Assessment of Cost and Time of Errors in Construction Documents on Selected Building Projects in Nigeria

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The construction industry has generally been tagged with poor project performance. Cost and time overruns are the leading causes of poor performance. Design and construction errors are equally leading causes of cost and time overruns. The objectives of this study are to investigate the prevalent types of errors in construction documents, the cost implication of the errors, the time implication of the errors, and strategies adopted to mitigate the errors. The study involves an interview of construction professionals on 51 selected building projects across the southwestern States of Nigeria through the non-probabilistic convenience sampling technique. The findings of the study indicated that the Nigerian construction industry is largely dominated by the use of traditional procurement method and many construction projects lack complete construction documents. Also, errors in construction documents added about 9% to the contract sum and 31% to cost overrun. It also added about 21% to the agreed duration and 40% to the total time overrun. The study concluded that errors in construction documents affect project duration more than the project cost and can triple the agreed duration of building projects in some cases. The study recommended that based on the projects investigated, an additional 10% should be added to the agreed cost and 20% to the scheduled duration of building projects.

Keywords: Cost of error, construction documents, project performance, time of error, types of error

INTRODUCTION

The construction industry is an important aspect of every national economy which contributes to the national Gross Domestic Product (GDP), employment, and environmental development of the countries (Berk and Bicen, 2016). However, it has been continually plagued by poor project performance in terms of cost, time, quality, safety and sustainability criteria. Poor project performance is peculiar to many countries especially the developing ones like Nigeria (Akanni, 2015), Malaysia (Jatarona *et al.,* 2018), and India (Dixit, 2020). Among the project performance criteria, cost and time performances appear to continually be the key measures of construction project success for all stakeholders (Dosumu & Onukwube, 2013) despite the sustainability campaigns by the United Nations through the seventeen (17) Sustainable Development Goals (SDGs) (Dosumu & Uwayo, 2023).

The Nigerian construction industry remains largely dominated by the traditional procurement method which is characterised by enormous errors in construction documents (Dosumu, 2018). These errors have led to the exasperation of several clients (Love *et al*., 2011), building collapses, disputes, reduction of profit for contractors, reputation for consultants, loss of confidence and discouragement of investment in the construction industry (Mukaka, *et al*., 2014). Building collapse has had debilitating effects on the lives, properties and investments of the Nigerian populace and many of them are linked to errors in the design or construction of the projects. In 2014, the Church of all Nations collapsed in Lagos and killed 30 Nigerians, 84 South Africans, and one Zimbabwean. The collapse was attributed to the omission of the design for frames as unbraced structures (Dosumu, 2018).

In December 2016, the roof of the Reigners Bible Church International collapsed (due to poor design) in Akwa Ibom State and claimed about 160 lives (Coller & Akinloye, 2021). In March 2016, a five-story building collapsed (due to under-reinforcement) while under construction in the Lekki district of Lagos State and killed about 34 people (Nicholas, Dickson and Okeke, 2021). In March 2019, a three-story building in Lagos suffered a structural collapse and killed 20 people, leaving over 40 people trapped (Dosumu, 2018). In November 2021, a high-rise block of luxury flats in Ikoyi, Lagos collapsed under construction due to errors in frame alignment and killed about 42 people (Ayeyemi, 2021). Therefore, there is an urgent need to channel research efforts toward ameliorating the effects of errors in construction documents on the budget and duration of construction projects.

Studies (Niazi & Painting, 2017; Saidu & Shakantu, 2017) indicated that many factors influence the cost and time performance of construction projects in the form of cost and time overrun. Many of the factors attributed to poor cost and time performances were traced to errors in construction documents (Aljohani *et al*., 2017; Pham *et al.,* 2020) and some solutions for their mitigation have been proffered (Dosumu, 2018). However, the problem of poor cost and time performance seems to remain significantly unabated in construction projects, both in

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developed and developing countries (Gemada, 2012; Murwira & Bekker, 2017). There are several studies on the causes and effects of errors in construction documents (Aljohani *et al.*, 2017; Dosumu *et al*., 2017; Nasa & Space, 2018) and methods of mitigating their occurrence (Kumar, 2019). In the context of this study, the cost of error represents the total amount of money that accrues to a project due to errors in construction documents. Time of error is the total duration that accrues to a project due to errors in construction documents.

This study would complement existing studies on errors (design and construction) in construction projects. It would also assist stakeholders to know the prevalent types of errors in construction documents to determine how to effectively mitigate them. The probable cost of error and time of errors in construction documents would equally be established so that quantity surveyors/estimators, project managers, contractors and consultants could put them into consideration (rather than adopting the contingency fees) during the preparation of the project cost and duration. Therefore, the study investigates the prevalent types of errors, the cost of errors, and the time of errors in construction documents.

LITERATURE REVIEW

A project is regarded as successful if it is completed on time, within budget and to the specified quality (Odediran & Windapo, 2014; Nakhleh, 2019). Recently, projects are termed to be successful if they meet the requirements of sustainable design and construction which equally encompasses the requirements of cost, time and quality targets of the client (Dosumu & Aigbavboa, 2018). Ali and Kamaruzzaman (2010) and Dosumu and Onukwube (2013) argued that cost and time targets are the most required performance criteria for construction projects because they are tangible criteria that have quantitative, direct and visible effects on the performance of construction projects. Moreover, cost and time targets have been the subject of controversy, disputes, arbitration, litigation, project failures and abandonment (Shamsudeen & Biodun, 2016). The lack of cost and time monitoring on construction projects usually results in cost and time overruns in the construction industry (Dosumu & Aigbavboa, 2017).

