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Critical Risks to Construction Cost Estimation

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Abstract: The prevalence of cost overrun in project delivery suggests an acute dearth of inclusive understanding of the effect of risks on construction cost estimation. In aberrant to the generic assumptions, customary to inquiries in construction risk researches, this paper appraised critical construction estimating risks. The study evaluated the sources, frequency and significance of construction estimating risks, using data from a questionnaire survey of 206 quantity surveyors in Nigeria. The data were analysed using factor analysis, Fussy Set Theory, Terrell Transformation Index (TTI), and Kruskal Wallis H tests. The results showed that estimating risks are correlate seven principal sources, namely: estimating resources, construction knowledge, design information, economic condition, the expertise of estimator, geographic factor, cost data, and project factors (λ, > 0.70 <1.0). Twenty-nine risk factors likewise emerged critical construction estimation risks (TTI, 69-87 > 65 percent) and the top three were low construction knowledge, inaccurate cost information and changes in government regulations (factor scores > 0.60 > 0.50). The awareness and accurate assessment of these risks into project cost estimation would reduce cost overrun. The study, therefore, recommends synergies between projects' internal/ external environments for proper scoping of these risks into project estimates.

Keywords: Building projects, costs, estimating, estimates, risk.

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1. Introduction

Uncertainties are some indispensable features of construction project delivery. Elements of uncertainties within construction projects instruct risk management and set up the effectiveness of risk management processes as a critical determinant of a successful project (Nawaz et al., 2019). Cost estimation guides the decision to progress with project execution on-site; therefore, the risks inherent in its processes are the crux to problems predisposing failure (Adedokun et al., 2019). Theories of estimating revealed that deviation between budgeted cost and the final cost of projects are associate uncertainties in construction estimates (Adafin et al., 2016; Adafin and Rotimi, 2016). Despite advances in quantitative risk management, the prevalent risk management practice among quantity surveyors, is to set up a blanket allocation of contingencies to the baseline (Ekung and Onwusonye, 2015; Cartlidge, 2018). Even though the practice is widely criticised, the increasing cases of cost growth in contemporary projects portray an acute knowledge gap in the conceptualisation of the effect of risks on cost estimates (Ekung and Onwusonye, 2017). This study was conducted to unbundle the dimensions of critical construction estimating risks. The motivation originated from the growing rationalisation of the research gap in the assessment of construction estimation risks (Oyewobi et al., 2012; Abdulrahman et al., 2019). The objectives were to prioritise the sources, frequency and significance of critical construction estimating risks affecting project cost performance in Nigeria.

Several researchers have examined the drivers of imprecisions in construction estimates (Akintoye, 2000; Aibinu and Pasco, 2008; Elfaki and Alatawi, 2015). However, their assumptions did not isolate the risk dimension for critical inquiry despite the emerging consensus, that process lapses and expert inputs underwrite ineffective risk management (Elfaki and Alatawi, 2015). Many construction projects failed due to inadequate attention to pre-contract activities (Odediran and Windapo, 2015) including cost estimation. The failure of discrete project activities, therefore, predispose the entire project to unsuccessful completion. Even though several studies exist on construction risks management, the scope of construction estimating risks is unclear. Rather, past researches showed penchant towards the effect of risks on contractors' estimates (Oyewobi et al., 2012), contractors' risk allocation practices during tender (Laryea and Hughes, 2008) and identification of cost risks (Jimoh, 2014). This study argues that cost risks are multi-dimensional, straddles the project's life cycle and their contributions to project failure are ceaseless. Moreover, the risk management practice of cost managers has not changed extensively from the allocation of contingencies in cost and time to unknown risks, despite vastly reported effects of risks on project success. This paper, therefore, addressed the research question, which states, what are the critical construction estimating risks? The study conveys an enormous undertaking to improve the accuracy of construction estimating. Even though risk-based estimating models proliferate (Khemani et al., 2010; Ekung and Onwusonye, 2017), facilitating risk management processes could generate value capture early in the project. The value of risk register peculiar to construction estimating would likewise improve knowledge relating to cost performance (Chalmers, 2013). The study would also advance risk-based estimating and deters stakeholders' penchant to arbitrary risk management approaches (Jimoh, 2014).

