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Perceived Effects of Prevalent Errors in Contract Documents on Construction Projects

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Abstract

One of the highly rated causes of poor performance is errors in contract documents. The objectives of this study are to investigate the prevalent errors in contract documents and their effects on construction projects. Questionnaire survey and 51 case study projects (mixed method) were adopted for the study. The study also involved the use of Delphi technique to extract the possible errors that may be contained in contract documents; it did not however constitute the empirical data for the study. The sample of the study consists of 985 consulting and 275 contracting firms that engaged in the construction of building projects that were completed between 2013 and 2016 and were above the ground floor. The two-stage stratified random sampling technique was adopted for the study. The data for the study were analysed with descriptive and inferential statistics (based on Shapiro-Wilk's test). The results of the study indicate that errors in contract documents were moderately prevalent. However, overmeasurement in bill of quantities was prevalent in private, institutional and management procured projects. Traditionally procured projects contain 68% of the errors in contract documents among the procurement methods. Drawings contain the highest number of errors, followed by bill of quantities and specifications. The severe effects of errors in contract documents were structural collapse, deterioration of buildings and contractors' claims among

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others. The result of the study implies that, management procurement method is the route to error minimization in developing countries, but it may need to be backed by law and guarded against overmeasurement.

Keywords

Construction projects, contract documents, effects of errors, project performance, prevalent errors.

Introduction

The construction industry is an important part of any nation as it contributes immensely to the growth and development of such nations (Dang and Low, 2011). However, the industry has been battling with perennial problems of poor performance (cost, time and quality differentials); thereby reducing its input in the economies of those nations (Aibinu and Jagboro, 2002). Poor project performance has continually led to the frustration of many clients (Love, Edwards and Han, 2011), profit marginalization for contractors, disputes, loss of confidence and reputation for consultants and eventual discouragement of investment in construction projects (Mohammed, 2007).

The causes of poor project performance are multifaceted and were categorized into project-related, procurement-related, project management-related, project participants-related and external factors-related (Puspasari, 2005). However, among the sub-factors in this categorization, errors in contract documents have rated highly as one of the prominent causes of poor project performance (Ade-Ojo and Babalola, 2013). This was supported by Mohammed (2007) who noted that errors in contract documents are the major reasons why construction projects are not completed within budgeted cost, scheduled time and prescribed quality. Okuntade (2014) affirmed that errors in contract documents account for more than 82% of all construction errors. Ade-Ojo and Babalola (2013) and Mukaka, Aigbavboa and Thwala (2014) noted that errors in contract documents are the major factors affecting the cost and time performance of building projects. Therefore, there is the need for a study on how errors in contract documents may be minimized, especially in developing countries.

About eighty-seven (87) causes of errors in literature were attributed to contract documents. Dosumu, Idoro and Onukwube (2017) found that errors in contract documents are due to frequent design changes by clients, lack of adequate time to prepare contract documents and design management experience among others. Other causes are lack of consistency (Norman, 1983), reusing of notes and details of similar projects, wrong assumptions of standard practice, inexperience, lack of clarity and poor co-ordination (Palaneeswaran, Ramanathan and Tam, 2007), unreliable and incompetent staff, and acceptance of low design fee (Love, Edwards and Han, 2011). Although, Dosumu and Adenuga (2013) noted that error entails different meanings depending on how it is conceptualized; Love, Edwards and Irani (2008) described it as an unintended deviation from acceptable standard. With these definitions, error in contract documents may be defined as any unintended deviation from the acceptable standards during the preparation of contract documents (architectural drawings, structural drawings, specifications, and bills of quantities among others).

Contract documents include drawings (architectural, structural, mechanical and electrical), bills of quantities, specifications, contract forms and conditions, all addenda, modifications and changes, bidding requirements, project quality management plan, construction programme,

project health and safety plan and contractors' all-risk-insurance (Hill, 1986; Federal Republic of Nigeria, 2006; Mohammed, 2007) that are used for executing construction projects. For this study, the contract documents investigated are drawings (structural and architectural), specifications and bills of quantities. These are the main documents prepared by construction consultants. Other documents either have templates or are standard documents.

Researchers (Barkow, 2005; Palaneeswaran, Ramanathan and Tam, 2007; Vrouwenvelder, Holicky and Sykora, 2009) have worked on the causes, effects and remedies of design errors in contract documents. These researches have not yielded much result, as errors in contract documents are still prevalent and their effects on construction projects are equally grave. This condition may be due to the scarcity of research that classified errors into different types and that most have been non-empirical in nature. Consequently, the determination of the prevalent types of errors in contract documents and their effects on projects is being inhibited. Babalola and Idehen (2011), Olaniyan (2011) and Okuntade (2014) clearly stated that errors in contract documents are the major reasons why construction projects are plagued with disputes, waste, variation and project abandonment among others. What is unclear in the studies are the prevalent errors in the contract documents that contributed to the problems identified.

This study postulates that, without determining the prevalent errors in contract documents, it may be difficult to prevent their effects on construction projects. This is because the exact errors to be mitigated during the production of contract documents would remain obscure to construction project designers and consultants. Therefore, this study investigates the prevalent errors in construction contract documents and their effects on construction projects. Moreover, a study of prevalent errors in contract documents is extremely important, not only to complement the few existing studies in the area but also to determine its severe effects on construction projects. Therefore, the research problem to be solved by this study is the investigation of the prevalent errors in contract documents and their perceived effects on construction projects. The objectives of the study are to: (1) determine the prevalent errors in contract documents based on organizational profile, sector of projects, types of project and procurement methods; (2) investigate the frequency of errors in contract documents; and (3) determine the perceived effects of errors in contract documents on construction projects.

Literature Review

Farinloye et al. (2010) and Memon, Rahman and Azis (2011) worked on the factors responsible for cost and time overrun of construction projects and the result of the study showed that design related issues are prominent. However, the prevalent design related issues that affect construction project performance were not probed further. Babalola and Idehen (2011) and Amiruddin et al. (2012) noted that variations are a result of errors and changes in design by consultants. Issues not addressed by these studies were the prevalent errors in the contract documents investigated and their effects on projects. Hence, this study focuses on the investigation of the prevalent errors in contract documents and their effects on construction projects.

Many studies on error in contract documents failed to classify them into different categories and the few studies that classified them did not use empirical methods. Saurin, Formoso and Cambraia (2008) classified errors generally (not errors in contract documents) into non-intentional errors and violation. In the same vein, Atkinson (1999) classified error into latent and active error. Latent errors are undiscovered errors that exist while active errors are discovered and treated errors. Lopez et al. (2010) noted that design errors can occur at

the level of people, project and organization. Hence, design error was classified into skill/performance based, violation/non-compliance, and rule/knowledge-based design error. Lee, Barnes and Hardy (1983) noted that errors can be classified into slips, lapses, rule-based mistakes and knowledge-based mistakes; however, types of errors were identified as errors of omission and commission. Errors of omission and commission were further divided into intentional and unintentional omission and commission which form the basic classification of Saurin, Formoso and Cambraia (2008). Airbus (2005) believed that errors of commission and omission are not types but classification of errors. Mason (2001) stated that slips and lapses, mistakes and violations are the three classes of human errors.

The problem with these classifications is that, apart from being based on non-empirical studies, they are generally too broad, thus making it difficult to place errors in contract documents under any single class. For instance, errors in design calculations can easily be placed under mistake, slip, lapses or violation. Therefore, a more concise classification is required to capture and classify errors in contract documents. Lee, Barnes and Hardy (1983) expatiated that human errors have four categories which are: error of omission, error of commission, sequential error and time error. This exposition has added sequential and time error to error of commission and omission that was recognised by Airbus (2005).

