

Performance management of contractor's quantity surveyors through the use of proper documents and records

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Received: December 2020 • Final Acceptance: March 2022

Abstract

Errors in construction documents and records can have serious impacts on construction projects. These impacts are manifested mostly during the construction and post-construction stages of the projects. The errors in documents and records significantly affect the performance of quantity surveyors (Qs) working for contractors. Thus, the aim of this study was to investigate how the performance of contractor Qs could be managed using proper documents and records. A mixed approach was used to collect the required empirical data via a series of interviews and a questionnaire survey. The collected data were analysed using manual content analysis and relative important index, respectively. The results of the analysis indicate the documents and records that are significantly relevant to contractor Qs. Similarly, significant errors that can occur in those documents and records and causes of those errors also were identified. Finally, the solutions that could minimize the errors were identified and ranked according to their significance. The study findings revealed that the use of proper documentation and record management can enhance the performance of contractor Qs and ensure project success by controlling cost and time overruns.

Keywords

Causes, Contractor QS, Documents and records, Errors, Solutions.

1. Introduction

Documents and records are inseparable in any construction project (Sundhar & Nandhini, 2015). They are the mirrors of the project and reflect the state of the project while boosting quality assurance and quality control aspects of the project (Gangane et al., 2017). Without proper documentation and record keeping, achieving project success would be a challenge (Akinradewo et al., 2020; Canteli, 2019). Errors in construction documents and records significantly contribute to poor project performance (Dosumu, 2018; Dosumu et al., 2017). Okuntade (2014) states that more than 82% of all construction errors are related to errors in construction documents and records.

Dosumu (2018) concludes that in contract documents, the highest number of errors is in contract drawings, followed by bills of quantities (BOQs) and specifications in that order. These errors are caused by the frequent design changes made by the client (Domusu et al., 2017). Thus, clients are mainly responsible for the errors in construction documents and records (Sunday & Afolarin, 2015). The frequent design changes made by the clients send designers back to the drawing board and thus require the quantity surveyors (QSs) to prepare fresh BOQs (Dosumu et al., 2017). Therefore, errors in documents and records significantly affect the performance of QSs. The effects of the errors manifest mostly during the construction and post-construction stages of the projects (Sunday & Afolarin 2015). The effect of documentation and record keeping errors on the performance of contractor QSs is higher than their effect on the performance of consultant QSs. Hence, the investigation of the effects of errors in construction documents and records on the performance of contractor QSs is important.

Literature mentions the errors that can occur in construction documents and records (Long, 2011; Vrouwenvelder et al., 2009; Love et al., 2008; Palaneeswaran et al., 2007). The causes of those errors (Dosumu et al., 2017; Dosumu & Adenuga, 2013; Love et al., 2011) and the effects of the errors (Dosumu, 2018; Okuntade, 2014; Dosumu & Iyagba, 2013; Love et al., 2011) also

are emphasised in the literature. The literature also discusses the strategies that can be adopted to manage those errors (Sunday & Afolarin, 2015) by holistically considering the projects. However, the literature that discusses the impact of poor construction document and record management on the performance of contractor QSs is scarce. The level of significance of the documents and records that QSs handle, the errors in those documents and records and the causes of those errors have been under-researched. Since contractor QSs have to work with and be responsible for many construction documents and records, proper document and record management will be essential to QSs (Towey, 2017). This study, therefore, was intended to enhance the performance of contractor QSs by identifying the causes and effects of errors in construction documents and records, and thereby minimise the errors (Sunday & Afolarin, 2015).

Thus, the aim of the study was to explore how the performance of contractor QSs could be managed by using proper documents and records. The objectives of the study were to identify the significant documents and records handled by contractor QSs; significant errors that can occur in those documents and records, and significant causes of those errors; and suggest strategies to minimise the identified errors.

2. Literature review

2.1. Document and record management in construction projects

All records are documents although not all documents are records (Gangane et al., 2017). Thus, documents and records are two different items. Construction documents contain information, while records contain evidence of past work, which can be used as proof of that work (Sunday & Afolarin, 2015). The main purpose of construction documents and records is to circulate information among construction stakeholders and convey messages to the stakeholders in the best possible way to guide them on the work to be done (Dowing, 2016). Construction documents shall include but not be limited to contract drawings; schedules; speci-

fications; BOQs; quality management plans; construction programmes; project health and safety plans; conditions of contract; and all-risk insurance for building works, personnel and equipment (Dosumu, 2018; Dosumu & Iyagba, 2013).