2. Classifications of Construction Risks

Different metrics are used to classify construction risks in the literature. Lmoussaoui and Jamouli (2016) adopted the framings, which examined nature, origin, impact, project phases, and project stakeholders. Emerging from related framings, several grouping exists based on their sources: technical, external, corporate and project management related (Project Management Institute, Practice Guide for Risk Management, 2013). Risk is also market-related, completion and institutional (Miller and Lessard, 2001). Eaton (2013) classified construction risks using the SLEEPT acronym (social, economic, environmental, political, and technological). Management, design, financial and economic, material and labour and equipment risks are also prevalent (Adu and Anjiba, 2015; Luka and Ibrahim, 2015). Zeng et al. (2007) adopted resource-related groupings such as human, site material and equipment risks. Rezakhani (2012) discussed operational, external and internal, project management, engineering and finance-related risks. Framings related to financial, managerial, construction, technical, partnering, environmental and force majeure, legal and economy also emerged in a recent study (Alashwal and Al-Shabahi, 2018). Eliufoo (2018), based on contractor's experience in Tanzania, validated four frames for estimating related risks: construction, physical, estimators and financial. A review of contemporary risk practices in the Nigerian construction industry (Oyedele, 2015), identified thirteen sources of risks, namely: political, economic, government policy, time, location, legal, security, year of the project, sector of project, complexity, experience, detail of brief, and corruption. The varying conceptions of risk sources in the literature portray the lack of absolute consensus. The classification of construction risks is, therefore, context-dependent. The converging trend in the literature, therefore, inclined to risk identification in the generic project sense (Rezakhani, 2012; Oyewobi et al., 2012; Lmoussaoui and Jamouli, 2016). Despite facilitating a comprehensive risk study, these classifications stopped short at specifying the most important construction estimating risks. The most seminal literature gap, therefore, is the missing link on risks associated with estimating inputs during project delivery (Lmoussaoui and Jamouli, 2016).

Estimating risks developed from differing but closely related factors, although, existing literature is concerned with causes of inaccuracies (Akintoye, 2000; Aibinu and Pasco, 2008; Oladokun, et al., 2011). Variables related to estimator's background, experience, construction tender period, market condition, client's financial situation and budget, location of the project, availability of resources and cognitive skills emerged imperative risks from the United Kingdom (UK)'s contracting sector's experience (Akintoye, 2000). Despite its fundamental account of causes of inefficiency in construction estimate, the study failed to establish the empirical relationship between listed factors and inaccurate estimates. Aibinu and Pasco (2008) identified biases in cost estimating procedures and estimator's qualifications based on a survey of Australian costing experts, but views in support of this position are sketchy. Market condition, availability of design information, inadequate tender documentation were significant causes of variability in cost estimates in the New Zealand region (Adafin and Rotimi, 2016). Another Australian study, Towner and Baccarini (2007) revealed the critical risk priced in the tender as design or documentation errors, non-availability of resources, buildability issues, incomplete design, possible estimation error and project team's experience. These dimensions of risks also received an important rating in Chalmers (2013). Chalmers (2013) revealed that factors related to estimating plan, scope definition, site conditions, estimate review, sources of benchmark data and available time were considerate process risks in the Canadian construction industry (see also Aibinu and Pasco, 2008; Odeyinka et al., 2012; Enshassi et al., 2013; Ameyaw et al., 2015). Incomplete scope definition, tender period, quality of cost data, access to the site, estimating skills and current workload were imperative estimating risks from the Tanzanian study (Elufioo, 2018). Unlike past studies, Elufioo (2018) despite its methodological lapses clearly headlined procedural risks relating to construction cost estimation.

