	0.080
2	Cement grade used (42.5)	3.65	1.10	2	3.42	0.89	9	3.88	1.31	3	3.39	0.98	3	0.276
3	Reinforcement grade: grade 60 for concreting	3.60	1.55	3	3.01	1.93	14	4.19	1.17	1	2.94	1.63	14	0.051
4	Grades of aggregates (Well-graded aggregates)	3.53	1.09	4	3.50	0.97	6	3.56	1.21	7	3.39	0.98	3	0.621
5	Reinforcement grade: grade 40 for concreting	3.50	1.32	5	3.37	1.38	10	3.63	1.26	5	3.17	1.34	8	0.214
6	28 days curing period for 25N/mm2 compressive strength	3.48	1.13	6	3.83	0.98	3	3.50	1.21	9	3.33	1.14	5	0.608
7	Concrete Mix (1:2:4)	3.47	1.11	7	3.33	1.21	11	3.56	1.15	6	3.44	1.1	2	0.865
8	Size of aggregates: 20mm diameter for coarse aggregates	3.38	1.28	8	3.50	1.52	7	3.56	1.26	8	3.17	1.25	6	0.610
9	16mm HY reinforcement for columns and 10mm HY reinforcement as stirrups	3.35	1.49	10	4.00	1.55	2	3.38	1.54	12	3.11	1.45	11	0.431
10	Use of HY reinforcement bar for construction	3.35	1.39	9	3.83	1.60	5	3.44	1.50	11	3.11	1.23	10	0.423
11	4.75mm diameter for fine aggregates	3.33	1.46	11	3.50	1.76	8	3.44	1.46	10	3.17	1.43	9	0.792
12	12mm HY reinforcement for slabs	3.27	1.32	12	3.83	1.17	4	3.19	1.52	15	3.17	1.20	6	0.534
13	12mm HY reinforcement for concrete in the foundation	3.17	1.43	13	3.17	1.60	13	3.25	1.34	14	3.11	1.53	12	0.975
14	Superplasticisers as concrete admixtures	3.13	1.34	14	3.17	1.47	12	3.69	1.25	4	2.61	1.24	16	0.068
15	16mm HY reinforcement for beams and 8mm HY reinforcement as stirrups	2.92	1.46	15	2.67	1.63	15	2.94	1.61	16	3.00	1.33	13	0.889
16	Types of cement (Ordinary Portland Cement)	2.82	1.04	16	2.33	0.82	16	3.25	1.13	13	2.61	0.92	15	0.093

SD = Standard Deviation, Rk = Rank, KW Sig. = Kruskal Wallis Significance

Table 4: Construction site-based factors influencing compliance with standards of concreting materials

S/N	Factors	Overall			Contracting firm group			Architectural and Quantity Surveying consulting group			Engineering consulting firm group			KW Sig.
		Mean (MS)	SD	Rk	Mean	SD	Rk	Mean	SD	Rk	Mean	SD	Rk	
1	Quality control on site	4.88	1.42	1	4.98	1.28	1	4.69	1.56	1	3.61	1.38	9	0.925
2	Non-adherence to concrete mix by workmen	4.82	1.25	2	4.95	0.91	2	4.69	1.59	1	3.56	1.34	12	0.994
3	The extent of supervision by local authorities	3.83	1.08	3	3.97	1.08	6	3.69	1.08	6	4.06	1.11	1	0.317
4	Use of low cement grade	3.82	1.26	4	3.83	1.35	8	3.81	1.17	4	3.83	1.43	4	0.942
5	Use of wrong professionals for supervision	3.78	1.10	5	3.18	1.24	11	4.38	0.96	3	3.50	1.04	13	0.010*
6	Nature of consistent materials	3.72	1.20	6	4.33	0.82	4	3.50	1.37	8	3.72	1.13	6	0.388
7	Non-compliance with reinforcement bar size	3.65	1.33	7	2.83	0.98	13	3.81	1.17	4	3.78	1.52	5	0.179
8	Absence of sanctions for professionals for non-compliance	3.60	1.32	8	2.83	1.17	14	3.50	1.41	9	3.94	1.21	2	0.183
9	Cost of concreting materials	3.57	1.45	9	3.83	1.17	7	3.44	1.50	10	3.61	1.54	10	0.869
10	Absence of sanctions for labour for non-compliance	3.53	1.43	10	4.17	1.60	5	3.19	1.56	14	3.61	1.24	7	0.282
11	Level of training of labour	3.53	1.43	10	2.83	1.60	15	3.31	1.49	12	3.94	1.26	3	0.201
12	Non-compliance with aggregate size	3.50	1.41	12	3.50	1.05	9	3.44	1.55	11	3.56	1.46	11	0.952
13	Non-compliance with reinforcement grade	3.45	1.65	13	3.17	2.04	12	3.56	1.55	7	3.44	1.69	14	0.932
14	Non-use of quality materials	3.35	1.42	15	4.50	0.84	3	3.25	1.24	13	3.06	1.59	16	0.090
15	Lack of test of water	3.35	1.33	14	3.17	0.98	10	3.13	1.50	15	3.61	1.29	8	0.535
16	Dependence on artisans only for supervision	3.03	1.27	16	2.50	0.55	16	3.12	1.46	16	3.11	1.28	15	0.695