Errors in construction documents are one of the top causes of cost and time overrun on construction projects and need to be appropriately mitigated to improve project performance (Ali & Kamaruzzaman, 2010; Abdullah & Azis, 2011; Memon *et al*., 2012; Fuadie *et al.,* 2017). Okuntade (2014) noted that errors in construction documents account for more than 82% of all construction errors that occur on building projects. Ade-Ojo and Babalola (2013), Mukaka *et al.* (2014) and Vashishtha, *et al.* (2020) affirmed that errors in construction documents are the major factors affecting the cost and time performance of building projects. Love *et al.* (2008) and Love *et al.* (2009), and Li and Taylor (2011) revealed that design errors can increase contract price by as much as 10-15% and omission errors account for up to 38% of total rework cost experienced in construction projects. Ndihokubwayo (2008) noted that 92% of the variations in the Australian construction industry were attributable to errors in construction documents. Dosumu (2016) indicated that error-induced deviations accounted for 16% of the total number of deviations. (Lopez et al. 2018) discovered that the mean direct and indirect costs of design error are 6.85% and 7.36% of the contract value. (Love et al. 2014) affirmed that the mean design error costs on a project's contract value are 14.2%.

The impact of error on the duration of construction projects appears to have been scarcely investigated. Many of the studies (Aibinu & Jagboro, 2002; Ogunsemi & Jagboro, 2006; Ade-Ojo & Babalola, 2013; Nasir *et al.* 2016) on time in the construction industry concentrated on the causes, effects, remedies and models of time overrun on construction projects. Aibinu and Jagboro (2002) examined the effects of delay on project delivery in Nigeria. Ogunsemi and Jagboro (2006) developed a time-cost model for predicting the duration of construction projects. Ade-Ojo and Babalola (2013) evaluated the cost and time performance of construction projects under the due process reforms in Nigeria. These studies sought to improve the time performance of construction projects without considering the impact of errors in construction documents on time overrun. Yet, error remains a leading cause of cost and time overrun on construction projects.

Errors in the construction industry have been classified into various categories and types. However, they have not been classified according to construction documents (Dosumu, 2018). Saurin, Formoso and Cambraia (2008) classified errors into non-intentional and violation errors. Atkinson (1999) divided errors into undiscovered and discovered errors. Lee *et al.* (1983) categorised errors into lapses, slips, knowledge-based mistakes and rule-based mistakes. Lopez *et al.* (2010) classified errors into, violation/non-compliance, skill/performance-based, and rule/knowledge-based design errors. The problem with these classifications is that they are broad and makes it difficult to place errors in construction documents under any single class. For example, a single error may be classified under mistake, slip, lapses or violation. Therefore, a more concise classification is required to capture and classify errors in construction documents.

Lee *et al.* (1983) noted that human errors can be classified as commission, omission, time, and sequential error. Airbus (2005) believed that errors of commission and omission are not types but a classification of errors. Ortega and Bisgaard (2000) claimed that underestimating, insufficient knowledge, carelessness, ignorance, negligence, forgetfulness, relying on others, unclear definition of responsibilities, unknown situations, communication, and selection of low-quality

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items are the types of errors in the construction industry. Love *et al.* (2009) and Love *et al.* (2011) noted that slips, mistakes, omission, and lapses are reasons for error occurrence rather than being types or classifications of errors. From the literature reviewed, it is apparent that there is no unanimous agreement on how errors could be classified. This may be linked to the assertion of Dosumu and Aigbavboa (2018) that error has different meanings to different people depending on how it is perceived. Allchin (2009) buttressed this by stating that error is field-specific. Therefore, it is not certain that a single categorisation can fit error. Even in the construction industry, errors may be experienced at any phase of a project and hence, difficult to classify. Therefore, there is a need to contextualize the classification of errors in construction documents.

Mohammed (2007) identified 23 types of error in construction documents and categorized them into erroneous action, omissions, failure to conform to design parameters, failure to follow procedures and coordination problems. This classification is equally ambiguous because a single error can fall into more than one classification. Juszczyk *et al.* (2014) classified errors in construction documents according to the place of occurrence (documents), the person responsible for the error and the type of error. This classification however did not capture all the possible errors in the construction documents; it considered only technical descriptions, drawings and calculations. Hence, the study did not consider errors in the bill of quantities which is a major document for project cost performance. Peansupap and Ly (2015) classified design errors into architectural, structural, plumbing and electrical works. This classification also did not consider specifications and bills of quantities. This study builds on the classifications of Juszczyk *et al.* (2014) and Palaneeswaran *et al.* (2007) to classify errors in construction documents according to the documents that produced the errors. Therefore, error in this study was classified into contract drawings (architectural and structural), specifications, bill of quantities, and coordination error. Apart from classifying the errors based on construction documents, the study also examined the prevalence of the identified errors in construction documents. The study is important for developing countries like Nigeria where building collapse, wastage and safety problems occur regularly.