In Nigeria, a rich literature on drivers of deficiencies in cost estimates also exists. Odusami and Onukwube (2008) validated factors related to the expertise of consultants, quality of information and flow requirements, project team's experience, construction type, tender period and market condition (see also Akintoye, 2000; Aibinu and Pasco, 2008). A similar study, Odusami and Onukwube (2008) established risk factors related to previous studies (Towner and Baccarini, 2007; Aibinu and Pasco, 2008); in addition to underestimation, defective design and inadequate specification. In a study of risks affecting contractors' estimate, Oyewobi et al. (2012) also validated defective designs, inflation, contractor's expertise (competence), political uncertainty and switch in government. Similar to past studies from the international settings, the underlying assumptions of these studies are generic and at best, provide knowledge about causes of variability between initial estimates and final project costs. In sum, numerous researchers have spawned multiple sources of risks related to the general construction domains. The theoretical review showed that risk variables are dependent on prevailing regional practices. Therefore, associated factors are possible exponents of construction estimating risks in Nigeria. However, the knowledge gap related to critical construction estimating risks has not received relevant structured research attention. This study is therefore a leap of response targeted to feel the theoretical gap on risk variables associated with construction estimating.

3. Methods

The study set out with a review of past literature related to the research problem. The review aided the mining of relevant variables that can explore the dimensions of construction estimating risks to feel the research gap. The explorative study adopted a survey research design based on a structured questionnaire. The population of the study was registered quantity surveyors in Nigeria. The directory of registered quantity surveyors in the six geopolitical zones of Nigeria and Abuja provided the sample frame. A preliminary investigation into the directory of financially up-to-date registered quantity surveyors at the time of the study revealed 2020 members. Using the Kish equation, the study extrapolated the sample size of 95 from the population (see Kish, 1965). However, the study covered 206 targets with a view to obtain a valid response equivalent to the minimum sample size. The research respondents were randomly sampled through face-to-face administration and email, while the retrieval likewise followed similar protocols. This research strategy is consistent with past studies (Aibinu and Pasco, 2008; Bello and Odusami, 2008; Elufioo, 2018). The design of the research questionnaire employed a five-point Likert scale, where one indicates the lowest degree of significance/ frequency and five the highest degree of significance/ frequency. The questionnaire addressed two main issues, the frequency and significance of the identified risk factors and their contributions to the inefficiencies in construction estimating. Reliability test was conducted because the measurement variables despite, their spread in pertinent literature were not applied to explore the dimension of construction estimating risks. The reliability test was determined by exploring the suitability of the survey data for factor analysis (see results section).

The study developed database management systems for field data and analysis involved SPSS version 23. The significance of risk sources and factors can be increasingly determined using risk matrix (Odeyinka et al., 2012) and coefficient of variation (COV) (Aibinu and Pasco, 2008; Adafin, et al., 2016), while agreement within the sample favored Kendall's coefficient of concordance (Adafin and Rotimi, 2016). These tools are criticised for inducing fussiness in data. Various studied therefore applied the Terrell transformation index (TTI) to tackle fussiness in risk studies. The use of TTI in this study assisted to transform ordinal data into concrete data (Toh et al., 2012) with a view to determining the significant risk factors. The value of TTI ranges from zero - 100 and indices above 65 percent is an acceptable benchmark (Toh et al., 2012). Eq. (1) states the mathematical interpolation of TTI:

$$[ARS - LPRS / PRSR] \times 100 \quad (1)$$

where:

ARS: the average raw score (mean);

LPRS: the least possible score (1);

PRSR: the possible raw score range.

The significant sources of risks were determined using confirmatory factor analysis (Alkhadim et al., 2018) and fussy set theory (FST) (Ekung et al., 2020). Results of exploratory factor analysis (determinant and sampling adequacy) determined the reliability tests. Factor score benchmarks (> 0.90) are excellent; scores (> 0.8) are very good, scores (> 0.70) are good, while (> 0.60) are acceptable ((Liu et al., 2017) were applied to categorised the spread (frequency) of the risk factors. Studies by Xu et al. (2012) and Yudollahi et al. (2014) provide extensive discussions of theoretical issues underpinning FST. The analysis of data using FST consists of exporting SPSS data to Excel sheet and the associated computations involved four stages. The first step was to determine the mean score and standard deviation, the second step was to calculate the Z-score, the third step ascertained the degree of association using Excel normal distribution program, while the step was to decide the critical risk sources based on Lambda cut (λ). This study adopted a 0.70 benchmark following a similar decision in the past study (Shen et al., 2012). The components with scores above 0.70 are therefore the principal sources of construction estimating risks. The study also determined variance in the significance and frequency of the risks within the sample based on respondents' experience using Kruskall Wallis test (Pallant, 2016).