A distinct opinion emerged, when Love, et al. (2009) and Love, Edwards and Han (2011) noted that mistakes, slips, lapses and omissions are neither types of error nor classifications but reasons for the occurrence of errors. The types of errors according to Ortega and Bisgaard (2000) were insufficient knowledge, underestimating influences, ignorance, carelessness, negligence, forgetfulness, errors, relying on others, unknown situations, unclear definition of responsibilities, communication, and selection of low quality items. These errors were not classified. From the literature reviewed, it appears there is a lack of consensus on how errors could be universally classified as there are many discordant discussions by authors on the subject. This may be related to the claim of Dosumu and Adenuga (2013) that error entails different meanings in diverse fields, depending on how it is conceptualized. This was confirmed by Allchin (2009) who noted that errors are generally field-specific.

Error is not peculiar to the construction industry, it cuts across many disciplines including the medical sector (Rooney, Heuvel and Lorenzo, 2002), plant operation and maintenance (Chen-Wing and Davey, 1998), Psychology (Reason, 2000), software implementation (Chapman, 1991), artificial intelligence (Rauterberg and Felix, 1996), industrial robotics (Lee, Barnes and Hardy, 1983), aviation (Shappell and Wiegmann, 1997) and science (Allchin, 2009) to mention a few. As a result, it is uncertain that any single classification can satisfy all the fields of its occurrence. Even in the building construction industry errors can be experienced at the design and construction phase. Therefore, there is the need to contextualize the classification of errors in contract documents.

In view of this, Mohammed (2007) identified 23 types of error in construction documents and categorized them into five namely; erroneous action, omissions, failure to conform to design parameters, failure to follow procedures and coordination problem. This classification was not sectionalized according to construction documents. It however accommodated the errors that could possibly occur in various contract documents. Love and Zhou (2012) investigated documentation errors in instrumentation and electrical systems and found that errors can be classified into seven, namely; incorrect labelling, inconsistent labelling, drawing omissions, incorrect connections, cable schedule omissions, wrong design and missing labels. An examination of these error classifications indicates that they are drawings and specifications related. The problems with the classification of Mohammed (2007) is that, it is

possible to have an error in construction documents fitting into one or two of the categories at the same time. For example, failure to conform to design standard on any of the design rules may be due to omission of the rule or intentional failure to follow design procedure. In the case of Love and Zhou (2012), only electrical and instrumentation errors were classified thus, making the classification completely unsuitable for this study.

Juszczyk et al. (2014) classified errors in contract documents using three methods namely; according to place of occurrence (documents), person responsible for the error and the type of error. These classifications would have suited errors in contract documents if they captured all possible errors in major construction documents. However, the study only classified discrepancy, number of information and errors in designing into technical description, drawings and calculations. Also, only architects, investors and discipline-specific designers (collectively considered) were captured. Hence, the study failed to consider errors in bill of quantities which is a major document that can determine the success or failure of any project. Peansupap and Ly (2015) classified design errors according to construction trades which include architectural, structural, plumbing and electrical works. This classification did not also consider important contract documents such as specifications and bill of quantities; it however indicated the possibility of classifying design errors according to contract documents. Hence, the summary of the literature reviewed is that, design errors may be classified according to the field of discipline and the interest of the researcher(s). Hence, this study builds on the classifications of Juszczyk et al. (2014) and Peansupap and Ly (2015) to classify errors in contract documents according to the documents that produced the errors. Therefore, error in this study was classified into errors in contract drawings (architectural and structural), errors in specifications, errors in bill of quantities and coordination error (error relating to conflict among the contract documents).

Lastly, none of the literature reviewed for this study investigated the prevalent errors in the documents they examined and their effects on construction projects. This is a necessary study especially in developing countries like Nigeria where building collapse, wastages and construction-related deaths occur on a regular basis. Moreover, as the focus of research and practice is shifting from the iron triangle performance criteria of cost, time and quality performance to sustainable design and construction, it is good for developing countries to move with the times and quickly overcome the challenges of errors in contract documents and their effects on construction projects.

Table 1 summarizes the authors, error types, classifications of errors, construction documents examined and remarks about the classifications. From Table 1, it is evident that, there is no generally acceptable classification for errors in contract documents. While the developed countries may claim to have found solution to errors in their contract documents using error minimization strategies such as Building Information Modelling (BIM), lean technologies and so on, developing countries like Nigeria still have errors in contract documents bedevilling its construction industry. Lack of uniformity in the classification of errors in contract documents may have inhibited the identification of the prevalent errors in those documents and consequently their effects on construction projects. Developing countries have many challenges with adopting modern technologies (Sahil, 2016) to absorb design related problem. Therefore, there is a need to classify errors in contract documents, determine the prevalent ones among them and investigate their effects on construction projects.

Research Method

The questionnaire survey, case study projects and Delphi techniques (mixed research method) were used to execute this research. The adoption of the mixed research method was necessitated to take advantage of the enablement of data triangulation it offers among other benefits. The research area was the southwestern part of Nigeria. South-west, Nigeria consists of six (6) states which include Lagos, Ogun, Oyo, Osun, Ondo and Ekiti States. These states had many construction activities going on, especially Lagos State which is the economic hub of Nigeria. Lagos State is currently transforming into a mega city and fortunately, the five other neighbouring states share part of the development of Lagos State. Therefore, for effective research on a study of this nature, it was wise to pick the states in the Southwest ahead of others. The population of the study consisted of contracting and consulting firms in Southwest, Nigeria that were engaged on building projects above the ground floor and completed between 2013 and 2016. The consultants' opinions were required because they prepared the contract documents of construction projects. The opinions of contractors were required because they make use of the documents prepared by consultants and they discover the errors in them. Projects between 2013 and 2016 were selected to ensure that the projects used for the study were recent. This ensured that the errors in contract documents and the effects discovered were equally recent. The list of contracting firms (contractors' sampling frame) was collated from the Federation of Construction Industry (FOCI) and states tender boards of the six states. There were situations where companies appeared in both sources; therefore, a unified list was prepared to take care of repeatedly listed firms. Hence, 275 contracting firms (sampling frame for contracting firms) were collated from the six states.

Table 1 Classification of construction-related errors based on previous studies

Author	Number of errors identified	Classification of errors	Documents investigated	Remarks
Peansupap and Ly, 2015	-	Structural works, electrical works, plumbing works and architectural works	Structural, electrical, plumbing and architectural drawings	This study considered important contract documents. It however, did not consider contract specifications and bill of quantities. There is the need to combine the similar classifications according to contract documents in this study. The study is not empirical hence, could not depict prevalent errors in contract documents

Table 1 continued

Juszczyk, et al., 2014	-	Discrepancy in design, no information, incorrect/ incomplete information, error in designing	Technical description, Drawings and calculations	This study did not investigate some important documents such as errors in bill of quantities. Also, there are some errors in contract documents (e.g. estimating error) that do not fall into any of these classifications. Lastly, Investigation is not empirical
Love and Zhou, 2012	-	Incorrect labelling, inconsistent labelling, drawing omissions, incorrect connections, cable schedule omissions, wrong designs and missing cables.	Instrumentation and electrical system drawings	The document investigated is grossly insufficient to be used for this study in any capacity. Many of the classifications can be combined, e.g. labelling error can take care of two of the classifications. The same goes for omission
Saurin, Formoso and Cambraia, 2008	-	Intentional and violation error	-	This classification of errors is not related to construction but safety operations. However, the items, although not adequate can be adapted to construction contract documents.
Mohammed, 2007	23	Difficulty in buildability, erroneous actions, omission, failure to conform to design parameters, failure to follow procedure and coordination problem	-	No document was investigated; some of them were only mentioned during the discussion of the 23 listed error types. Besides, some of the errors like for example, errors in bill of quantities are too broad. Some of the error types may be amalgamated, e.g. incorrect notes and error in specification.

Table 1 continued

Airbus, 2005	-	Error of omission, commission, sequential and timing	-	This classification of errors is not related to construction but flight operations. However, the items, although not adequate can be adapted to construction contract documents.
Atkinson, 1999	-	Latent and active errors	-	This classification is too general and needs to be further broken down to the level of contract documents for easy identification and treatment
Lee, Barnes and Hardy, 1983	-	Slips, lapses, rule-based and knowledge-based mistakes	-	The classification is generic and needs to be broken down to the level of contract documents for easy identification and treatment.