Construction document management is critical in a project because it provides a comprehensive record of the project (Benarroche, 2020). The type of construction management adopted can differ from project to project and from stage to stage of the project (Gangane et al., 2017). Most documents used in a construction project go through numerous rounds of revisions and editing because of change orders made to adjust the scope of work (Benarroche, 2020). Therefore, construction documents of a project provide a permanent record of the events and actions related to the project, enabling their detailed reconstruction, review and analysis (Sutton, 2014). Documentation is the foundation on which all proposals, changes, orders, and claims are built (Benarroche, 2020). Construction documents and records are the means through which information flows among the stakeholders (Sunday & Afolarin, 2015). The way the documents are perceived varies among individuals (Lee and Foo 2020). Thus, document and record management is essential for all construction stakeholders to ensure proper project implementation.

2.2. Document and record management by contractor QSs

The client, consultant, and contractor are the major stakeholders of a construction project (Satankar & Jain, 2015; Meyer & Kara, 2020). The basic responsibility of a contractor is to deliver the works in accordance with construction documents (Sunday & Afolarin, 2015). The construction documents that QSs require to perform their roles successfully include almost all project asset data and records (Towey, 2017). Ashwoth et al. (2013) emphasised that QSs are required to prepare several documents pertaining to the contract of which the BOQ is one of the most important documents that has to be professionally prepared complying with the standards (Bandara, 2018). One key purpose of

construction document management by contractor QSs is to ensure that the delivered works are in line with the agreed BOQ in terms of cost, time and quality (Cunningham, 2015). Tender document preparation is also a key task of QSs and it requires the QSs to refer several other documents, such as BOQs, conditions of contract and preambles to the schedules of prices. (QS-Tuts, 2019). Documentation is one of the skills and competencies required by QSs (Oke & Otasowie, 2020; Oke et al., 2018). Contractor QSs spend less time on cost planning, feasibility studies and tender appraisal than they do on post-contract critical services (Cunningham, 2017).

Most of the financial issues faced in building construction are caused by inadequate or unclear tender documents and culminate in disputes between employers and builders on the items included in the price of the work (Cunningham, 2015). Therefore, QSs need to have a clear understanding of the nature and purpose of the various documents they use. In contracting organisations, poor cost performance reduces or eliminates profit margins, which may lead to project or company failure (Hongtao, 2014). Cost overruns are a major problem in construction companies. Therefore, record management becomes necessary for a contractor QS because it would help minimise material waste and financial losses and provide useful evidence during any litigation (Gangane et al., 2017). Cartlidge (2017) comments 'planning is only half of the story and once a project commences on site there is a need to control cost targets to ensure that costs do not spiral out of control'. Therefore, contractor QSs should strive to improve their cost controlling and accounting capabilities to help the construction companies for which they work (Cunningham, 2017).

2.3. Errors in documents and the causes and impacts of the errors

Busby (2001) defines errors as unexpected occurrences that involve surprise and which cannot be entirely attributed to chance or circumstances. Many factors have been traced to poor project performance and errors in construction documents and records are prominent among them (Dosumu

et al., 2017). Emphasising the gravity of these errors, Okuntade (2014) affirmed that errors in construction documents and records amount to more than 82% of all construction errors committed and that they contribute to a 5% increase in the contract value of the project (Love et al., 2011). Thus, the identification of the causes of the errors is important to minimise the errors (Dosumu & Iyagba, 2013).

Causes of errors in construction documents and records vary based on the types of buildings involved and the services rendered by the construction organisations and states concerned (Dosumu et al., 2017). Thus, errors in documents and records are of different types and can be classified in diverse ways (Sunday & Afolarin, 2015). Dosumu et al. (2017) found that frequent design changes made by clients were the most frequent cause of errors. The clients and consultants were more responsible for those errors than the contractors were (Dosumu & Iyagba, 2013).

The effects of errors in documentation were the abandonment of work, delays, rework, dissatisfaction of the owner, loss of confidence in the consultants, loss of consultants' reputation, frustration of the stakeholders, loss of concentration on other projects, discouragement of the investors and lowering of the profits made by the designers (Shrivastava & Singla, 2020; Gangane et al., 2017). Fatawu (2016) mentions that project abandonment, delays (time overruns), cost overruns, payment claims, and variation/change orders are the major impacts of errors in documents and records. Rework, cost overruns, and time overruns are the common impacts of the errors in documents and records as identified in almost all the literature related to errors in construction documents and records (Larsen et al., 2015).

Love et al. (2011) suggested that a multitude of strategies should be collectively adopted to prevent errors in documents and records and ensure satisfactory project performance. Initially, clients should provide adequate time for the preparation of construction documents and records and adopt appropriate procurement methods to minimise the errors (Oluwaseun et al.,

2013). Designers are advised to apply quality assurance once the designs have been prepared (Dosumu et al., 2017; Sunday & Afolarin, 2015; Dosumu & Iyagba, 2013). Oluwaseun et al. (2013) identified providing comprehensive information, refining the communication skills of the stakeholders and improving project management as the most suitable strategies. However, none of the previous studies have focused on the relationship between Qs and document and record management.