4. Results

4.1. Respondents' Characteristics

The study achieved an efficiency rate of 58.74% in the survey. The number of valid responses retrieved (121) is greater than the minimum sample size (95); therefore, the survey strategy was effective. The sample consists of registered quantity surveyors with varying years of experience in construction estimating. The minimum educational qualification of respondents is a first degree and its equivalent, while 35 percent of the sample had postgraduate degrees (MSc and above). The respondents' construction estimating experience varies between the building and civil engineering projects, but the majority are engaged in building projects. In sum, therefore, the data in Table 1 shows that the professional/ educational qualifications of the respondents as well as their experience in construction estimating are adequate for making an inference.

Table 1. Respondents' characteristics

Variables	Frequency	Percent
Professional registration		
Members	105	87
Fellow	16	13
Total	**121**	**100**
Construction estimating experience		
0-10 years	58	48
10 -20 years	38	31
20 years and above	25	21
Total	**121**	**100**
Educational qualification		
First degree	78	65
MSc	37	31
Mphil/PhD	5	4
Total	121	100
Sector of respondents		
Consultancy	74	61
Contracting	47	39
Total	121	100
Projects		
Building	88	73
Civil	33	27

Table 2. Explained variance

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	13.025	40.705	40.705	13.025	40.705	40.705
2	3.625	11.327	52.032	3.625	11.327	52.032
3	2.698	8.430	60.462	2.698	8.430	60.462
4	1.865	5.828	66.290	1.865	5.828	66.290
5	1.547	4.834	71.124	1.547	4.834	71.124
6	1.333	4.166	75.289	1.333	4.166	75.289
7	1.137	3.553	78.843	1.137	3.553	78.843
8	1.065	3.328	82.171	1.065	3.328	82.171

Extraction Method: Principal Component Analysis

4.2. Reliability Tests

The reliability of the research instrument, measurement variables and factor analysis were determined in the study by screening the data for multicollinearity and sampling adequacy. These dimensions were determined using a descriptive determinant of the correlation matrix and Kaiser-Mayer-Olkin (KMO). The reliability tests were benchmarked on the values 0.00001 and 0.5 (Field, 2005). The determinant of the correlation matrix was 0.0008 > 0.00001, while the KMO and Barlett values were 0.762 > 0.50 and 1824.473 (p-value: 0.000), respectively. These results show the absence of multicollinearity and indicate that the order of correlation is compact. Therefore, the survey data and factor analysis are appropriate, while the factors generated by the analysis are likewise consistent. Strong interrelationships, therefore, exist among the variables and the correlation matrix is not an identity matrix.

4.3. Explained Variance

Eight risk factors explained the significant variance in the dataset. Eight risk factors generated initial Eigenvalues greater than one with a cumulative explained variance of 82.17 percent (Table 2). The explained variance is an exploratory factor analysis that directs the number of principal components that can be extracted to explain the full dimensions of construction estimating risks. Therefore, only 8 out of 35 risk factors surveyed pose the greatest threats to the efficiency of construction cost estimation. The result in Table 2 also shows that twenty-seven risk factors can only explain an insignificant 17.83 percent of the inefficiency experienced during construction cost estimation.

4.4. The Frequency of Construction Estimating Risks

The frequency of construction estimating risks was first determined using the degree of commonness among variables (based on communality scores). The frequency of each risk is based on the factor scores stated in the methodology section. The result shown in Table 3 reveals four bands in the degree of frequency with score ranges (0.60 < 0.70; 0.70 < 0.80; 0.80 < 0.90 and > 0.90). Two risk factors (six percent), that is, lack of estimate preparation plan and low level of competition are excellent (scores > 0.90) and the most prevalent construction estimating risks. Twenty-three risk factors (sixty-six percent) are very good (scores > 0.8) and frequent construction estimating risks. Eight risk factors (twenty-three percent) are good (scores > 0.70) with the moderate occurrence, while another two risk factors (six percent), are acceptable (scores > 0.60) and infrequent construction estimating risks. The implication indicates that 35 risk factors obtained 0.60 > 0.50 (Xue et al., 2018) and are frequent within cost management practice in the research environment.