RESEARCH METHODOLOGY

The study adopted the qualitative (in-depth interview) research design to obtain the necessary information. The interview involved an interview guide (see the appendix) that was served to the interviewees (mostly via emails) before the actual scheduled date of the interview. This is to avail them ample time to obtain the required necessary information before the discussions. The list of errors investigated in the study were obtained through meticulous review of literature on the types of errors in construction documents. Consequently, the interviews were conducted with professionals that were ready to provide necessary information on the fifty-one (51) selected building projects for the study. It was ensured that the selected building projects for the projects were not bungalows. The is to ensure that all projects adopted for the study had structural drawings and specifications. The projects were selected from the Southwestern part of Nigeria through the convenience (non-probabilistic) sampling technique. The criteria for the selection were; suitability of the project for the study and availability/willingness of the respondents to provide the required information. The project documents of the projects were examined in cases where clarity was required during discussions. The southwestern part of Nigeria consists of six (6) states that had many construction activities going on, especially Lagos State which is the economic hub of Nigeria. Lagos State is equally evolving into a megacity and the other five other neighbouring states share part of the development. Therefore, for effective research, Southwest, Nigeria was considered appropriate for the study.

Based on the errors in construction documents obtained through the Delphi technique, an interview guide was prepared to obtain information on the types of errors in the construction documents of the selected projects. The interview guide also asked questions about cost and time overrun, the cost of the identified errors and the time expended on the errors. The types of errors in construction documents were analysed with descriptive statistics (frequencies and percentages). The cost and time of errors in the construction documents were calculated manually and presented in table format. The following formulae were adopted to evaluate the cost and time of errors in construction projects:

I. $\textbf{Cost of error in relation to cost overrun}\ (\%) = \frac{Cost\ of\ error}{Cost\ overun} X \frac{100}{1}$

II. $\textbf{Cost of error in relation to initial sum}\ (\%) = \frac{Cost\ of\ error}{Initial\ sum} X \frac{100}{1}$

III. $\textbf{Time of error in relation to time overrun}\ (\%) = \frac{Time\ of\ error}{Time\ overun} X \frac{100}{1}$

IV. $\textbf{Time of error in relation to agreed duration}\ (\%) = \frac{Time\ of\ error}{Agreed\ duration} X \frac{100}{1}$

RESULTS AND DISCUSSION

This section presents the analysis of the data collected from the 51 building projects and the respondents of the study. Thus, the positions of the respondents on the projects for which they provided information were 16 contractors (31.40%), 18 project managers (35.30%), and 17 consultants (33.30%). Table 1 indicates the details of the projects adopted for this study. While '1' was used to represent the availability of the project document, '0' was used to represent the unavailability of the document. Hence, out of the 51 projects

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investigated, 100% had architectural drawings, 90% had structural drawings, 80% had mechanical and electrical drawings, 86.3% had bills of quantities, 94% had conditions of contracts, 56.9% had specifications, and 47.06% had other documents such as landscape drawings, health and safety documents, quality management plan, programme of works, and site plans. Also, 58.8% of the projects were categorised as commercial buildings, 5.9% as religious buildings, 17.6% as residential buildings and 17.6% as institutional buildings. This shows that majority of the projects investigated in the study were commercial projects.

In addition, 60.8% of the projects adopted the traditional procurement method, 29.4% adopted the design and build procurement method and 9.8% adopted the management procurement method. This indicates that the traditional procurement method is the most widely adopted procurement method and the management procurement method is the least adopted procurement method in the study area based on the selected projects for the study. This result is in agreement with the research of Dosumu (2018) which affirmed that the management procurement method is the least used in the Nigerian construction industry despite its potential to reduce errors on construction projects when compared with other procurement methods. It is surprising to discover that some of the projects investigated did not possess vital documents like structural drawings and specifications (despite the fact that they are not bungalows) and this could be one of the major reasons for the recent spate of building collapses in Nigeria especially Lagos state as noted by Mukaka *et al.* (2014) and Dosumu (2018).