The list of consulting firms (consultants' sampling frame) used for this study was obtained from the directories of professional/regulatory bodies such as the Architect Registration Council of Nigeria/Nigerian Institute of Architects (ARCON/NIA), Council of Registered Builders of Nigeria/Nigerian Institute of Building (CORBON/NIOB), Quantity Surveyors Registration Board of Nigeria/Nigerian Institute of Quantity Surveyors (QSRBN/NIQS) and the Council for the Regulation of Engineering/Nigerian Society of Engineers (COREN/NSE). Hence, the consulting firms used for this study were 986 (128 Building firms, 369 Engineering firms, 166 Quantity Surveying firms and 323 Architectural firms respectively). Thus, the samples for this study were 275 building contracting and 986 consulting firms. The sampling technique adopted for the study was the two-stage stratified-random sampling technique. The first stratum was the consulting and contracting firms and the second was the categorisation of consulting firms into architecture, building, engineering and quantity surveying.

In addition, to obtain quantitative data on the frequency of errors in contract documents, 51 case-study building projects were selected and the contractors (16), project managers (18) and consultants (17) of those projects were interrogated on the frequency of errors and the documents affected. The convenience (Non-probabilistic) sampling technique was used to select the case study projects based on suitability of the projects and availability/willingness of the respondents to provide the required information. The project documents were examined in cases where clarity was required during discussions with the respondents before placing the errors into categories. The average working experience of the respondents was eight years with a minimum of Bachelor's degree in built environment courses like building, architecture, quantity surveying and civil/services engineering. The interview guide was sent to all respondents via email or by hand before the discussions so that they can get the necessary information required before discussions.

The purpose of collecting the 51 case study projects was to provide a platform for multiple perspectives to interpret results (theory triangulation) (Alzheimer, 2009). Johnson and Onwuegbuzi (2004) affirmed that the mixed research method offers complementary strength, can be used together or successively, and enables data/investigator/theory/methodical triangulation. For instance, while the data collected from case study projects was able to give quantitative data (frequency, sum and percentage) on the extent to which errors in contract documents were affected by procurement methods and types of projects; the scale of measurement of the questionnaire could only at best determine the significance of procurement methods and types of projects to errors in contract documents.

The questionnaire for the study was designed to elicit data on the background information of respondents and the building projects used for the study. The variables investigated under the prevalent types of errors in contract documents were obtained through the Delphi technique and tested on a 5-point Likert scale of 'not prevalent' (1) to very prevalent (5). Also, the severity of the perceived effects of errors in contract documents was tested on a 5-point Likert scale of 'not severe' (1) to 'very severe' (5). The validity of the questionnaire for the study was based on the vetting and contributions of both academic and professional experts in cost, procurement and construction management. Their inputs were helpful in drafting and restructuring the research instruments for the study. The reliability of the questionnaire was tested after it was first administered on the respondents used for pilot study. Thereafter, the variables under each objective (prevalent types of errors and their effects on construction projects) on errors in contract documents were then subjected to reliability test on Statistical Package for Social Scientists (SPSS) to determine the reliability of the instrument. The errors in contract documents had Cronbach's alpha of 0.926 and the effects of errors in contract documents on building projects had Cronbach's alpha of 0.897. Polit and Hungler (1985) posited that Cronbach alpha of 0.7 and above indicates higher reliability of the instrument and are therefore, generally accepted for reliable instrument.

The sample size of the study was determined with the Creative Research System (2001) formula:

$$SS = \frac{Z^2 * P * (1-P)}{C^2}$$

Where: SS = Sample size, Z = Z-value at 95% confidence level (1.96), P = probability of selecting a population member (0.5), C = Margin of error at 95% confidence level (0.05).

Hence, SS = 384.16 = 384. For sample size, the adjustment formula is:

$$SS_{new} = \frac{SS}{1 + \frac{SS - 1}{SF}}$$

Where SS is the sample size (384), and SF = the sampling frame as indicated in Table 2

Table 2 Sampling frames and sample size of questionnaire survey

LOCATION OF PROJECT	CONTRACTING FIRMS		CONSULTING FIRMS							
			ARCHITECTS		BUILDERS		ENGINEERS		QTY. SURV	
	SF	SS	SF	SS	SF	SS	SF	SS	SF	SS
Lagos	122	71	120	33	70	20	148	41	54	15
Ogun	61	36	46	13	23	6	71	20	32	9
Oyo	32	19	46	13	16	5	49	14	23	6
Osun	25	15	44	12	11	3	35	10	22	6
Ekiti	14	8	36	10	-	-	36	10	17	5
Ondo	21	12	31	9	8	2	30	8	18	5
Total	**275**	**161**	**323**	**90**	**128**	**36**	**369**	**103**	**166**	**46**

SF = Sampling frame, SS = sample size, Qty. Surv = Quantity Surveyors

Since the literatures reviewed for this study do not have a completely useable list of error types in construction contract documents especially as it relates to the study area, the Delphi technique was used to generate a list of errors in drawings, specifications and bill of quantities. Hence, two practicing academics and one industry practitioner from building, architecture, civil engineering, building services and quantity surveying were engaged to generate a possible list of error types in construction contract documents. Thus, 15 experts were responsible for generating the list of error types in contract documents that were used for the study. The list was generated based on the contract documents prepared in Nigeria. Therefore, it may be slightly different in the case of other countries. For convenience and precision, the study chose to classify errors according to the documents within which they occurred. The result of the study was analysed with frequencies, percentages, mean item score, t-test and analysis of variance.

Sample characteristics

The inferential statistics used in this study was determined by the results of the normality test that was conducted on the prevalent types of error in contract documents and effects of errors in contract documents (dependent variables) based on organizational profile, sector of project, procurement methods and types of project (independent variables). The Shapiro-Wilk's tests ($P > 0.05$) (Razali and Wah, 2011) and visual inspection of histograms, normal Q-Q plots and box plots indicate that, the prevalent types of errors and effects of errors in contract documents were approximately normally distributed across organizational profiles, sector of projects, procurement methods and types of project (i.e. Skewness and Kurtosis in all cases were within $\pm$ 1.96, and P value > 0.05) (Doane and Seward, 2011). Based on the results of the normality test, it could be assumed that the data investigated in this study were normally distributed in terms of skewness and kurtosis, hence, they were tested parametrically with t-test and analysis of variance (ANOVA) as applicable.

Data Analysis and Results

Table 3 displays the general information of respondents and their organizations. The distribution of respondents depending on their profession shows that 17.4% of the respondents were architects, 19.6% were civil/structural engineers, 30.4% were quantity surveyors, 23.4% were builders and 9.2% were electrical/mechanical engineers. Among the

contractors, respondents that were civil/structural engineers, quantity surveyors and builders were the most represented.

Table 3 General information of respondents and their organizations

	Consultant (Frequency)	Consultant (%)	Contractor (Frequency)	Contractor (%)	Total (Frequency)	Total (%)
Profession of respondents						
Architecture	15	8.2	17	9.2	32	17.4
Civil/Structural engineering	16	8.7	20	10.9	36	19.6
Quantity surveying	30	16.2	26	14.1	56	30.4
Building	15	8.2	28	15.2	43	23.4
Electrical/ Mechanical engineering	10	5.4	7	3.8	17	9.2
Total	86	46.7	98	53.3	184	100.0
Sector of project involvement						
Public	43	23.4	49	26.6	92	50.2
Private	43	23.4	49	26.6	92	50.2
Total	86	46.7	98	53.3	184	100.0
Work experience of respondents						
1-5 years	17	9.2	32	17.4	49	26.6
6-10 years	35	19.0	45	24.5	80	43.5
11-15 years	22	12.0	13	7.1	35	19.0
16-20 years	12	6.5	8	4.3	20	10.9
Total	86	46.7	98	53.3	184	100.0
Position on building project						
Architect	14	7.6	16	8.7	30	16.3
Engineer	15	8.2	29	15.8	44	23.9
Quantity surveyor	27	14.6	18	9.8	45	24.5
Project manager	16	8.7	14	7.6	30	16.3
Builder	14	7.6	21	11.4	35	19.0
Total	86	46.7	98	53.3	184	100.0
Educational qualification						
OND	3	1.6	2	1.1	5	2.7
HND/B.Sc	55	29.9	84	45.7	139	75.5
M.Sc	28	15.2	11	6.0	39	21.2
Ph.D	0	0.0	1	0.5	1	0.5
Total	86	46.7	98	53.3	184	100.0
Professional affiliation						
NIA	35	19.0	16	8.7	51	27.7
NSE	24	13.0	30	16.3	54	29.3
NIQS	16	8.7	16	8.7	32	17.4
NIOB	7	3.8	32	17.4	39	21.2
Others	4	2.2	4	2.2	8	4.3
Total	86	46.7	98	53.3	184	100.0
Type of project						
Residential	40	21.7	48	26.1	88	47.8
Institutional	20	10.9	17	9.2	37	20.1