4.5. Significance of Construction Estimating Risks

The significance of risks was determined using TTI. The transformation present concrete data that closely reflect the importance of each risk factor in the practice environment based on 65 percent benchmark (Toh et al., 2012). The results in Table 4 shows that 29 risk factors (83 percent) are significant drivers of inefficiencies in construction estimating. This set of risk obtained TTI between 69 - 87 percent and their degree of significance vary with their TTI indices. The most important risks include a low level of construction knowledge, unstable market conditions, inflation and level of competition. However, six risk factors (14 percent) were insignificant and their impact on construction estimating is therefore inconsequential. The insignificant risk factors in the study include lack of team integration and alignment, wrong choice of the form of contract, lack of quality and reliable cost information, non-availability of resources and location of projects. The opinion of the respondents about these risk factors indicates their degree of uncertainty is minimal. Therefore, even though 35 risk factors occur frequently; only 29 have a significant impact on construction estimating.

4.6 Components of construction estimating risks

Table 5 shows the component matrix with suppressed loading less than 0.50. The matrix extracted eight components in line with explained variance (Table 2). Twelve factors loaded into the first component with inaccurate cost information (0.817) emerging the most important factor. Cost data are therefore the first source of construction estimating risk. The second principal risk component has eight factors, the most important factor is inadequate level of construction knowledge (0.817), and the second principal source of construction estimating risk is therefore construction knowledge. The third component has four factors, the most significant risk is frequent design stage variations (0.873) and the third source of construction estimating risk is quality of design information. The fourth component also has four factors, level of competition (0.851) emerged the most important factor in this category. The fourth source of construction estimating-risks is economic condition. The fifth component of the matrix has three important risk factors, but estimator's years of experience (0.819) emerged the most important factor. The fifth source of construction estimating-risk is expertise of estimator. Three risk factors also underpin the sixth component and the most important variable relates to inadequate number of estimating staff (0.782). The sixth component is named estimating resources. The seventh component has two factors and the most important risk factor is government regulation (0.781), this source of construction estimating risk is geographic factor. The eight component has the factor score (0.845) and the only risk retained in this category is project characteristics, this source of risk is framed project related factors.

Table 3. Frequency of estimating risks

S/N	Risk factors	Initial	Extraction	Remarks
1	Level of education	1.000	.762	Good
2	Years of experience	1.000	.806	Very good
3	Level of construction knowledge	1.000	.741	Good
4	Available tools and equipment	1.000	.844	Very good
5	Error in judgement	1.000	.824	Very good
6	Synergies with other firms	1.000	.898	Very good
7	Bidding climate/economic situation	1.000	.688	Acceptable
8	Political stability	1.000	.844	Very good
9	Market condition	1.000	.823	Very good
10	Government regulation	1.000	.878	Very good
11	Location of projects	1.000	.893	Very good
12	Availability of resources	1.000	.795	Good
13	Current workload	1.000	.810	Very good
14	Inadequate Number of estimating staff	1.000	.881	Very good
15	Estimator's nature of practices	1.000	.807	Very good
16	Professional qualification	1.000	.806	Very good
17	Political interference	1.000	.802	Very good
18	Poor estimating coordination	1.000	.944	Excellent
19	Level of management involvement	1.000	.893	Very good
20	Lack of team integration and alignment	1.000	.773	Good
21	Lack of accurate cost data bank	1.000	.789	Good
22	Inaccurate cost information	1.000	.760	Good
23	Lack of procedure of updating cost information	1.000	.881	Very good
24	Lack of quality and reliable cost assumptions	1.000	.804	Very good
25	Inadequate time of prepare estimate	1.000	.865	Very good
26	Frequent design stage variations	1.000	.877	Very good
27	Client requirements and priorities	1.000	.613	Acceptable
28	Inflation	1.000	.733	Good
29	Level of competition	1.000	.909	Excellent
30	Procurement strategies	1.000	.851	Very good
31	Project/program duration	1.000	.843	Very good
32	scope/type of project	1.000	.779	Good
33	Type of tendering	1.000	.841	Very good
34	Form of contract	1.000	.826	Very good
35	Contract period/tendering period	1.000	.828	Very good

Extraction Method: Principal Component Analysis.