SD = Standard Deviation, Rk = Rank, KW Sig. = Kruskal Wallis Significance, *KW Significant factors with p-value ≤ 0.05

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Table 5: Procurement-based factors influencing compliance with national standards

		Overall			Contracting firm group			Architectural and Quantity Surveying consulting group			Engineering consulting firm group			
S/N	**Factors**	**Mean (MS)**	**SD**	**Rk**	**Mean**	**SD**	**Rk**	**Mean**	**SD**	**Rk**	**Mean**	**SD**	**Rk**	**KW Sig.**
1	Procurement policies	3.72	1.18	1	3.63	1.03	9	3.81	1.33	6	3.67	1.09	1	0.834
2	Construction methodology	3.72	1.21	2	3.37	1.20	13	4.07	1.22	1	3.44	1.10	5	0.229
3	Professionalism	3.63	1.37	3	3.76	1.23	1	3.50	1.51	14	3.39	1.34	9	0.125
4	Inefficient regulatory framework	3.62	1.30	5	3.30	1.31	17	3.94	1.29	3	3.39	1.34	9	0.419
5	Networking	3.62	1.17	4	3.43	1.17	12	3.81	1.17	5	3.44	1.15	6	0.657
6	Monitoring	3.60	1.17	6	3.83	1.17	3	4.00	0.89	2	3.17	1.30	15	0.126
7	Ethical standards	3.60	1.41	7	3.83	1.47	5	3.88	1.41	4	3.28	1.41	13	0.374
8	Contractor's resistance	3.55	1.22	9	3.83	1.17	3	3.44	1.59	16	3.56	0.86	3	0.839
9	Faculty design	3.55	1.06	8	3.33	0.82	14	3.75	1.24	8	3.44	0.98	5	0.533
10	Perceived inefficiency	3.55	1.43	10	3.50	1.76	10	3.81	1.38	7	3.33	1.41	12	0.598
11	Self-interest	3.53	1.26	12	3.83	0.98	2	3.56	1.55	12	3.39	1.09	7	0.653
12	Ambiguity	3.53	1.24	11	3.33	1.03	16	3.75	1.39	9	3.39	1.20	8	0.500
13	Misconception	3.50	1.38	13	3.67	1.63	7	3.31	1.58	18	3.61	1.15	2	0.855
14	Weak enforcement mechanism	3.49	1.21	14	3.83	0.98	2	3.60	1.45	11	3.28	1.07	13	0.503
15	Nature of materials	3.30	1.20	15	3.50	0.84	10	3.44	1.26	15	3.11	1.28	16	0.674
16	Inadequate funding	3.26	1.21	16	3.00	0.63	18	3.53	1.30	13	3.11	1.28	16	0.598
17	Procurement stakeholders' training	3.26	1.60	17	3.67	1.63	7	3.33	1.63	17	3.06	1.63	18	0.689
18	Labour skills	3.20	1.49	18	3.33	0.82	14	2.75	1.84	20	3.56	1.25	4	0.400
19	Supervision	3.13	1.44	19	3.67	1.21	6	3.19	1.47	19	2.89	1.49	19	0.493
20	Familiarity with the regulatory framework	3.12	1.40	20	3.00	1.67	19	3.63	1.26	10	2.72	1.36	20	0.148

SD = Standard Deviation, Rk = Rank, KW Sig. = Kruskal Wallis Significance.