Table 1: Details of the projects

S/N	Projects adopted for the study	Purpose of Building	Procurement method	Documents available for the project						
				AD	SD	M/E	BOQ	COC	SPEC	Others
1	Industrial building for Nestle plc, Agbara	Commercial	Traditional	1	1	0	1	1	1	1
2	4 blocks of 2-bedroom flats, Ibadan	Commercial	Design & Build	1	1	0	1	1	0	0
3	Central bank of Nigeria building, Osun	Institutional	Management	1	1	1	1	1	0	0
4	15 units/blocks of 2 bedrooms flats, University of Lagos	Commercial	Management	1	1	1	1	1	0	0
5	Radio/television house, Lekki phase II	Commercial	Management	1	1	1	1	1	0	0
6	12 blocks of 3 bedroom flat, Yaba college of technology GRA	Commercial	Design & Build	1	1	1	1	1	0	1
7	4 blocks of 2 bedroom flat, Lagos Island	Residential	Traditional	1	1	0	1	1	0	0
8	3 wings of 4-bedroom duplex, Banana Island	Commercial	Traditional	1	1	1	1	1	0	0
9	10 units of duplexes, Lekki	Commercial	Management	1	1	1	1	1	1	0
10	Private duplex, Magboro	Commercial	Traditional	1	1	1	1	1	1	0
11	6 blocks of 3-bedroom flats	Commercial	Design & Build	1	1	0	1	1	0	0
12	Role model school, Ikosi road	Institutional	Design & Build	1	1	1	1	1	1	1
13	Diagnostic centre and warehouse	Commercial	Design & Build	1	1	1	1	1	1	1
14	Piling work of faculty and hostel building, UNILAG	Institutional	Traditional	1	1	1	1	1	1	0
15	5-bedroom duplex plus boys' quarter	Residential	Traditional	1	1	1	1	1	1	0
16	4 units of 3-bedroom flats (all en-suite)	Commercial	Traditional	1	1	1	1	1	1	1
17	Printing press building of Redeemed Christian church of God	Religious	Design & Build	1	1	1	1	1	1	1
18	5-bedroom duplex, Gbagada	Residential	Traditional	1	0	1	0	1	1	0
19	Semi-detached twin duplex, Millennium Estate	Residential	Design & Build	1	0	0	0	1	1	0

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20	Semi-detached duplex for Nestle plc	Residential	Traditional	1	1	1	1	1	1	0
21	Twin duplex, Ajah, Sangotedo	Residential	Traditional	1	1	1	1	1	1	0
22	3 flats of one 1 bedroom, one 2 bedroom and one 3-Bedroom	Commercial	Design & Build	1	0	0	1	1	1	0
23	Ultra-modern market, Tejuosho, Yaba	Commercial	Design & Build	1	1	1	1	1	0	0
24	5 nos of duplex (family house) + courtyard	Commercial	Traditional	1	1	1	1	1	1	0
25	Head office of manufacturing company, Apapa	Commercial	Design & Build	1	1	1	1	1	0	0
26	Low-cost housing estates, Igando	Commercial	Traditional	1	1	1	0	1	1	0
27	6 blocks of 2 bedroom flat, Oyingbo	Commercial	Traditional	1	1	1	1	1	1	0
28	Renovation of 5 bedroom, 3 sittings, 1 study, 1 kitchen & 1 ante room at Mobil estate, Ajah	Residential	Management	1	1	1	1	1	1	0
29	Shopping mall, Ikeja	Commercial	Traditional	1	0	0	0	1	1	1
30	Sport facilities, Ogun state	Institutional	Traditional	1	1	1	1	1	0	0
31	Model school, Lagos	Institutional	Traditional	1	1	1	1	1	1	1
32	Entrepreneurial building with offices and workshops, Yaba College of Technology	Institutional	Traditional	1	1	0	0	0	0	1
33	3 storey buildings of 2 and 3 bedroom flat	Commercial	Traditional	1	1	1	1	1	1	1
34	3 floors of detachable 2 bedroom flat (18 flats)	Commercial	Traditional	1	1	1	1	1		1
35	Luxury apartment, Osborne	Residential	Design & Build	1	1	1	1	0	1	0
36	Access bank building, Victoria Island	Institutional	Traditional	1	1	1	1	1	1	1
37	5 number of duplexes at Victoria Island	Commercial	Design & Build	1	1	1	0	1	0	1
38	6 apartments of 3-bedroom flats with 2 penthouses, Banana Island	Commercial	Traditional	1	1	1	1	1	1	1
39	Bank building, Victoria Island	Institutional	Traditional	1	1	1	1	0	0	1
40	Bank building, Meiran	Institutional	Design & Build	1	1	0	1	1	0	1
41	Hotel suite, Port Harcourt	Commercial	Traditional	1	0	0	1	1	1	1
42	4 blocks of 3-bedroom duplex with terrace and garden, Ikeja	Commercial	Traditional	1	1	1	1	1	0	1
43	Refurbishment work for Syke bank (Ground and 1st floor)	Commercial	Traditional	1	1	1	1	1	0	0
44	4 blocks of 3 bedroom flat	Commercial	Design & Build	1	1	1	1	1	1	1
45	Private group of schools	Commercial	Traditional	1	1	1	1	1	0	1
46	Montessori model college	Commercial	Traditional	1	1	1	1	1	0	0
47	Church building, Lekki	Religious	Traditional	1	1	1	1	1	1	1
48	Country home luxury apartment, Ikoyi	Residential	Traditional	1	1	1	1	1	1	1
49	4 blocks of 2-bedroom flats	Commercial	Traditional	1	1	1		1	0	1
50	Shopping mall, Ikeja	Commercial	Traditional	1	1	1	1	1	0	0
51	Mosque building, Lagos mainland	Religious	Design & Build	1	1	1	1	1	1	1
	Total (sum)			**51**	**46**	**41**	**44**	**48**	**29**	**24**
	Total (%)			**100**	**90**	**80**	**86.3**	**94**	**56.9**	**47.06**

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AD = Architectural drawing, SD = Structural drawing, M/E = Mechanical/Electrical drawings, BOQ = Bill of quantities, SPEC = Specifications, COC = Conditions of contract, Others = Other documents apart from the ones listed, D & B = Design and Build, 0 = No, 1 = Yes.