2.4. Need for document and record management by contractor Qs

Because of the adverse effects of errors in the construction documents, identifying the factors responsible for those errors is important for the professionals who prepare construction documents (Dosumu & Iyagba, 2013). These effects are manifested mostly during the construction and post construction stages of the projects (Sunday & Afolarin, 2015). Therefore, document and record management will be critically important during post construction stages although errors caused by the client and the consultants frequently occur during the design stage (Dosumu et al., 2017). Gunawardena and Kumana (2007) also emphasised the need for proper documentation and record keeping by the contractors. Dhakal et al. (2020) suggest ontology-based semantic modelling for document classification, which helps document management.

Contractor Qs, being the key stakeholders of construction projects, play a major role in ensuring project success during the construction and post contract stages of a project (Jasper, 2015; Latiffi et al., 2015). They should strive to improve the cost controlling of project for the benefit of the construction companies for which they work (Cunningham, 2017). However, most of the financial problems originate because of inadequate or unclear tender documents, culminating in disputes between employers and builders over the items included in the price of the work (Cunningham, 2015). Therefore, Qs should have a clear understanding of the nature and purpose of the various

Table 1. Profiles of the interviewees and questionnaire survey respondents.

Details of the Interviewees						
Code	Designation	Profession	Total Experience in Years	No. of Years of Experience as a Contractor		
R1	Senior Architect	Architecture	16	12		
R2	Senior Engineer	Engineering	20	16		
R3	Contract Specialist	Quantity Surveying	30	22		
R4	Architectural Consultant	Architecture	20	14		
R5	Project Manager	Engineering	25	24		
R6	Project engineer	Engineering	16	11		
R7	Claims manager	Quantity Surveying	15	12		
R8	Director	Quantity Surveying	25	20		
R9	Chief QS	Quantity Surveying	28	24		
R10	Deputy General Manager	Quantity Surveying	26	19		
R11	Assistant General Manager	Quantity Surveying	17	14		
R12	Assistant General Manager	Quantity Surveying	16	12		
R13	Contracts Manager	Quantity Surveying	20	16		
R14	Chief QS	Quantity Surveying	23	17		
R15	Managing Director	Quantity Surveying	21	13		
R16	Project QS	Quantity Surveying	23	14		
R17	Senior QS	Quantity Surveying	28	25		
R18	Contracts Manager	Quantity Surveying	28	28		
R19	Commercial Manager	Quantity Surveying	22	22		
Details of the Questionnaire Survey Respondents						
Designation	Work Experience (Years)					Total
	6-11	11-15	16-20	21-25	Above 25	
Quantity Surveyor	08	10	-	-	-	18
Senior Quantity Surveyor	04	08	03	-	-	15
Chief Quantity Surveyor	-	-	08	08	-	16
Cost Controller	-	04	06	02	-	12
Commercial Manager	-	04	04	06	03	17
Assistant General Manager	-	02	04	06	04	16
Managing Director	-	-	03	04	05	12
Total	12	28	28	26	12	106

documents they use. The BOQ is one of the most important documents prepared by consultant QSs and it has to be properly maintained by contractor QSs (Ashwoth et al., 2013) to ensure that the delivered works are in line with the agreed BOQ in terms of cost, time and quality (Cunningham 2015) and ensure compliance with building codes (Amarachukwu & Wilkinson, 2020). Fatawu (2016) and Noruwa et al. (2020) mention that variations are the major impacts of errors in documents and records. According to Dosumu et al. (2017), 92% of the variations in the Australian construction industry are attributable to errors in construction documents. Perera et al. (2019) have identified that late, incomplete, and substandard information is one of the root causes of variations. The contractor QS is one of the key professionals expected to perform competently when variations are inevitable (Maarouf & Habib, 2011) because variations can adversely affect contracting firms (Yadeta, 2016; Hanna et al., 2002). Therefore, the proper management of documents and records is necessary for a contractor QS because it would help minimise waste, financial losses, quality controlling issues, disputes and at times the insolvency of the contractor (Gangane et al., 2017). Thus, according to the past studies mentioned, a study on construction document management and record keeping will be useful for contractor QSs to enhance the overall performance of the contractor.