Table 6: Factor Loading Points

Component	Loading	Total	% of variance	Cumulative %
Component 1: Technical-related factors		6.196	30.981	30.981
Faulty design	0.538			
Construction methodology	0.775			
Contractor's resistance	0.882			
Nature of materials	0.661			
Ambiguity	0.817			
Component 2: Regulation-related factors		3.345	16.723	47.704
Familiarity with the regulatory framework	0.782			
Inefficient regulatory framework	0.741			
Monitoring	0.847			
Professionalism	0.709			
Component 3: Procurement-related factors		2.015	10.076	57.779
Misconception	0.717			
Procurement policies	0.882			
Weak enforcement mechanism	0.662			
Self-interest	0.702			
Inadequate funding	0.559			
Component 4: Capacity-related factors		1.402	7.010	64.789
Networking	0.695			
Supervision	0.741			
Procurement stakeholders' training	0.854			
Component 5: Performance-related factors		1.210	6.048	70.837
Ethical standards	0.821			
Perceived inefficiency	0.756			
Component 6: Skill-related factors		1.031	5.154	75.990
Labour skills	0.803			

Table 7: Effects of Non-compliance with National Standards on Building Projects Delivery

S/N	Effects of Non-compliance	Overall			Contracting firm group			Architecture and Quantity Surveying consulting group			Engineering consulting firm group			KW Sig.
		Mean (MS)	SD	Rk	Mean	SD	Rk	Mean	SD	Rk	Mean	SD	Rk	
1	Rework	3.97	3.25	1	4.61	1.60	1	3.33	1.50	10	4.67	4.50	1	0.724
2	Extra cost of rework	3.87	1.27	2	3.86	1.23	8	3.88	1.31	1	3.83	1.30	2	0.968
3	Late project delivery	3.74	1.29	3	3.61	1.22	12	3.87	1.36	2	3.61	1.34	4	0.772
4	Major defects in the building	3.68	1.27	4	3.61	1.54	13	3.75	1.00	3	3.56	1.42	5	0.847
5	Damage to the environment	3.60	1.37	5	3.70	1.37	10	3.50	1.37	8	3.56	1.46	6	0.746
6	Collapse of structures	3.55	1.43	6	4.17	0.98	3	3.63	1.36	5	3.28	1.60	8	0.469
7	Cost schedule implementation resulting from rework	3.51	1.36	7	4.00	1.27	6	3.07	1.49	14	3.72	1.23	3	0.249
8	Workmen's compensation increase	3.45	1.41	8	4.50	0.84	2	3.19	1.56	12	3.33	1.33	7	0.124
9	Government fines	3.32	1.31	9	4.00	1.27	6	3.44	1.26	9	3.00	1.33	12	0.252
10	Reduction in the Nation's GDP	3.31	1.44	10	4.00	1.10	5	3.53	1.51	7	2.89	1.41	13	0.251
11	License termination	3.30	1.76	11	3.50	1.98	14	3.75	1.53	4	2.83	1.86	15	0.381
12	Material wastage	3.28	1.49	12	4.17	1.60	4	3.06	1.53	15	3.17	1.38	9	0.263
13	Poor productivity	3.13	1.59	13	3.80	1.64	9	3.19	1.56	12	2.89	1.64	14	0.574
14	Image tarnishing	3.10	1.37	14	3.17	1.60	15	3.19	1.52	11	3.00	1.24	11	0.924
15	Partial disability of site workers resulting from structure collapse	3.08	1.47	15	3.67	1.51	11	2.87	1.59	16	3.06	1.39	10	0.496
16	Loss in revenue	3.07	1.51	16	2.83	1.47	16	3.56	1.41	6	2.72	1.57	16	0.252

SD = Standard Deviation, Rk = Rank, KW Sig. = Kruskal Wallis Significance.