Table 2 presents the prevalent errors in the construction documents of the projects investigated for this study. Thirteen (13) types of errors were classified under four headings of errors in drawings, errors in the bill of quantities, errors in specifications and coordination errors. Thus, 304 errors were discovered in the construction documents and 28.62% were found in the bills of quantities, 43.75% were found in drawings (architectural, mechanical, electrical, etc.), 17.11% were found in technical specifications and 10.53% represent conflicting information among the documents. This indicates that construction drawings have the most prevalent type of error, followed by the bill of quantities and specifications. In the bills of quantities, omission of items (41.38%) has the highest contribution, followed by over/under measurement (31.03%), use of wrong units/quantities (17.24%) and wrong description of items (10.34%). Errors in design (43.61%) have the highest contribution to construction drawings, followed by the omission of items (20.30%) and dimension error (20.30%).

In the technical specification, ambiguous/wrong description and incomplete/inadequate specification (34.62% each) have the highest contribution of error, followed by omission/absence of specification (30.77%). Omission in all the documents contributes 27.30% of the entire error in construction documents, followed by errors in design (19.08%), and conflicting information in documents (10.53%). This indicates that omission, errors in design and conflicting information in documents are the types of errors that require urgent attention to reduce error and its effects. The result of this study is not unexpected as it agrees with the study of Peansupap and Ly (2015) and Love *et al.* (2014) on the prevalence of design error and Love *et al.* (2011) on the prevalence of omission error in construction document.

Table 2: Prevalent errors in construction documents

Construction documents	Types of errors in construction documents	Number of errors	Number of errors (%)	Total error (%)	Total error per document (N)	Individual Error per document (%)
ERRORS IN BILL OF QUANTITIES	Over/under measurement of bill of quantities	27	8.80	28.62	87	31.03
	Omission of items in bills of quantities	36	11.84			41.38
	Wrong units/quantities for measurement	15	4.93			17.24
	Wrong description of items in bill of quantities	9	2.96			10.34
	Subtotal					**100.00**
ERRORS IN DRAWINGS	Errors in design (e.g. loading error)	58	19.08	43.75	133	43.61
	Dimensional errors in drawings	27	8.88			20.30
	Errors in electrical/mechanical symbol	8	2.63			6.02
	Omission of items/details in drawings	31	10.20			23.31
	Violation of building code, laws and regulations	9	2.96			6.77
	Subtotal					**100.00**
ERRORS IN SPECIFICATIONS	Omission/ absence of specifications	16	5.26	17.11	52	30.77
	Ambiguous/wrong description in specifications	18	5.92			34.62
	Incomplete/inadequate specifications	18	5.92			34.62
	Subtotal					**100.00**
COORDINATION ERROR	Conflicting information in contract documents	32	10.53	10.53	32	100.00
	TOTAL	**304**	**100.00**	**100.00**	**294**	

Table 3 indicates the cost of errors in construction documents in relation to the project cost overrun and the agreed project cost. The respondents for the study provided the initial cost, final cost, and cost of error on the projects. This information was used to calculate the cost overrun, percentage cost overrun, percentage cost of error in relation to cost overrun and percentage cost of error in relation to the initial cost of the projects. Thus, the percentage total cost of error in relation to the initial cost was 9.31% and the percentage total cost of

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error in relation to the cost overrun was 30.92%. That means error in construction documents increase the initial contract sum of construction projects by 9.31% and contributed to 30.92% of the total cost overrun of the projects. Only 15.7% of the projects investigated exceeded the average 9.31% cost of error.

Furthermore, it is interesting to discover that only errors in construction documents were responsible for the cost overrun on some projects like projects 14, 16 and 18. Similarly, errors in construction documents were responsible for more than 50% of the cost overrun on projects 29, 50, 12, 27 and 49. In the case of project 14, the project manager noted that it was a Federal government project (Central Bank of Nigeria) and such projects usually have fixed costs except there were major apparent errors in the design. Therefore, ₦1.3 billion was added to the initial contract sum of ₦ 7.5 billion to give ₦ 8.8 billion. This makes the cost of error on the project to be 100%. The result of the study is closely related to the findings of previous studies like Burati *et al.* (1992) which established that the cost of error is 16% of cost overrun. Lopez and Love (2012) equally established that the direct design error cost is 6.85% of the contract sum and the indirect design error cost is 7.36% of the contract sum. Also, Love *et al.* (2014) discovered that design error is 14.2% of the contract value. Although design error is only a subset of errors in construction documents, it is apparent that errors in construction documents hover between 7% and 15% as established in this study and previous studies.