3. Methodology

A mixed approach was found to be most suitable for this study since because it helps integrate both qualitative and quantitative data (Uprichard & Dawney, 2019) and discover the research problem in depth (McCusker & Gunaydin, 2015). In the first part of the study, a qualitative approach was used to assess the validity of the literature findings on the documents and records used in the construction industry and the errors in those documents and records, causes of the errors and the strategies that would prevent those errors. A quantitative approach was suitable for the second part of the study to identify the significance of the findings of the first part of the study. Expert interviews were most suitable to collect the required qualitative data based on the experience of the experts (Fellows & Liu, 2015). Experts who had more than 15 years of experience in construction and more than 10 years of experience as a contractor QS were selected for interviewing. Semi-structured interviews were conducted face to face for 45–60 minutes. The interview guideline was prepared based on the literature review findings. Expert interviewees and questionnaire survey respondents were selected using purposive sampling to enable the selection of those with experience and knowledge in the research area. The number of interviews was limited to 19 to avoid data saturation. The empirical findings of the interviews were analysed using manual content analysis. The profiles of the interviewees and the questionnaire survey respondents are presented in Table 1.

The questionnaire survey respondents had to have more than 5 years of working experience as contractor QSs. The questionnaires were distributed via email among 150 respondents, who were selected from a population of 400. Only 111 survey respondents returned the filled-up questionnaires. Five of the received questionnaires were incomplete. Therefore, only 106 (70.7%) questionnaires could be considered for the analysis.

The questionnaire survey findings were analysed using the relative importance index (RII), a well-recog-

nized statistical tool used to measure the relative significance of several attributes (Doloi, 2008) and rank them (Tejale et al., 2015). $RII = \sum(W_n) / N \times A$ is the formula used to calculate RII, where W = rating given to a factor by each of the respondents; n = frequency of the responses; N = total number of responses and A = the highest weight.

Three identical colour scales were used to represent the data in a heat map to visualise the findings. In the heat map, high values are presented in “green”, moderate values in “yellow”, and low values in “red” (Figure 1). Thus, the factors with a high impact/ranking/significance are presented in “green”, whereas those with a low impact/ranking/significance are presented in “red”.

4. Research findings and analysis

The interviewees were requested to assess and validate the literature findings particularly applicable to contractor QSs. They were free to add to the literature findings. The additions they made are highlighted in the relevant tables. The significance of the interview findings was finally identified using the relative importance indices (RIIs) calculated based on the questionnaire survey findings.

4.1. Documents and records significant to contractor quantity surveyors

Documents and records identified from the literature review were classified into four main categories: documents used by contractor QSs, documents for which contractor QSs are responsible, records used by contractor QSs and records for which contractor QSs are responsible. Eight construction documents used by contractor QSs and twelve documents for which contractor QSs are responsible were identified. Eleven records were identified as records used by contractor QSs, while nineteen were identified as records for which contractor QSs are responsible. The questionnaire survey respondents were requested to identify the significance of each of the identified documents/records for contractor QSs and rank them according to their levels of significance. The results are presented in Table 2.

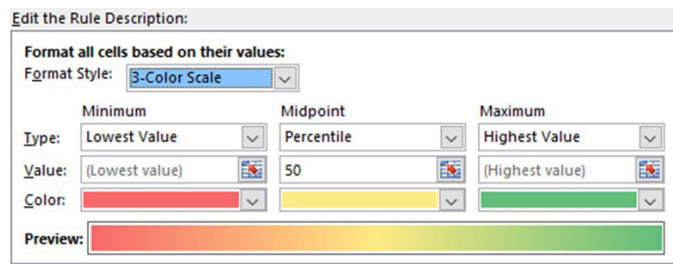


Figure 1. Heatmap colour scale.

Documents and records that were identified by the experts are highlighted in Table 2. *Organisational chart, marked drawings/ sketches, gazette notifications, site clearance requests, change requests, variation valuation confirmation and approval request forms* were the new documents/records identified by the experts.

In Table 2, the colour scale varying from dark green to dark red shows the documents and records relevant to contractor QSs in the descending order of their significance. Contract documents and specifications with RIIs of 0.906 and 0.903, respectively, and in shades of green are the most significant documents used by contractor QSs. *Staff organisation charts* with a RII of 0.456 and shown in red are the least significant documents used by contractor QSs. The first six documents listed under the documents for which contractor QSs are responsible are the most significant documents according to the colour scale. The two most significant documents among them are the *variation applications and interim payment applications*, coloured in dark green. *Subcontract agreement-related documents and monthly progress reports* are the two least significant documents for which contractor QSs are responsible.