Table 3 continued

Religious	2	1.1	2	1.1	4	2.2
Commercial	24	13.0	31	16.8	55	29.9
Total	86	46.7	98	53.3	184	100
Procurement method						
Traditional	13	7.1	18	9.8	31	16.8
Design and build	26	14.2	40	21.7	66	35.9
Management	47	25.5	40	21.7	87	47.3
Total	86	46.8	98	53.2	184	100

The respondents' organizations were equally involved in public (50%) and private (50%) sector projects. The consultants' organization were involved in 23.4% of public projects and 23.4% of private sector projects. The contractors' organizations were involved in 26.6% of public projects and 26.6% of private sector projects. Table 3 further shows that many of the respondents have sufficient experience to be involved in this study. Those with 1–5years work experience were 26.6%, 43.5% had 6-10years work experience, 19% had 11–15years work experience and 10.9% had 16–20years work experience. Also, 16.3% of the respondents were architects on the building projects used for the study, 23.1% were engineers, 24.5% were quantity surveyors, 16.3% were project managers and 19% were builders. The educational qualification of the respondents indicates that 2.7% had OND, 75.5% had HND/B.Sc, 21.2% had M.Sc, and 0.5% had Ph.D. While majority of the contractors had HND/B.Sc, a good number (15.2%) of the consultants had M.Sc. This shows that consultants go for higher academic studies that could assist their practices more than contractors. About 27.7% of the respondents were affiliated to the Nigerian Institute of Architects (NIA), 29.3% were affiliated to the Nigerian Society of Engineers (NSE), 17.4% were affiliated to the Nigerian Institute of Quantity Surveyors (NIQS), 21.2% were affiliated to the Nigerian Institute of Building (NIOB) and 4.3% were affiliated to other professional bodies. The building projects considered for the study were residential (47.8%), institutional (20.1%), religious (2.2%) and commercial (29.9%). Lastly, the traditional (16.8%), design and build (35.9%) and management (47.3%) procurement methods were used to procure the projects investigated in this study.

Table 4 shows the prevalence of errors in construction contract documents based on organizational profiles (consultants' and contractors' organization).

It also tested the difference in the perceptions of the two sets of respondents and recorded their P-values. According to consultants' organizations, only over/under measurement of items in bill of quantities (3.58) is prevalent in contract documents. Others are moderately prevalent (approximately 3.0). All the types of errors in contract documents are moderately prevalent to the contractors. The combined perception of the organizations is that all the types of errors in contract documents are moderately prevalent (mean score approximately 3.0). Also, t-test statistics show that, there is no significant difference ($P > 0.05$) in the opinions of respondents' organizations on the prevalent types of errors in contract documents. Thus, the views of the consultants and contractors are the same in this study.

Table 5 indicates the prevalent types of errors in contract documents based on the sector of projects. T-test was also used to determine the difference in the prevalent types of errors between public and private sector projects. Findings indicate that, all types of errors are moderately prevalent in public sector projects. However, over/under measurement of items in bill of quantities is prevalent (3.55) in private sector projects. T-test result shows that there is no difference in the prevalence of errors in public and private sector projects except in the case

of incomplete/inadequate specifications for construction projects (P, 0.025 < 0.05). Looking at the mean scores, it could be said that private sectors projects are more affected by inadequate/ incomplete specifications due to the higher mean value (3.09) it carries in comparison with public sector projects (2.58).

Table 4 Prevalent errors in contract documents based on organizational profile

Types of errors	Consultants	Rank	Contractors	Rank	Total	Rank	P value	Decision
Over/ undermeasurement in bill of quantities	3.58	1	3.23	2	3.39	1	0.081	Accept Ho
Dimensional errors in drawings	3.29	3	3.35	1	3.33	2	0.784	Accept Ho
Ambiguous/wrong description in specifications	3.22	5	3.17	3	3.19	3	0.801	Accept Ho
Conflicting information in drawings	3.35	2	3.04	4	3.18	4	0.129	Accept Ho
Use of wrong unit/quantity for measurement	3.23	4	3.04	4	3.13	5	0.397	Accept Ho
Omission of items in drawings	3.14	8	3.03	6	3.08	6	0.612	Accept Ho
Conflicting information in specifications	3.12	9	3.00	7	3.05	7	0.592	Accept Ho
Violation of codes, laws and regulations in drawings	3.14	7	2.96	9	3.04	8	0.344	Accept Ho
Wrong description of items in bill of quantities	3.19	6	2.80	14	2.98	9	0.071	Accept Ho
Mechanical/ Electrical symbol error	2.82	12	2.97	8	2.90	10	0.502	Accept Ho
Omission/ absence of specifications	2.88	10	2.91	11	2.90	10	0.889	Accept Ho
Omission of items in bill of quantities	2.82	12	2.93	10	2.88	12	0.571	Accept Ho
Incomplete/ inadequate specification	2.78	14	2.90	12	2.84	13	0.584	Accept Ho
Errors in design	2.83	11	2.84	13	2.83	14	0.993	Accept Ho

5= Very prevalent (VP, 81-100%), 4= Prevalent (P, 61-80%), 3= Moderately prevalent (MP, 41-60%), 2= Slightly prevalent (SP, 21-40%), 1=Not prevalent (NP, 0-20%); Cut point for prevalence = 3.5; P < 0.05= Reject Ho

Table 5 Prevalent errors in contract documents based on sector of projects

Types of errors	Public	Rank	Private	Rank	Total	Rank	P value	Decision
Over/undermeasurement in bill of quantities	3.21	1	3.55	1	3.39	1	0.088	Accept Ho
Dimensional errors in drawings	2.16	14	3.48	2	3.33	2	0.121	Accept Ho
Ambiguous/wrong description in specifications	3.05	4	3.33	3	3.19	3	0.175	Accept Ho
Conflicting information in drawings	3.08	3	3.28	4	3.18	4	0.322	Accept Ho
Use of wrong unit/quantity for measurement	3.01	5	3.24	5	3.13	5	0.285	Accept Ho
Omission of items in drawings	3.11	2	3.06	10	3.08	6	0.801	Accept Ho
Conflicting information in specifications	2.95	7	3.15	6	3.05	7	0.348	Accept Ho
Violation of codes, laws and regulations in drawings	2.94	8	3.14	7	3.04	8	0.307	Accept Ho
Wrong description of items in bill of quantities	3.01	5	2.95	11	2.98	9	0.785	Accept Ho
Mechanical/ Electrical symbol error	2.70	12	3.10	8	2.90	10	0.065	Accept Ho
Omission/ absence of specifications	2.91	10	2.88	12	2.90	10	0.892	Accept Ho
Omission of items in bill of quantities	2.93	9	2.84	13	2.88	12	0.662	Accept Ho
Incomplete/inadequate specification	2.58	13	3.09	9	2.84	13	0.025	Reject Ho
Errors in design	2.84	11	2.83	14	2.83	14	0.948	Accept Ho

5= Very prevalent (VP, 81-100%), 4= Prevalent (P, 61-80%), 3= Moderately prevalent (MP, 41-60%), 2= Slightly prevalent (SP, 21-40%), 1=Not prevalent (NP, 0-20%); Cut point for prevalence = 3.5; P < 0.05= Reject Ho

Table 6 shows the prevalent errors in contract documents based on types of projects. Analysis of variance (ANOVA) was used to determine the difference in the prevalent errors among the types of projects. The findings of the study indicate that all the types of errors are moderately prevalent in residential building projects. However, in institutional buildings, over/under measurement in bill of quantities (3.73) and dimensional errors in drawings (3.68) are prevalent. Also, use of wrong unit/quantity for measurements in bill of quantities (4.00), omission of items in bill of quantities (4.00), omission/absence of specification and dimensional errors in drawings (3.75) are prevalent in the documents of religious buildings. For commercial buildings, none of the types of errors is prevalent, it is however worthy to note that over/under measurement in bill of quantities (3.49) and conflicting information in drawings (3.47) were almost prevalent.