Table 3: Cost of errors of building projects

S/N	Project	Initial cost (=N=)	Final cost (=N=)	Cost overrun (=N=)	Cost overrun (%)	Cost of error (=N=)	Cost of error in relation cost overrun (%)	Cost of error in relation to initial cost (%)
1	14	7,500,000,000.00	8,800,000,000.00	1,300,000,000.00	17.33	1,300,000,000.00	100.00	17.33
2	16	32,000,000.00	36,000,000.00	4,000,000.00	12.50	4,000,000.00	100.00	12.50
3	18	55,000,000.00	60,000,000.00	5,000,000.00	9.09	5,000,000.00	100.00	9.09
4	29	2,494,463,849.00	2,918,522,704.00	424,058,855.00	17.00	339,247,083.50	80.00	13.60
5	50	80,500,000.00	90,300,500.00	9,800,500.00	12.17	7,350,375.00	75.00	9.13
6	12	108,000,000.00	150,000,000.00	42,000,000.00	38.89	30,000,000.00	71.43	27.78
7	27	37,500,200.00	39,150,300.00	1,650,100.00	4.40	1,072,565.00	65.00	2.86
8	49	29,795,360.00	36,801,000.00	7,005,640.00	23.51	4,203,384.00	60.00	14.11
9	51	330,000,000.00	350,000,000.00	20,000,000.00	6.06	11,000,000.00	55.00	3.33
10	47	250,000,000.00	400,000,000.00	150,000,000.00	60.00	60,000,000.00	40.00	24.00
11	31	98,894,250.86	126,745,500.70	27,851,249.84	28.16	8,355,375.00	30.00	8.45
12	7	48,300,486.75	50,378,811.89	2,078,325.14	4.30	581,931.04	28.00	1.20
13	8	148,500,456.80	189,478,231.90	40,977,775.10	27.59	10,244,443.78	25.00	6.90
14	6	180,000,000.00	210,000,000.00	30,000,000.00	16.67	7,500,000.00	25.00	4.17
15	33	1,481,116,001.00	1,903,043,409.00	421,927,408.00	28.49	94,933,666.77	22.50	6.41
16	23	6,000,000,000.00	12,000,000,000.00	6,000,000,000.00	100.00	1,200,000,000.00	20.00	20.00
17	32	19,000,000.00	32,000,000.00	13,000,000.00	68.42	2,600,000.00	20.00	13.68
18	48	210,000,000.00	231,000,000.00	21,000,000.00	10.00	4,200,000.00	20.00	2.00
19	41	85,000,000.00	99,000,000.00	14,000,000.00	16.47	2,240,000.00	16.00	2.64
20	37	132,150,182.30	150,156,200.30	18,006,018.00	13.63	2,700,902.27	15.00	2.04
21	42	177,106,822.40	200,842,502.00	23,735,679.60	13.40	3,560,351.94	15.00	2.01
22	15	59,800,000.00	66,130,000.00	6,330,000.00	10.59	949,500.00	15.00	1.59
23	44	185,000,000.00	192,500,000.00	7,500,000.00	4.05	1,125,000.00	15.00	0.61
24	36	595,000,000.00	611,000,000.00	16,000,000.00	2.69	2,400,000.00	15.00	0.40
25	5	1,700,000,000.00	1,940,000,000.00	240,000,000.00	14.12	34,000,000.00	14.17	2.00
26	4	80,050,000.00	83,470,000.00	3,420,000.00	4.27	444,600.00	13.00	0.56
27	19	12,700,000.00	18,700,000.00	6,000,000.00	47.24	720,000.00	12.00	5.67
28	39	1,200,000,000.00	1,600,000,000.00	400,000,000.00	33.33	40,000,000.00	10.00	3.33
29	45	77,784,415.80	89,652,319.90	11,867,904.10	15.26	1,186,790.41	10.00	1.53
30	25	22,000,000.00	25,000,000.00	3,000,000.00	13.64	250,000.00	8.33	1.14
31	17	89,000,000.00	147,000,000.00	58,000,000.00	65.17	4,640,000.00	8.00	5.21
32	34	99,000,000.00	150,000,000.00	51,000,000.00	51.52	4,080,000.00	8.00	4.12
33	1	245,000,000.00	268,000,000.00	23,000,000.00	9.39	1,725,000.00	7.50	0.70
34	28	8,000,000.00	10,000,000.00	2,000,000.00	25.00	135,000.00	6.75	1.69
35	46	43,745,605.00	60,000,000.00	16,254,395.00	37.16	812,719.75	5.00	1.86
36	24	150,162,189.50	165,308,495.60	15,146,306.10	10.09	757,315.55	5.00	0.50
37	3	5,239,490,638.00	5,649,490,639.00	410,000,001.00	7.83	20,500,000.00	5.00	0.39
38	11	126,000,000.00	132,000,000.00	6,000,000.00	4.76	300,000.00	5.00	0.24
39	40	120,000,000.00	125,000,000.00	5,000,000.00	4.17	250,000.00	5.00	0.21
40	20	109,162,496.90	121,324,000.00	12,161,503.10	11.14	486,460.12	4.00	0.45
41	30	3,644,309,668.00	3,789,462,460.00	145,152,792.00	3.98	5,559,351.93	3.83	0.15
42	3	165,000,000.00	175,000,000.00	10,000,000.00	6.06	350,000.00	3.50	0.21
43	2	15,500,000.00	17,500,000.00	2,000,000.00	12.90	60,000.00	3.00	0.39
44	21	35,000,000.00	42,000,000.00	7,000,000.00	20.00	175,000.00	2.50	0.50