Daily site progress, labour, material, and daily work records with a RII of 0.867 are the records most significant to contractor QSs. These same records (with a RII of 0.761) are the 9th most significant records for which contractor QSs are responsible. *Claim notices and correspondence, quotations and invoices, and price and rate breakdowns* are the three most significant records for which contractor QSs are responsible. *Confirmation of verbal instructions (CVIs)/ Engineer's instructions* (with a RII of 0.511) and shaded in red is the 2nd most significant record used by contractor QSs. *Health, safety, and environmental*

records/accident records carry low significance for contractor QSs. They are also of low significance as records for which contractor QSs are responsible. *Quality assurance records* are the least significant records for which contractor QSs are responsible. However, with a RII of 0.761, they are the 3rd most significant records used by contractor QSs.

4.2. Significance of the errors in documents and records handled by contractor QSs

From the literature, 11 errors in documents and records that are of significance for QSs were identified (Table 3). *Documents/records that are inconsistent with the source document and quotations*

Table 2. Significance of documents and records handled by contractor QSs.

Documents					
Documents used by Contractor QSs	RII	Rank	Documents for which contractor QSs are responsible	RII	Rank
Contract documents	0.906	1	Variation applications	0.984	1
Specifications	0.903	2	Interim payment applications	0.968	2
Cash flow	0.761	3	Subcontract payment documentation	0.935	3
Construction programme	0.720	4	Claim documents	0.924	4
Shop, as-built and revised drawings	0.717	5	Final statement	0.913	5
Weather reports	0.594	6	Periodic cost reviews/cost reports	0.895	6
Test reports	0.594	7	Dispute-related documents	0.889	7
Organisational charts (Staff)	0.456	8	Completion statement	0.886	8
			Material reconciliation reports	0.795	9
			Labour reconciliation and productivity reports	0.703	10
			Subcontract agreement-related documentation	0.556	11
			Monthly progress reports	0.528	12
Records					
Records used by Contractor QSs	RII	Rank	Records for which Contractor QSs are responsible	RII	Rank
Daily site progress, labour, material, and day work records	0.867	1	Claim notices/ correspondence/ letters	0.900	1
Confirmation of verbal instructions/ Engineer's Instructions	0.861	2	Quotations/ Invoices	0.865	2
Quality assurance records	0.761	3	Price breakdowns/ Rate breakdowns	0.853	3
Store records	0.728	4	Change requests	0.832	4
Marked drawings/ sketches	0.728	5	Variation valuation confirmation	0.832	4
Certificates/ Permits	0.697	6	Marked drawings/ Sketches	0.817	6
Clarifications/ Requests for information	0.694	7	Site clearance requests	0.809	7
Method statements	0.623	8	Clarifications/ Requests for information	0.772	8
Photographs	0.622	9	Daily site progress, labour, material and day work records	0.761	9
Health and safety environment records/ accident records	0.578	10	Certificates/ Permits	0.561	10
Gazette notifications	0.567	11	Approval request forms	0.557	11
			Weather records	0.550	12
			Gazette notifications	0.537	13
			Method statements	0.533	14
			Photographs	0.528	15
			Confirmation of verbal instructions/ Engineer's Instructions	0.511	17
			Health and safety environment records/ accident records	0.461	18
			Quality assurance records	0.418	19

that are inconsistent with the specifications, which are highlighted in Table 3, were the errors identified by the experts. The RIIs of the identified errors and their rankings according to their levels of significance are presented in the Tables 3 and 4, respectively.

In the heat map, 4 of the 10 errors are in shades of green, and thus are significant. Among these four significant errors, *lack of substantiation*, the failure to provide the required evidence or supporting records and document backup, with a RII of 0.767 is the most significant. *Documents/records that are inconsistent with the required specimen or format, failure to use relevant documents/ records or false records and details, and calculation mistakes in the measurement sheets* are the 2nd, 3rd, and 4th most significant errors. Warranty errors, which have received the lowest RII of 0.467 and shaded in dark red, are less significant. Five out of the eleven errors are coloured with a shade of red.

4.3. Significance of the causes of the identified errors in documents and records

At the expert interviews, 11 causes were validated as being responsible for the errors in documents and records of contractor QSs. These 11 causes were ranked according to their significance using their RIIs, and the interviewees were requested to group the causes according to the errors for which they were responsible (Table 3). The highlighted causes in Table 3, namely *lack of interest* and *frequent changes made to the details*, are the causes identified by the interviewees.

Table 3. Significance of the errors in documents and records and the causes of the errors.