Table 6 prevalent errors in contract documents based on type of projects

Types of errors	Residential	Rank	Institutional	Rank	Religious	Rank	Commercial	Rank	P value	Decision
Use of wrong unit/quantity for measurement	2.91	6	3.47	3	4.00	1	3.20	5	0.173	Accept Ho
Omission of items in bill of quantities	2.61	14	3.15	9	4.00	1	3.04	9	0.036	Reject Ho
Omission/ absence of specifications	2.76	12	3.00	13	3.75	3	2.96	11	0.424	Accept Ho
Dimensional errors in drawings	3.17	3	3.68	2	3.50	4	3.32	3	0.326	Accept Ho
Conflicting information in drawings	2.99	4	3.23	7	3.25	5	3.47	2	0.245	Accept Ho
Omission of items in drawings	2.89	7	3.44	4	3.25	5	3.14	8	0.235	Accept Ho
Over/ undermeasurement in bill of quantities	3.24	1	3.73	1	3.20	7	3.49	1	0.143	Accept Ho
Violation of codes, laws and regulations in drawings	2.88	8	3.20	8	3.00	8	3.20	5	0.441	Accept Ho
Ambiguous/wrong description in specifications	3.21	2	3.03	12	2.75	9	3.30	4	0.715	Accept Ho
Conflicting information in specifications	2.96	5	3.11	10	2.75	9	3.18	7	0.799	Accept Ho
Wrong description of items in bill of quantities	2.86	9	3.35	5	2.75	9	2.94	12	0.379	Accept Ho
Mechanical/ Electrical symbol error	2.84	10	3.00	13	2.25	12	2.98	10	0.719	Accept Ho
Errors in design	2.83	11	3.09	11	1.50	13	2.78	13	0.178	Accept Ho
Incomplete/inadequate specification	2.74	13	3.34	6	1.00	14	2.77	14	0.020	Reject Ho

5= Very prevalent (VP, 81-100%), 4= Prevalent (P, 61-80%), 3= Moderately prevalent (MP, 41-60%), 2= Slightly prevalent (SP, 21-40%), 1=Not prevalent (NP, 0-20%); Cut point for prevalence = 3.5; P<0.05= Reject Ho

Analysis of variance on the prevalence of errors in contract documents indicates that there is significant difference among the types of projects on omission of items in bill of quantities (P = 0.036) and incomplete/inadequate specification (P = 0.020). This means that respondents perceived differently on the prevalence of errors in the different types of projects as it relates to both types of errors.

Table 7 Prevalent errors in contract documents based on procurement methods

Types of errors	Traditional method	Rank	Design and build	Rank	Management method	Rank	Total	Rank	P value	Decision
Over/ undermeasurement in bill of quantities	3.11	9	3.19	3	3.66	1	3.39	1	0.048	Reject Ho
Dimensional errors in drawings	3.30	1	3.27	1	3.38	2	3.33	2	0.898	Accept Ho
Ambiguous/wrong description in specifications	3.26	5	3.23	2	3.13	5	3.19	3	0.865	Accept Ho
Conflicting information in drawings	3.25	6	3.03	6	3.24	3	3.18	4	0.484	Accept Ho
Use of wrong unit/quantity for measurement	3.07	10	3.03	7	3.23	4	3.13	5	0.703	Accept Ho
Omission of items in drawings	3.30	1	2.98	8	3.08	7	3.08	6	0.574	Accept Ho
Conflicting information in specifications	2.85	12	3.05	5	3.13	5	3.05	7	0.673	Accept Ho
Violation of codes, laws and regulations in drawings	3.30	1	3.06	4	3.03	8	3.04	8	0.984	Accept Ho
Wrong description of items in bill of quantities	2.97	11	2.93	9	3.03	8	2.98	9	0.929	Accept Ho
Mechanical/ Electrical symbol error	3.14	8	2.78	11	2.89	12	2.90	10	0.537	Accept Ho
Omission/ absence of specifications	3.15	7	2.93	9	2.78	14	2.90	10	0.447	Accept Ho
Omission of items in bill of quantities	3.28	4	2.71	14	2.86	13	2.88	12	0.161	Accept Ho
Incomplete/ inadequate specification	2.58	14	2.74	12	3.00	10	2.84	13	0.363	Accept Ho
Errors in design	2.72	13	2.72	13	2.96	11	2.83	14	0.536	Accept Ho

5= Very prevalent (VP, 81-100%), 4= Prevalent (P, 61-80%), 3= Moderately prevalent (MP, 41-60%), 2= Slightly prevalent (SP, 21-40%), 1=Not prevalent (NP, 0-20%); Cut point for prevalence = 3.5; P<0.05= Reject Ho

Table 7 depicts the prevalent types of errors in contract documents based on the procurement method adopted for the projects.

Analysis of variance (ANOVA) was also adopted to determine the difference in the prevalence of errors in contract documents based on procurement method. The results of the study indicate that all the types of errors in contract documents are moderately prevalent based on all the procurement methods used in this study. However, over/under measurement in bill

of quantities was found to be prevalent in projects that were procured with the management method. Based on this, analysis of variance indicates that there is significant difference among the procurement methods on the prevalence of over/under measurement in bill of quantities (P = 0.048). This shows that there is usually over/under measurement in projects procured through the management method.

To obtain quantitative data on the number of errors in contract documents and ascertain the performance of procurement methods and types of projects with respect to errors in contract documents, 51 case study projects were examined as explained earlier. The projects considered were those whose contractors, consultants and project managers were willing to provide the required information for the study, irrespective of their confidentiality.

Table 8 summarizes the frequency of the error types identified in the case study projects of this study based on procurement methods. The findings indicate that, traditional procurement method is responsible for 68% of the total errors identified while design and build and management methods were responsible for 24% and 8% of the total errors identified respectively. This shows that, the traditional procurement method is prone and mostly responsible for most of the errors in contract documents. The traditional construction method is mostly an uncontrolled procurement method where the architect or any other professional is responsible for the design and procurement of project constructor on behalf of the client regardless of the inefficiencies of such professional. Therefore, it is not unexpected that contract documents in Nigeria are mostly characterized by errors because most contracts in Nigeria are being executed with this method. Despite the advocacy for methods that embrace quality control of contract documents, developing countries like Nigeria have continued to overwhelmingly adopt the traditional method.

Table 8 Frequency of error occurrence in contract documents based on procurement methods

Procurement Methods	Drawings	%	Bill of Quantities	%	Specifications	%	Conflicting information	%	Total	%
Traditional	95	31	54	18	35	11	23	7	207	68
Design and build	30	10	24	8	12	4	8	3	74	24
Management	8	3	9	3	5	2	1	0	23	8
Total	**133**	**44**	**87**	**29**	**52**	**17**	**32**	**10**	**304**	**100**

Table 9 indicates the frequency of error occurrence in contract documents based on the types of projects investigated. The result indicates that errors in contract documents based on type of projects are evenly spread with residential projects having 28%, institutional buildings having 23%, religious building having 14% and commercial buildings having 35%.