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45	26	110,000,000.00	263,600,000.00	153,600,000.00	139.64	3,686,400.00	2.40	3.35
46	9	300,000,000.00	450,000,000.00	150,000,000.00	50.00	3,000,000.00	2.00	1.00
47	38	520,486,000.00	560,412,000.00	39,926,000.00	7.67	798,520.00	2.00	0.15
48	10	56,253,457.00	58,621,187.00	2,367,730.00	4.21	47,354.60	2.00	0.08
49	43	50,000,000.00	52,000,000.00	2,000,000.00	4.00	40,000.00	2.00	0.08
50	22	11,800,000.00	13,700,000.00	1,900,000.00	16.10	19,500.00	1.03	0.17
51	35	90,000,000.00	145,000,000.00	55,000,000.00	61.11	550,000.00	1.00	0.61
	Total	**34,657,572,079.31**	**45,095,290,261.29**	**10,437,718,181.98**	**30.12**	**3,227,838,590.66**	**30.92**	**9.31**

Table 4 indicates the time of errors in construction documents in relation to the project time overrun and the agreed project duration. The respondents provided information on the agreed duration, actual duration, and time of error. The information was used to calculate the time overrun, percentage time overrun, percentage time of error in relation to time overrun and percentage time of error in relation to the agreed duration of the projects. Thus, the percentage total time of error in relation to the agreed duration was 21.30% and the percentage total time of error in relation to the cost overrun was 40.40%. That means error in construction documents increase the agreed duration of the construction projects by 21.3%% and contributed to 40.40% of the total time overrun of the projects.

The agreed duration of project 47 was increased by 150% as a result of errors in construction documents; the agreed duration of project 7 was increased by 100% as a result of errors in construction documents. This shows that errors in construction documents can double the agreed duration of a project if it is not properly mitigated. Also, the time overruns on projects 7, 18, 37, 14, 8, 6, 30, and 4 were completely due to the errors in their construction documents. Moreover, 47% of the projects investigated in this study had over 50% of their cost overruns caused by errors in construction documents. The respondents for projects 38 and 46 noted that, although the projects overran their agreed duration, the differences were not attributable to errors. The result of this study could be used in conjunction with the model of Ogunsemi and Jagboro (2006) which sought to predict the duration of proposed projects. Hence, the time of error evaluated in this study can be used as a variable to calculate the duration of construction projects.

Table 4: Time of errors of building projects

S/N	Project	Agreed Duration (months)	Actual Duration (months)	Time Overrun (months)	Time overrun (%)	Time of errors (months)	Time of error as per time overrun (%)	Time of error as per agreed duration (%)
1	47	12	36	24	200.00	18.00	75.00	150.00
2	7	12	24	12	100.00	12.00	100.00	100.00
3	26	12	26	14	116.67	8.00	57.14	66.67
4	18	3	4.5	1.5	50.00	1.50	100.00	50.00
5	37	6	9	3	50.00	3.00	100.00	50.00
6	31	11	24	13	118.18	5.00	38.46	45.45
7	16	8	13	5	62.50	3.00	60.00	37.50
8	33	23.6	32.4	8.8	37.29	8.75	99.43	37.08
9	14	38	51	13	34.21	13.00	100.00	34.21
11	8	18	24	6	33.33	6.00	100.00	33.33
10	1	12	18	6	50.00	4.00	66.67	33.33
13	51	12	18	6	50.00	4.00	66.67	33.33
12	32	12	33	21	175.00	4.00	19.05	33.33
14	19	2.5	5.6	3.1	124.00	0.82	26.45	32.80
15	10	9	14	5	55.56	2.50	50.00	27.78
16	6	8	10	2	25.00	2.00	100.00	25.00
17	5	18	24	6	33.33	4.00	66.67	22.22
18	23	21	72	51	242.86	4.00	7.84	19.05
19	42	20	30	10	50.00	3.50	35.00	17.50
22	30	24	28	4	16.67	4.00	100.00	16.67
20	12	6	8	2	33.33	1.00	50.00	16.67
21	22	6	11	5	83.33	1.00	20.00	16.67
23	34	6	12	6	100.00	1.00	16.67	16.67
24	25	3	3.5	0.5	16.67	0.48	96.00	16.00
25	27	6	7	1	16.67	0.95	95.00	15.83
26	39	13	19.5	6.5	50.00	2.00	30.77	15.38
27	50	6	7.5	1.5	25.00	0.90	60.00	15.00

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28	24	14	18	4	28.57	2.00	50.00	14.29
31	36	6	8	2	33.33	0.75	37.50	12.50
30	15	6	8.5	2.5	41.67	0.75	30.00	12.50
29	3	24	42	18	75.00	3.00	16.67	12.50
32	9	18	24	6	33.33	2.00	33.33	11.11
33	21	9	12	3	33.33	1.00	33.33	11.11
34	35	10	17	7	70.00	1.00	14.29	10.00
35	11	8	10	2	25.00	0.75	37.50	9.38
36	49	10	13	3	30.00	0.90	30.00	9.00
37	4	12	13	1	8.33	1.00	100.00	8.33
39	29	18	21	3	16.67	1.50	50.00	8.33
38	20	6	8	2	33.33	0.50	25.00	8.33
40	17	8	9	1	12.50	0.50	50.00	6.25
41	40	12	15	3	25.00	0.75	25.00	6.25
43	44	9	10	1	11.11	0.50	50.00	5.56
42	13	18	24	6	33.33	1.00	16.67	5.56
44	48	45	70	25	55.56	2.00	8.00	4.44
45	43	6	7	1	16.67	0.25	25.00	4.17
46	28	7	8	1	14.29	0.25	25.00	3.57
47	41	24	36	12	50.00	0.75	6.25	3.13
48	2	15	15	0	0.00	0.00	0.00	0.00
49	38	12	14	2	16.67	0.00	0.00	0.00
50	45	18	18	0	0.00	0.00	0.00	0.00
51	46	12	15	3	25.00	0.00	0.00	0.00
	Total	**655.10**	**1,000.50**	**345.40**	**52.72**	**139.55**	**40.40**	**21.30**