Table 4. Level of significance of estimating risks

S/N	Risk Factors	ARS	LPRS	PPRS	TS	TTI	Decision
1	Estimator’s inadequate education and qualification	4.17	1.00	4.00	0.79	79.00	Critical
2	Inadequate estimating experience	4.04	1.00	4.00	0.76	76.00	Critical
3	Inadequate knowledge of construction	4.44	1.00	4.00	0.86	86.00	Critical
4	Lack of estimating tools and equipment	4.37	1.00	4.00	0.84	84.00	Critical
5	Error in judgement	4.00	1.00	4.00	0.75	75.00	Critical
6	Lack of synergies with other firms	4.43	1.00	4.00	0.86	86.00	Critical
7	Unstable bidding climate/economy	4.13	1.00	4.00	0.78	78.00	Critical
8	Political instability	4.20	1.00	4.00	0.80	80.00	Critical
9	Unstable market condition	4.22	1.00	4.00	0.81	80.00	Critical
10	Changes in government regulation	4.17	1.00	4.00	0.79	79.00	Critical
11	Location of projects	3.48	1.00	4.00	0.62	62.00	Not critical
12	Non-availability of project resources	3.24	1.00	4.00	0.56	56.00	Not critical
13	Estimating firm’s current workload	4.04	1.00	4.00	0.76	75.00	Critical
14	Inadequate number estimating staff	4.24	1.00	4.00	0.81	81.00	Critical

Table 4. Level of significance of estimating risks (continued)

S/N	Risk Factors	ARS	LPRS	PPRS	TS	TTI	Decision
15	Lack of estimate preparation plan)	4.28	1.00	4.00	0.82	82.00	Critical
16	Non-involvement of management	4.41	1.00	4.00	0.85	85.00	Critical
17	Lack of team integration and alignment	3.39	1.00	4.00	0.60	60.00	Not Critical
18	Lack of accurate cost data bank	3.86	1.00	4.00	0.71	72.00	Critical
19	Inaccurate cost information	3.93	1.00	4.00	0.73	73.00	Critical
20	Lack of procedure for updating cost information	3.22	1.00	4.00	0.56	56.00	Not critical
21	Lack of quality and reliable cost assumptions	3.41	1.00	4.00	0.60	60.00	Not critical
22	Inadequate time of prepare estimate	3.83	1.00	4.00	0.71	71.00	Critical
23	Frequent design stage variations	4.04	1.00	4.00	0.76	75.00	Critical
24	Improper scoping of client requirements	4.07	1.00	4.00	0.77	77.00	Critical
25	Inflation	4.39	1.00	4.00	0.85	84.00	Critical
26	Low level of competition	4.35	1.00	4.00	0.84	84.00	Critical
27	Use of wrong procurement strategies	4.17	1.00	4.00	0.79	79.00	Critical
28	Length of Project/program duration	4.46	1.00	4.00	0.87	87.00	Critical
29	Scope/type of project	3.85	1.00	4.00	0.71	71.00	Critical
30	Type of tendering	3.80	1.00	4.00	0.70	70.00	Critical
31	Form of contract	3.22	1.00	4.00	0.56	56.00	Not critical
32	Contract period/tendering period	4.22	1.00	4.00	0.81	81.00	Critical
33	Inadequate specifications	4.19	1.00	4.00	0.80	80.00	Critical
34	Defective designs	4.00	1.00	4.00	0.75	75.00	Critical
35	Inflation	3.78	1.00	4.00	0.69	69.00	Critical