Table 10 summarizes the frequency of errors in the contract documents used for this study. The result of the study indicates that drawings (43.56%) have the largest frequency of errors in contract documents, followed by bill of quantities (28.65%), specifications (17.20) and coordination problem (10.6%). From the results, overcoming the problem of errors in drawings and bill of quantities could mean overcoming 72% of errors in contract documents. It appears

logical that errors in drawings will most likely translate into errors in bill of quantities and specifications.

Table 9 Frequency of error occurrence in contract documents based on type of project

Types of project	Drawings	%	Bill of Quantities	%	Specifications	%	Conflicting information	%	Total	%
Residential	39	13	23	8	14	4	8	2	84	28
Institutional	36	12	20	7	9	3	6	2	71	23
Religious	19	6	12	4	9	3	3	1	43	14
Commercial	39	13	32	10	20	7	15	5	106	35
Total	**133**	**44**	**87**	**29**	**52**	**17**	**32**	**10**	**304**	**100**

Table 10 Frequency of the types of errors in contract documents

Category of errors in Contract documents	Types of errors in contract documents	Individual frequency	Individual (%)	Category (%)
ERRORS IN DRAWINGS	Errors in design (e.g. loading error)	58	18.88	43.56
	Dimensional errors in drawings	27	8.86	
	Errors in electrical/mechanical symbol	8	2.62	
	Omission of items/details in drawings	31	10.20	
	Violation of building code, laws and regulations	9	3.00	
ERRORS IN BILL OF QUANTITIES	Over/under measurement of bill of quantities	27	8.88	28.65
	Omission of items in bills of quantities	36	11.84	
	Wrong units/quantities for measurement	15	4.93	
	Wrong description of items in bill of quantities	9	3.00	
ERRORS IN SPECIFICATIONS	Omission/ absence of specifications	16	5.27	17.20
	Ambiguous/wrong description in specifications	18	5.92	
	Incomplete/inadequate specifications	18	5.92	
CO-ORDINATION ERROR	Conflicting information in contract documents	32	10.60	10.60
	TOTAL	**304**	**100**	**100**

Therefore, it is important to tackle errors in drawings, being the first set of project documents to be prepared so that they can moderate the accuracy of specifications and bill of quantities. In practice, specifications are sometimes regarded as being inclusive of drawings because they are meant to describe symbols and specify the quality of materials to be used on a project. Hence, errors in specification could be added to errors in drawing in some instances. Therefore, if the problem of drawings and their specifications (61%) can be effectively handled, more than half of problems in contract documents will be solved.

Omissions in contract documents add up to 27.31% of error occurrence, errors in designs have 18.88% of occurrence and conflicting information in documents has 10.6%. This result can be compared with that of questionnaire survey in the sense that in both instances, omissions and conflicting information in contract documents are prevalent. Therefore, apart from identifying that drawings and bill of quantities have the most prevalent errors, attention needs to be paid to omission and conflicting information in documents among others.

Table 11 presents the severity of the perceived effects of errors in contract documents on building projects according to consulting and contracting organizations. The consultants opined that structural collapse (3.73), deterioration of building (3.72), reduced productivity (3.61), claims by contractors (3.60) and frequent design changes/variation (3.54) are the severe effects of prevalent errors in contract documents on building projects.

Table 11 Perceived effects of prevalent errors in contract documents on building projects

Effects of errors in contract documents	Consultants	Rank	Contractors	Rank	Total	Rank	P value	Decision
Structural collapse	3.73	1	3.76	1	3.75	1	0.844	Accept Ho
Deterioration of building	3.72	2	3.76	2	3.74	2	0.829	Accept Ho
Claims by contractors	3.60	4	3.58	5	3.59	3	0.885	Accept Ho
Reduced productivity	3.61	3	3.57	6	3.59	4	0.785	Accept Ho
Increased complexity	3.49	6	3.60	3	3.55	5	0.512	Accept Ho
Schedule pressure	3.48	7	3.57	6	3.53	6	0.539	Accept Ho
Death	3.46	8	3.52	10	3.49	7	0.772	Accept Ho
Unreliable progress monitoring	3.37	12	3.60	3	3.49	8	0.182	Accept Ho
Additional work	3.46	8	3.51	11	3.49	9	0.765	Accept Ho
Undiscovered rework	3.35	15	3.53	9	3.45	10	0.306	Accept Ho
Design changes/ variation	3.54	5	3.35	19	3.44	11	0.259	Accept Ho
Costly litigation/ dispute	3.38	11	3.49	12	3.44	12	0.541	Accept Ho
Design co-ordination problems	3.29	19	3.56	8	3.43	13	0.079	Accept Ho

Table 11 continued

Redesigning details that have already been designed	3.29	19	3.49	12	3.40	14	0.280	Accept Ho
Reduced profit	3.36	14	3.41	15	3.39	15	0.766	Accept Ho
Idle time	3.37	12	3.40	16	3.39	16	0.858	Accept Ho
Reduced construction process efficiency	3.40	10	3.22	23	3.36	17	0.614	Accept Ho
Wastages	3.32	17	3.36	18	3.34	18	0.810	Accept Ho
Increased project administration workload	3.25	22	3.42	14	3.34	19	0.292	Accept Ho
Increased labour and management turnover	3.28	21	3.38	17	3.33	20	0.528	Accept Ho
Disruptions	3.33	16	3.33	21	3.33	21	0.983	Accept Ho
Loss of reputation	3.30	18	3.30	22	3.30	22	0.990	Accept Ho
Increased contactor's request for information	3.14	24	3.34	20	3.25	23	0.236	Accept Ho
Abnormal use of machinery and equipment	3.24	23	3.21	25	3.23	24	0.864	Accept Ho
Social problems	3.12	25	3.20	26	3.16	25	0.666	Accept Ho
Accident, sickness and life safety problems	3.09	26	3.22	23	3.16	26	0.437	Accept Ho
Inconveniences	2.99	27	3.20	26	3.10	27	0.183	Accept Ho

>4.49 = Very severe (81-100%), 3.5-4.49 = Severe (61-80%), 2.5-3.49 = Moderately severe (41-60%), 1.5-2.49 = Slightly severe (21-40%), 1-1.49= Not severe (0-20%). Cut point = 3.5. P < 0.05 = reject Ho.

The contractors consent that structural collapse (3.76), deterioration of buildings (3.76), increased complexity (3.60), unreliable progress monitoring (3.60), claims by contractors (3.58), reduced productivity (3.57), schedule pressure (3.57), design co-ordination problems (3.56), undiscovered rework (3.53), death (3.52) and additional works are the severe effects of prevalent errors in contract documents on building projects. The respondents jointly noted that structural collapse (3.75), deterioration of buildings (3.74), claims by contractors (3.59), reduced productivity (3.59), increased complexity (3.55) and schedule pressure (3.53) are the severe effects of prevalent errors in contract documents on building projects. The result of t-test statistics indicates that there is no significant difference in the opinions of consultants and contractors on the severe effects of prevalent errors in contract documents on building projects ($P > 0.05$) in all cases.

Discussion of Findings

The study adopted the empirical data from questionnaire and case study survey to investigate 184 and 51 building projects respectively. The list of errors in construction contract documents was generated through the Delphi technique. Many of the literature reviewed for this study except Juszczyk, et al. (2014) and Mohammed (2007) were simply too broad and less specific about the types and classifications of errors in contract documents.

The study of Juszczyk et al. (2014) was basically too shallow to be solely used for this study because it only considered drawings and technical specifications. It also failed to capture all the possible errors that could occur in contract documents, thus making it an incomplete reference for this study. In Mohammed (2007), the classification of errors in construction documents was equally broad, although it managed to bring many of the listed types of errors under the classifications. The problem with the study however was that the classification gets confusing as some of the errors identified could arguably be placed under more than one classification. Hence, the need to generate a more suitable list of errors that could be used for this study and possibly in any other study. This study has particularly contributed to the scanty body of knowledge on types of errors in contract documents, their prevalence and effects on building projects.