Error	Cause	RII	Error	Cause	RII
Lack of substantiation	Failure to keep contemporary records	0.869	Quotations that are inconsistent with the specifications	Time constraints faced in handling the workload	0.840
	Time constraints faced in handling the workload	0.840		Lack of interest	0.794
	Lack of interest	0.794		Dependency on subcontractors lacking in knowledge	0.743
	Unfamiliarity with the conditions of contract	0.782		Inadequate communication with the members	0.737
Rank 1	Dependency on subcontractors lacking in knowledge	0.743	False records		0.688
	Inadequate communication with the members	0.737			
Documents/records that are inconsistent with the required specimen or format	Time constraints faced in handling the workload	0.840	Pricing errors/ rate build-up errors	Time constraints faced in handling the workload	0.840
	Lack of interest	0.794		Lack of interest	0.794
	Lack of trained and knowledgeable employees	0.789		Lack of trained and knowledgeable employees	0.789
Rank 2	Lack of quality assurance	0.731	Unfamiliarity with the conditions of contract	Dependency on subcontractors lacking in knowledge	0.743
				Inadequate communication with the members	0.737
Failure to use relevant documents or records/ False records and details	Failure to keep contemporary records	0.869	Wrong interpretations	False records	0.688
	Insufficient time available to handle the work load	0.840		Drawing errors	0.651
	Lack of interest	0.794		Unrealistic programmes	0.571
	Lack of trained and knowledgeable employees	0.789			
Rank 3	Dependency on subcontractors who are not knowledgeable	0.743	Time constraints faced in handling the workload	Time constraints faced in handling the workload	0.840
	Poor communication with the members	0.737		Lack of interest	0.794
	Lack of quality assurance	0.731		Lack of trained and knowledgeable employees	0.789
Calculation mistakes present in measurement sheets	Insufficient time available to handle the work load	0.840	Irrelevant categorisation	Unfamiliarity with the conditions of contract	0.782
	Frequent changes made to the details	0.794		Language barriers	0.737
	Lack of trained and knowledgeable employees	0.789		Lack of interest	0.794
	Drawing errors	0.651		Lack of trained and knowledgeable employees	0.789
Rank 4	Lack of interest	0.583	Warranty Errors	Internal organisation-related problems	0.749
				Inadequate communication with the members	0.737
Missing notifications/ contractual points	Failure to keep contemporary records	0.869	False records		0.688
	Time constraints faced in handling the workload	0.840		Language barriers	0.671
	Lack of interest	0.794			
Rank 5	Lack of trained and knowledgeable employees	0.789			
	Unfamiliarity with the conditions of contract	0.782			
Documents/records that are inconsistent with the source document	Lack of interest	0.794			
	Lack of trained and knowledgeable employees	0.789			
	Unfamiliarity with the conditions of contract	0.782			
Rank 6	Language barriers	0.671			

Performance management of contractor's quantity surveyors through the use of proper documents and records

Table 4. Significance of strategies suitable for the identified errors in documents and records.

Error	Strategy	RII	Error	Strategy	RII	
Lack of substantiation	Using properly designed checklists for documents and records	0.918	Quotations that are inconsistent with the specifications	Getting a qualified and responsible person to prepare/check the documents/records	0.829	
	Keeping contemporary records	0.886		Establishing proper communication and teamwork among the members	0.800	
	Getting a qualified and responsible person to prepare/check the documents/records	0.829		Distributing the work and responsibilities among the team members	0.794	
	Making arrangements for obtaining contemporary records	0.811		Checking and verifying the backup records before their use	0.771	
	Checking and verifying the backup records before their use	0.800		Keeping contemporary records	0.886	
Rank	RII		Rank	RII		
1	0.767		7	0.611		
Documents/records that are inconsistent with the required specimen or format	Using standard or given formats for the records	0.931	Pricing errors/ rate build-up errors	Getting a qualified and responsible person to prepare/check the documents/records	0.829	
	Getting a qualified and responsible person to prepare/check the documents/records	0.829		Visiting the site at least once a day	0.818	
	Using applicable quality management procedures	0.800		Checking and verifying the backup records before their use	0.811	
	Distributing the work and responsibilities among the team members	0.794		Making arrangements for obtaining contemporary records	0.800	
	Using draft documents and developing them based on feedback before submitting them	0.729		Establishing proper communication and teamwork among the team members	0.794	
Rank	RII		Rank	RII		
2	0.744		8	0.600		
Failure to use relevant documents or records/ False records and details	Keeping contemporary records	0.886	Wrong interpretations	Getting a qualified and responsible person to prepare/check the documents/records	0.829	
	Maintaining a directory of records as a record management practice	0.840		Establishing proper communication and teamwork among the team members	0.800	
	Getting a qualified and responsible person to prepare/check the documents/records	0.829		Making proper claims based on relevant contractual grounds	0.800	
	Visiting the site at least once a day	0.818		Distributing the work and responsibilities among the team members	0.794	
	Making arrangements for obtaining contemporary records	0.811		Using draft documents and developing them based on feedback before submitting them	0.729	
	Rank	RII		Rank	RII	
	3	0.726		9	0.583	
	Calculation mistakes present in measurement sheets	Establishing proper communication and teamwork among the team members	0.800	Irrelevant categorisation	Getting a qualified and responsible person to prepare/check the documents/records	0.829
		Checking and verifying the backup records before their use	0.800		Making proper claims based on relevant contractual grounds	0.800
		Using applicable quality management procedures	0.794		Distributing the work and responsibilities among the team members	0.794
Distributing the work and responsibilities among the team members		0.771	Checking and verifying the backup records before their use		0.771	
Using draft documents and developing them based on feedback before submitting them		0.729	Using draft documents and developing them based on feedback before submitting them		0.729	
Rank	RII		Rank	RII		
4	0.722		10	0.539		
Missing notifications/contractual points	Getting a qualified and responsible person to prepare/check the documents/records	0.829	Warranty Errors	Using a properly designed checklist for each document and record	0.918	
	Making proper claims based on relevant contractual grounds	0.800		Getting a qualified and responsible person to prepare/check the documents/records	0.829	
	Distributing the work and responsibilities among the team members	0.794		Distributing the work and responsibilities among the members	0.794	
Rank	RII		Rank	RII		
5	0.667		11	0.467		
Documents/records that are inconsistent with the source document	Getting a qualified and responsible person to prepare/check the documents/records	0.829				
	Making proper claims based on relevant contractual grounds	0.800				
	Distributing the work and responsibilities among the team members	0.794				
	Using draft documents and developing them based on feedback before submitting them	0.729				
Rank	RII					
6	0.650					