Performance-related factors explained 6.048% of the overall variance. It comprises ethical standards (0.821) and perceived inefficiency (0.756). Concerning ethical standards, if continuous training and codes of professional ethics are significant factors among the stakeholders, a breach of ethical standards reduces and enhances contractor compliance with national standards. This concurs with Hemstromet al. (2017), who concluded that contractors could influence project output via professional skills.

Skill-related factors explained 5.15% of the overall variance. It is only clustered with labour skills (0.803). It emerged that the skill of the labour force employed on a building project impacts the outcome. Thus, a gang of skilled labour should be used where efficient building project delivery is paramount to the contractor and the client.

4.6 Assessment of effects of non-compliance with national standards in building projects delivery

The results of the assessment of the effects of non-compliance of materials for concreting components to standard on building project delivery are shown in Table 7. The 16 variables evaluated have 3.00 and above MS. This is interpreted as either significant or very significant in the assessment scale. The top five significant effects are rework 3.97 MS, rework cost 3.87 MS, late project delivery 3.74 MS, major defects on building 3.68 MS, and damage to the environment 3.60 MS. The least effects are also rated high; materials wastage 3.28 MS, poor productivity 3.13 MS, image tarnishing 3.10 MS, building collapse-induced accidents 3.08 MS and revenue losses 3.07 MS.

Rework as the effect of non-compliance with standards in the Nigerian construction industry is supported by the findings of Yusuf (2016) and Doloi et al. (2012). They identified rework as a significant contractor-related effect influencing construction project delivery and, eventually, a time overrun factor. Reworks are necessitated by poor performance, which in the first instance, is evidence of non-compliance with standards. The high ranking of rework cost reflects its financial implications, which Lind and Brunes (2014) found as an effect of non-compliance with the standard that lead to cost overrun and project delay. Project delivery behind schedule also ranked high, presumably because of extra time needed to remedy defects resulting from the use of sub-standard materials. Studies such as Yusuf (2016), Ameh and Osegbo (2011) and Aibinu and Odeyinka (2006) found project delay a common occurrence in the Nigerian construction industry. Non-compliance with concreting materials translates to poor quality structural members resulting in a building collapse, which is supported by the findings of Babatunde and Opawole (2009), and Ezema and Olatunji (2018).

Kruskal Wallis test was used to assess the difference in the opinions of the respondents on the effects of non-compliance with standards. The result shows no statistically significant difference ($p \geq 0.05$) in the respondents' views. This implies that respondents hold the same opinion on all the measured variables' effects on non-compliance with national standards in building project delivery.

5. Conclusion

The incessant cases of building collapse with its attendant devastating impacts, which have generated a lot of concerns, have been attributed to non-compliance with standards in the construction of buildings' structural components. Concrete members being major structural parts of buildings, therefore, necessitated the need to evaluate compliance with concreting materials to standards. This study evaluated the factors that influence compliance with standards of materials used for producing concrete elements. The study found that construction site-based and procurement factors influence concreting materials' compliance with standards in the study area. The site-based top factors are production quality control, non-adherence to the specified concrete mix, local authorities' supervision, low cement grade, and use of uncertified construction professionals for supervision. Others are water/cement ratio, cement grade, aggregates grading, grade 60 reinforcement for concreting, and grade 40 reinforcement bars. Low compliance with admixtures and cement types standards was found. The procurement-based factors are current procurement policies, construction methodology, professionalism, and inefficiency of the regulatory framework. Procurement factors influencing the extent of compliance of concreting materials to national standards enabled were compressed using the factor analysis technique. Six components were extracted; technical, regulation, procurement, capacity, performance, and skill component-factor, which relate to contractors, regulatory bodies, and construction professionals.

Finally, the effects of non-compliance with national standards found and ranked are reworked, the extra cost of rework, project delivery delay, remarkable building defects, and damage to the environment. The study provided implications for quality building production through improved compliance of concreting materials to national standards. Therefore, the study recommends that efficient regulatory policies and enforcement mechanisms be implemented to ensure compliance with national standards for concrete elements. These can be achieved and sustained through frequent training, sensitisation and instilling ethical standards among professionals by professional institutions such as the Nigerian Society of Engineers (NSE), Nigerian Institute of Building (NIOB), Nigerian Institute of Architects (NIA) and Nigerian Institute of Quantity Surveyors (NIQS).

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