The major findings of this study indicate that the types of errors identified in contract documents were moderately prevalent. However, over/under measurement in bill of quantities was prevalent in some of the projects. Discussions with case-study respondents indicated that over measurement is usually the case rather than undermeasurement. Further analysis revealed that over measurement is prominent in private sector projects. This result is not unexpected because public sector projects are more institutionalized in Nigeria than private sector projects. Private sector projects are mostly owned by individuals who in most cases do not follow due process before contracts are awarded. Besides, the fluctuation of material prices and instability in economic policies of developing countries including Nigeria must be acknowledged as a possible reason for this overmeasurement. In addition, a decent range of studies have noted that award of construction contracts in the public and private sector is characterized by corruption and unethical practices; therefore, this may also be a good contributor to the situation.

When the study was delineated to the level of types of projects, it was found that over/under measurement in bill of quantities and dimensional errors in drawings were prevalent in institutional buildings. Use of wrong unit/quantity for measurements in bill of quantities, omission of items in bill of quantities, omission/absence of specification and dimensional errors in drawings were prevalent in religious buildings. There may be a need to do more investigation on the reasons for the prevalence of identified errors in the types of projects implicated. However, the reasons advanced for over/under measurement may not be unconnected with these errors as well. Findings based on procurement method indicate that over/under measurement was prevalent in management procured projects. This was substantiated by inferential statistics which confirmed that there is significant difference in the prevalence of errors among procurement methods. Despite the prevalence of over measurement in management procured projects, the case study projects investigated revealed that traditional procurement method is responsible for 68% of the total errors among the procurement methods. This shows that traditionally procured projects are more prone to errors in contract documents than other procurement methods.

This is expectedly so because the method places little emphasis on due process during the design and construction of projects. Studies have shown that the management procurement method is more controlled than the traditional method but developing countries in most cases still adopt the traditional construction method for their projects. The possible interpretation of the result is that, if the traditional method is still being used, contract documents will most likely continue to be filled with errors. The study also revealed that among the documents, drawings contain the highest error, followed by bill of quantities and specifications respectively.

The study also indicated that prevalent errors are mostly responsible for structural collapse, deterioration of buildings, claims by contractors, reduced productivity, increased complexity and schedule pressure. Among these severe effects, structural collapse and deterioration are prominent in the Nigerian context. Building collapse is the order of the day as the country has recorded about 20 building collapses between Lagos and Ogun states in 2017. Religious buildings were characterized by use of wrong units/quantity for measurement, omission of items in bill of quantities, omission in specifications and dimensional errors. These errors are many and it may be due to the methods used by most religious organizations to procure their buildings. Most religious organizations in Nigeria tend to supposedly save cost by avoiding the preparation of some required documents for their buildings. They also tend to engage their members irrespective of their level of experience in construction to reduce of consultants' fees.

A typical example of a church in Nigeria (Church of all Nations), belonging to Pastor T. B Joshua collapsed in 2014 and killed 30 Nigerians, 84 South Africans and 1 Zimbabwean. The collapse was attributed to failure to introduce rigid zones for bracing the structure and did not design the frames as an unbraced structure. Eight (8) out of the 12 main beams of the structure failed because they were undersized, under-reinforced (both in tension and shear), the tension bars were poorly anchored to the column supports and 8 x Y20 was used instead of 14 x Y20 and the ground floor columns were slender and readily gave in to buckling. All these were attributed to designers. Therefore, the design and preparation of contract documents must be given serious priority to prevent the current menace of incessant building collapse in the country.

Conclusion

The study concludes that contract drawings contain the most number of errors in contract documents, followed by bill of quantities and then specifications. Furthermore, errors in contract documents are more prevalent in traditionally procured buildings, followed by design and build buildings. The management method contains the least number of errors among the procurement methods, although findings show that it is the only procurement method with overmeasurement in bill of quantities and this could sometimes be worse for cost than those without the error. Religious buildings were characterized by use of wrong units/quantity for measurement, omission of items in bill of quantities, omission in specifications and dimensional errors. Institutional buildings were characterized by over measurement and dimensional errors. Private sector projects are also prone to overmeasurement in bill of quantities. The implication of these findings is that, designers need to be more conscious during the preparation of architectural, structural, electrical and mechanical drawings. This recommendation is particularly more applicable to architectural drawings which are usually the first set of documents to be prepared and upon which other documents to be prepared are based. Errors in drawings will most likely dovetail into other documents if they go undetected at any stage of the work. Also, management procurement method, having the least number of error is an indication of its efficacy for error minimization in construction contract documents. Hence, developing countries like Nigeria may find a solution to the perennial problem of errors in contract document in the management procurement method. A balance may however be required between its demerit of overmeasurement and its merit of error minimization capability. It is therefore desirable that the adoption of management procurement method for the execution of building projects be backed by law in developing countries like Nigeria.

In addition, overmeasurement in bill of quantities is usually due to the unregularized design procedures in private and institutional projects. This lack of regularization may be due to many

government related factors, but the role of unethical practices such as corruption and kickbacks among professionals cannot also be easily ignored in the entire process. Unstable economy and fluctuation of construction materials are problems for the government to tackle if these errors are to be controlled. Therefore, government must review economic policies that relate to construction and ensure stability of prices of construction materials. This way, the myriads of problems currently faced in the construction industry will be greatly reduced. In summary, the study contributed to the existing body of knowledge by establishing the prevalent errors in various construction contract documents. This was done across organizational profiles, procurement methods, sector and type of construction projects. The severity of the perceived effects of the prevalent errors on construction projects was also determined in this study.

Having established the prevalent errors in contract documents, it is desirable that their quantitative effects in terms of cost and time performance among others be determined. This was not achieved in this study as it only examined the perceived effects of the prevalent errors on construction projects. Additionally, this study was limited to building projects alone. This precluded the possibility of comparing the prevalent errors in building projects and their effects with other types of construction projects like oil and gas, information technology and civil engineering projects among others. In view of this, it is expected that future research efforts would be directed towards investigating the prevalent errors in the contract documents of other types of construction projects and their quantitative effects on those projects accordingly.

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References

Ade-Ojo, C.O. and Babalola, A.A., 2013. Cost and time performance of construction projects under the due process reforms in Nigeria. *International Journal of Engineering and Science,* 3(6), pp.1-6

Aibinu, A.A. and Jagboro, G.O., 2002. The effects of construction delays on project delivery in Nigerian construction industry. *International Journal of Project Management*, 20(8), pp.593-99. https://doi.org/10.1016/S0263-863(02)00028-5

Airbus, 2005. *Human performance-error management*. [online] Available at: www.skybrary.aero [Accessed 12 September 2014]

Allchin, D., 2009. Error types. *Perspectives on Science,* 9(1), pp.38-58 https://doi.org/10.1162/10636140152947786.

Alzheimer, E., 2009. *Understanding Dementia Research*. [online] Available at: www.alzheimer-europe.org [Accessed 13 May 2015]

Amiruddin, I., Towhid, P., Amir, S. and Majid, G., 2012. Factors causing variation orders and their effects in roadway construction projects. *Research Journal of Applied Science, Engineering and Technology,* 4(23), pp.4969-72.

Atkinson, A.R., 1999. Project Management: Cost, Time and Quality, Two Best Guesses and a Phenomenon, its time to accept other Success Criteria. *International Journal of Project Management,* 17(6), pp.337-42 https://doi.org/10.1016/s0263-7863(98)00069-6.

Babalola, J.A. and Idehen, A.F., 2011. Causes of variation on building projects in Nigeria. In: Laryea, S., Leiringer, R. and Hughes, W. (Eds) *Proceedings of West Africa Built Environment Research (WABER) conference*. Accra, Ghana, 19-21 July 2011.

Barkow, B., 2005. *Human factors underlying building failures.* Toronto, Ontario: National Research Council of Canada.

Chapman, J., 1991. Data accuracy and model reliability. *AEESEAP Conference*. University of Canterbury, New Zealand, 8-11 December 2011.