Failure to keep contemporary records and time constraints faced in handling the workload with RIIs of 0.869 and 0.840, respectively, are the two most significant causes of errors in the documents and records handled by contractor Qs. The five causes coloured in shades of green in the heat map are the five most significant causes. Two of the five causes are coloured in dark green. Though *lack of interest* is the 3rd most significant cause, it is responsible for 10 of the identified errors. The most significant cause and the second most significant cause are responsible for 2 and 9 of the errors, respectively. The use of unrealistic programmes is responsible for *pricing errors/ rate build-up errors*, which are only the 8th most significant type of errors with a RII of 0.600 and coloured in a shade of red. Similarly, only 4 out of the 13 causes are responsible for the 2nd most significant error that occurs when *the documents/records are inconsistent with the required specimen or format*.

Therefore, the levels of significance of the errors and their causes need to be considered in minimising the errors.

4.4. Significance of the strategies that would minimise the errors in documents and records

From the literature, 13 strategies that would minimise the errors in documents and records for which contractor Qs are responsible, were identified. The interviewees were requested to indicate the errors that each identified strategy would minimise. Questionnaire survey findings were used to rank the strategies according to their significance based on their RIIs. The results are presented in Table 4. The table also presents the strategies for minimising each error. The strategies *checking and verifying the backup records before their use* and *maintaining a directory of records as a record management practice*, which are highlighted in the table, were identified by the experts.

Using standard s or given formats for the records (RII=0.931), using properly designed checklists for documents and records (RII=0.918) and keeping contemporary records (RII=0.886) are the three most significant strategies that would minimise the errors. Using draft documents and developing them based on feedback before submitting them is the

least significant strategy. However, the number of errors that can be minimised through this least significant strategy is higher than the number of errors that can be minimised using the three most significant strategies. *Getting a qualified and responsible person to prepare/check the documents/records* is the 5th most significant strategy, which can eliminate all the errors in documents and records. As Table 4 indicates, only 7 of the 13 strategies are suitable to minimise *lack of substantiation* (having the highest RII), the most significant error in documents and records. Most of the identified strategies (10 out of 13) are focused on minimising the error associated with *the failure to use relevant documents or records/ false records and details*, which is the 3rd most significant error, for which 8 out of the 13 identified causes are responsible.

5. Discussion

Although several researchers discussed construction documents and records, only Gangane et al. (2017) explained the difference between construction documents and records. The findings of this study revealed that the documents and records handled by contractor QSs could be discussed under four main categories. The interviewees highlighted that documents and records used by different stakeholders vary. Dosumu et al. (2017) also emphasised this variation. Therefore, the stakeholders have to use the documents or records prepared by them and those that have been prepared by others. Thus, documents and records can be categorised as documents and records prepared by contractor QSs and documents and records used by contractor QSs.