CONCLUSION

The information collected for this study was used to calculate the cost and time of errors in construction documents. From the findings of the study, it was clear that the most errors in construction documents occur in construction drawings, followed by the bill of quantities and specifications. Also, omission error is the most occurring type of error in construction documents, followed by design errors, over/under measurement and wrong use of units and quantities for estimation. The Nigerian construction industry is still largely dominated by the traditional procurement method when the developed countries have moved to the management, integrated and sustainable procurement methods.

The projects investigated in the study indicated that the cost of errors on building projects is 9.31% of the agreed/initial contract sum, and 31% of the total cost overrun. The time of errors in construction documents is 21.30% of the scheduled project duration, and 40.40% of the total time overrun. the study further concludes that errors in construction documents affect the duration of building projects more than their costs. In some instances, errors in construction documents can double the initial duration of a project and sometimes triple it as seen in the study. similarly, errors in construction documents could be the major or only source of cost overrun on some projects. However, according to the respondents of the study, some projects may have to remove some items of work (in the same amount as the cost of errors) so that the error in the project does not constitute cost overrun. Also, the findings of the study indicated that not all errors in construction documents could lead to additional cost but all errors in construction documents could lead to additional time.

RECOMMENDATIONS

The findings of this study imply that it gives the needed knowledge of the likely cost and time of error in construction documents on building projects to quantity surveyors/estimators, construction managers, consultants, clients, educators and policymakers so that the likely final contract sum and duration of construction projects could be predicted based on the errors in construction documents. Therefore, while the methods of mitigating errors in construction documents are still being investigated, the study recommends that quantity surveyors/estimators should add about 10% to the calculated contract sum of construction projects and construction managers/contractors should about 20% to the scheduled duration of building projects. Furthermore, a quality control mechanism in the form of buildability analysis should be put in place to ensure that construction documents especially drawing go through a series of checks to reduce design errors, omissions, under/over measurement and use of wrong units/quantities. Clients and policymakers should make laws that would foster the adoption of management procurement methods for construction projects. Very importantly, professional builders must be engaged at

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the inception/design stage of a building project to capture the design errors in construction documents.

This study is limited in geographical coverage as it covers only the Southwestern states of Nigeria. Hence, it may not be readily generalised for all building projects. However, it is a pointer to where research efforts are required in the construction industry to achieve optimal project performance. Therefore, similar studies may be conducted in other geographical areas to validate the findings of this study. In addition, this study can be furthered by conducting similar studies on other types of construction projects such as civil engineering, oil and gas and telecommunication projects, to determine if the figures obtained in this study are generally applicable. Hence this study is useful for practice as designers and clients will be convinced of the need to specifically make allowance for cost and time of errors in the design of construction projects. For academia, this study will be a basis for advanced studies aimed at calculating and mitigating the effects of the cost of errors in construction projects. Also, the study will complement existing studies on errors in construction documents in the developed and developing countries.

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APPENDIX

INTERVIEW GUIDE ON ERRORS IN CONSTRUCTION DOCUMENTS

1. Position on project and name/location of project
2. Years of work experience in the construction industry
3. Academic qualification of respondent.
4. Type of project you are about to discuss (residential, institutional, etc.)
5. Procurement method for the project (design and build, traditional, management, etc.)
6. List the contract documents available for the project
7. What is the initial cost of project?
8. What is the final cost of project?
9. What is the agreed duration for the contract?
10. What is the actual duration of the contract?
11. Tick the errors in the documents from the list below and write the number of occurrences:

TYPES OF ERRORS IN CONTRACT DOCUMENTS	NO OF ERI
Errors in contract drawings	
Omission of details/items in drawings	
Error in designs (e.g. loading error)	
Dimensional errors in drawings	
Error in mechanical/electrical symbol	
Violation of codes, laws and regulations	
Others types of errors, please specify	
Errors in specifications	
Ambiguous/wrong description in specifications	
Omission/absence of specifications	
Incomplete/inadequate specifications	
Others types of errors, please specify	
Errors in bill of quantities	
Over/under measurement in bill of quantities	
Wrong units/quantities for measurement	
Omissions in bill of quantities	
Wrong description of items in bill of quantities	
Conflicting information in contract documents	
Others types of errors, please specify	

12. What **percentage or value** of your cost overrun is attributable to the errors you highlighted?
13. How many **days/weeks/months** of your time overrun is attributable to the errors you highlighted?

Thank you.

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