Chen-Wing, S.L. and Davey, E.C., 1998. *Designing to avoid human error consequences* [online] Available at: http://www.dcs.gla.ac.uk/~johnson/papers/seattle_hessd/sara-p.pdf. [Accessed 24 September 2011].

Creative Research System, 2001. *Sample size formula for our sample size calculator*. [online] Available at: www.surveysystem.com [Accessed 12 September 2014]

Dang, T.H. and Low, S.P., 2011. Role of construction in economic development: review of key concepts in the past 40 years. *Habitat international*, 35(1), pp.118-25. https://doi.org/10.1016/j.habitatint.2010.06.003 https://doi.org/10.1016/j.habitatint.2010.06.003

Doane, D.P. and Seward, L.E., 2011. Measuring skewness: A forgotten statistic? *Journal of Statistics Education,* 19(2), pp.1-18 https://doi.org/10.1080/10691898.2011.11889611.

Dosumu, O.S. and Adenuga, O.A., 2013. Causes, effects and remedies of errors in Nigerian construction documents. *Organization, Technology and Management in Construction*: *An International Journal*, 5(1), pp.676-86. https://doi.org//10.5592/otmcj.2013.1.4

Dosumu, O.S., Idoro, G.I. and Onukwube, H.N., 2017. Cause of errors in construction contract documents in Southwestern, Nigeria. *Journal of Construction Business and Management,* 2(1) pp.50-62.

Farinloye, O.O., Ogunsanmi, O.E., Mafimidiwo, B.A. and Ajala, K.A., 2010. Factors affecting the time performance of building projects. *Construction Research Journal*, pp.22-41

Hill, T.L, 1986. *An introduction to statistical thermodynamics.* Addison -Wesley Publishing Company, Incorporated

Johnson, R.B. and Onwuegbuzi, A.J., 2004. Mixed methods research: a research paradigm whose time has come. *Educational Researcher*, 33(7), pp.14-20.

Juszczyk, M., Kozik, R., Lesniak, A., Plebankiewicz, E. and Zima, K., 2014. Errors in the preparation of design documentation in public procurement in Poland. *Creative Construction Conference.* Prague, Czech Republic 21 - 24 June 2014 https://doi.org/10.1016/j.proeng.2014.10.553.

Lee, M.H., Barnes, D.P. and Hardy, N.W., 1983. Knowledge based error recovery in industrial robots. In: *Proceedings of the Eighth international joint conference on Artificial intelligence - Volume 2.* Karlsruhe, West Germany. 1623570: Morgan Kaufmann Publishers Inc.

Lopez, R., Edward, D.J., Love, P.E.D. and Davis, P., 2010. Design error classification, causation and prevention in construction engineering. *Journal of Performance of Constructed facilities,* 24, pp.399-408. https://doi.org/10.1016/ASCECF.1943.5509

Love, P.E, Edwards, D.J. and Irani, Z., 2008. Forensic project management: An exploratory examination of the causal behaviour of design-induced rework. *IEEE Transactions on Engineering Management,* 55(2), pp.234-47. https://doi.org/10.1109/TEM.2008.919677

Love, P.E. and Zhou, J., 2012. *Documentation errors in instrumentation and electrical systems: towards systems information modelling*. [pdf] Perth, Western Australia: School of Built Environment, Curtin University.

Love, P.E., Edward, D.J., Irani, Z. and Walker, H.T., 2009. Project pathogens: the anatomy of omission errors in construction and resource engineering project. *IEEE Transactions on Engineering Management,* 56(3), pp.425-35. https://doi.org/10.1109/TEM.2008.927774

Love, P.E., Edwards, D.J. and Han, S., 2011. Bad apple theory of human error and building information modelling: A systemic model for BIM implementation. *Conference of the 28th ISARC*, Seoul, Korea, 29 June - 2 July 2011 https://doi.org/10.22260/isarc2011/0062.

Mason, S., 2001. Improving maintenance- reducing human error. In: Railway Safety-Papers, *The Railway Technology Conference Railtex National Exhibition Centre,* Birmingham, UK, 21-23 November 2001.

Memon, A.H., Rahman, I.A. and Azis, A.A., 2011. Time and cost performance in construction projects in southern and central regions of Peninsular, Malaysia. *International Journal of Advances in Applied Sciences,* 1(1), pp.45-52.

Mohammed, R.E., 2007. An exploratory system dynamics model to investigate the relationships between errors that occur in construction documents in Saudi Arabia and their possible causes. PhD. Heriot-Watt University School of the Built Environment, UK.

Mukaka, M.J., Aigbavboa, C.O. and Thwala, W.D., 2014. A theoretical review of the causes and effects of construction projects cost and schedule overrun. *International Conference on Emerging Trend in Computer and Image Processing.* Pattaya, Thailand 15-16 December https://doi.org/10.1016/j.proeng.2017.07.227.

Federal Republic of Nigeria, 2006. *National Building Code*. South Africa: Lexis Nexis Butterworks.

Norman, D.A., 1983. Design rules based on analyses of human error. *Communications of the ACM,* 4(26), pp.254-58 https://doi.org/10.1145/2163.358092.

Okuntade, T.F., 2014. Effects of faulty construction on building maintenance. *International Journal of Technology Enhancements and Emerging Engineering Research,* 2(3), pp.73-79.

Olaniyan, O.A., 2011. Designing out waste on mass housing construction sites in Minna, Niger state. In: Laryea, S., Leiringer, R. and Hughes, W. (Eds) *Proceedings of West Africa Built Environment Research (WABER) Conference*, Accra, Ghana, 19-21 July 2011.

Ortega, I. and Bisgaard, S., 2000. Quality improvement in the construction industry; three systematic approach. *Total Quality Management*, 11(4), pp.383-92 https://doi.org/10.1080/09544120050007689.

Palaneeswaran, E., Ramanathan, M. and Tam, C., 2007. Rework in projects: Learning from errors. *Surveying and Built Environment,* 18(2), pp.47-58.

Peansupap, V. and Ly, R., 2015. Evaluating the impact level of design errors in structural and other building components in building construction projects in Cambodia. *Procedia Engineering,* 123, pp.370-78 https://doi.org/10.1016/j.proeng.2015.10.049.

Polit, D. and Hungler, B., 1985. *Essentials of nursing research: Methods and application*. Philadelphia: Lippincott.

Puspasari, T.R., 2005. *Factors causing the poor performance of construction projects*. M.Sc. University Technologi, Malaysia.

Rauterberg, M. and Felix, D., 1996. Human errors: Disadvantages and advantages. *Proceedings of the 4th Pan Pacific Conference on Occupational Ergonomics and Industrial Engineering*, Tapei, Taiwan, 11-13 November 1996.

Razali, N.M. and Wah, Y.B., 2011. Power comparisons of Shapiro-Wilk, Kolmogorov-Smirnov, Lilliefors and Anderson-Darling test. *Journal of Statistical Modelling and Analytics,* 2(1), pp.21-33.

Reason, J., 2000. *Human error: Models and management.* BMJ [online] Available at http://www.bmj.com/content/320/7237/768 [Accessed 11 September 2016] https://doi.org/10.1136/bmj.320.7237.768 .

Rooney, J.J., Heuvel, L.N. and Lorenzo, D.K., 2002. Reduce human error. *Quality Progress,* 35(9), pp.27-36.

Sahil, A.Q., 2016. Adoption of building information modelling in developing countries: A phenological perspective. M.Sc. University of Colorado.

Saurin, T.A., Formoso, C.T. and Cambraia, F.B., 2008. An analysis of construction safety best practices from a cognitive systems engineering perspective. *Safety Science*, 46(8), pp.1169-83 https://doi.org/10.1016/j.ssci.2007.07.007.

Shappell, S.A. and Wiegmann, D.A., 1997. A human error approach to accident investigation: The taxonomy of unsafe operations. *The International Journal of Aviation Psychology*, 7(4), pp.269-91.

Vrouwenvelder, T., Holicky, M. and Sykora, M., 2009. Modelling of human Error. *Joint Workshop of COST Actions*, Ljubljana, Slovenia, 21-22 September 2009.