Previous studies identified clients and consultants as the major contributors to most of the errors in documents and records (Sunday & Afolrin, 2015). However, the impacts of these errors occur only during and after the construction period (Dosumu et al., 2017; Benarroche, 2020). Therefore, document and record management of contracting firms is important as revealed in this study. Although several construction documents and records could be identified from the literature

(Towey, 2012; Dosumu & Iyagba, 2013; Gangane et al., 2017), only few of those documents were related to contractor QSs. Dosumu (2018) identified that the percentage of errors in BOQs was the 2nd most significant error, followed by errors in drawings. Gangane et al. (2017) identified the errors in BOQs, drawings, specifications, forms of contract and schedules as the most significant errors (listed in the descending order of significance) in documents. The documents and records that were identified as most significant for contractor QSs in the study were identified by Towey (2012) as well.

Sunday and Afolrin (2015) identified inexperience of the professionals, non-availability of information, and lack of quality management as the three most significant causes of errors in construction documents and records. These causes were identified in this study as the 4th, 8th, and 9th most significant causes of errors in the documents and records handled by contractor QSs. This difference between the level of significance of each of the three causes identified by past studies and that identified by this study is because this study focused only on the documents and records handled by contractor QSs. Sunday and Afolrin (2015) focused on all types of construction documents and records. The most significant cause identified in this study is the failure to keep contemporary records. Although all professionals in the construction industry are expected to keep contemporary records, it is essential for contractor QSs because they have to handle claims.

The study findings indicate that *lack of substantiation* is the most significant error, whereas design errors have been identified as the most significant error in the literature (Love et al., 2011). The most significant cause and the most significant error identified in this study are interrelated because *the failure to keep contemporary documents* is the main cause of the error *lack of substantiation*. Dosumu and Adenuga (2013) categorised errors according to the types of construction documents and identified design errors in the drawings as the most significant error; approximation errors in the BOQs are the

third most significant error, followed by design errors in the specification.

Failure to keep contemporary records was identified in this study as the most significant cause of the errors in the documents and record handled by Qs. Even though the literature on the errors in the documents and records handled by contractor Qs is scarce, poor communication among the project members and the negligence of the professionals were highlighted in the literature as the two most significant causes of errors in the BOQs, one of the important documents used by contractor Qs (Fatawu, 2016). These two causes, however, were identified in this study as the 7th and 8th most significant causes, respectively. According to Fatawu (2016), insufficient input information is the most significant cause of errors in construction documents.

The study findings indicate that *the use of standard formats for documents and records* is the most appropriate strategy to minimise errors in documents and records. Dosumu (2018), however, identified the provision of comprehensive information for document and record management as the most significant strategy, which, according to this study, is the most suitable strategy to address the most significant error identified in the study.

6. Conclusions and recommendations

How the performance management of contractor Qs using proper documents and records could be achieved was explored by identifying the significant documents and records handled by contractor Qs, significant errors that could occur in those documents/records and their causes, and the strategies that would minimise the identified errors, through a mixed approach. The study findings indicate that documents and records can be classified into four main categories: documents used by contractor Qs, documents for which contractor Qs are responsible, records used by contractor Qs, and records for which contractor Qs are responsible. Contract documents and specifications were identified as the most significant documents used by contractor Qs and other construction professionals. Even though cash flow statements and other

similar documents used by Qs also were identified as important, they are not as significant as contract documents and specifications. *Daily site progress, labour, material, and day work records* and *CVIs and Engineer's instructions* were identified as the most significant records used by contractor Qs, which are used by both contractor Qs and other construction professionals.

Variation applications were identified as the most significant documents for which contractor Qs are responsible. Variations are one of the major factors contributing to cost overruns of a project. *The interim payment application* was identified as the next most significant document because the request for the payments for the work done is made by a contractor through this document. *Claim notices, correspondence, and any other substantiation*, being mandatory records for making claims by the contractor, are the most significant records maintained by contractor Qs.

Lack of substantiation was identified as the most significant error in documents and records. *Time constraints faced in handling the workload, lack of interest and lack of trained and knowledgeable employees* are the causes attributable to most of the identified errors. However, *failure to keep contemporary records*, which had the highest RII, is the most significant cause because with no records available contractor will not be able to make claims. Similarly, *using standard or given formats*, which had the highest RII, was identified as the most significant strategy, *getting a qualified and responsible person familiar with conditions of contract to prepare/check the documents/records*, and *distributing the work and responsibilities among the team members* were found to minimise all identified errors.

The study findings would help reduce waste of money in projects, caused by erroneous documents. The study makes a theoretical contribution by providing proper guidelines for enhancing the performance of contractor Qs through proper document and record management. The study will also contribute to new knowledge related to document management, especially by contractor Qs, which would be useful for future researchers in the subject area. Howev-

er, the study identifies only the performance enhancement of contractor QSs, which makes generalising the study findings to other QSs and stakeholders difficult. However, the study findings can also be related to consultant QSs and other professionals.

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