Table 5. Rotated component matrix

Risk Factors	Component							
	1	2	3	4	5	6	7	8
Scope and other project characteristics								.845
Professional qualification				-.590			-.526	
Years of experience of estimator					.819			
Nature of practice					.796			
Level of construction knowledge		.817						
Cognitive skills		.721						
Available tools and equipment		.646						
Error in judgement	.768							
Synergies with other firms		.513				.519		
Bidding climate/economic situation		-.636			.503			
Political stability			.759					
Market condition	.783							
Government regulation							.781	
Location of projects	.791							
Availability of resources	-.621							
Current workload	.779							
Inadequate Number of estimating staff						.782		
Poor estimating coordination (planning)		-.570						
Level of management involvement	-.511		.556					
Lack of team integration and alignment	.514	-.734						
Inadequate Number of estimating staff			.700					
Inaccurate cost information	.817							
Lack of procedure for updating cost information	-.516	.602						
Lack of quality and reliable cost assumptions	.562							
Inadequate time of prepare estimate	.777							
Frequent design stage variations			.873					
Client requirements and priorities	.751							
Inflation						.560		
Level of competition				.851				
Procurement strategies								
Project/program duration				.777				
Level of education				-.730				

Table 6. Principal sources of estimating risks

S/N	Sources of Estimating Risks	Mean Score	Std. Dev	Z-score	λ	Decision
1	Costs data	4.22	0.603	2.023	0.978	Sig./ Accept
2	Construction knowledge	4.44	0.603	2.388	0.992	Sig./ Accept
3	Design information	3.85	0.737	1.153	0.876	Sig./ Accept
4	Economic condition	4.35	0.677	1.994	0.977	Sig./ Accept
5	Expertise of the estimator	4.02	0.726	1.405	0.920	Sig./ Accept
6	Estimating resources	3.93	0.749	1.242	0.893	Sig./ Accept
7	Geographic factors	4.17	0.607	1.928	0.973	Sig./ Accept
8	Project related factors	3.85	0.737	1.153	0.876	Sig./ Accept

4.7. The significance of Construction Estimating Risks Sources

The frames arising from Table 4 are validated further using the FST in this section. The objective was to determine their degree of association with the set of principal sources of construction estimating-risks. The significance of the source of risk depends on the value of the lambda cut, the study adopted a cut-off point of 0.70 and above (see methodology section). The result in Table 6 shows that the eight components are significant principal sources of estimating risks (λ, 0.876 - 0.992).

4.8. Test of Variation in Respondents' Perception of Risks Significance

The study used a random sample of registered quantity surveyors, but due to variation in respondents' level of experience (Table 1), the study assessed whether their perceptions about the frequency, significance and sources of risks validated vary, by testing a hypothesis. The hypothesis states that the perceptions of respondents about the three dimensions of construction estimating risks (frequency, significance, and sources) do not vary. The objective was to determine whether the degree of significance of the three dimensions is consistent across the sample using the Kruskal Wallis H test. The result revealed that respondents' perceptions about the three dimensions of construction estimating risks vary (Chi-Square: 2.484, df:, 2, p-value: 0.289 (> 0.05)). The study, therefore, accepted the null hypothesis. This result is never a surprise because prior theory posited that construction professionals' perception of risk impacts and their probability of occurrence depends on their length of service (Agyakwa-Baah and Chileshe, 2010).

5. Discussion

Twenty-nine risk factors originating from eight sources are critical construction estimating risks. The principal sources, frequency, and degree of significance of these risk factors vary across the sample (p-value: 0.289 > 0.05). The principal sources of estimating risks were estimating resources, construction knowledge, design information, economic condition, the expertise of estimator, geographic factor, cost data, and projected factors. Unlike past studies, various causes of inaccuracies in cost estimates are not focal risks that can inhibit the performance of construction estimates. This position is based on the dynamics of prevalent estimating practice in the research environment. The variability is therefore not a surprise, but similar to the findings reported for an Australian study (Lim et al., 2015). Lim et al. (2015) noted that possible drivers of variance in construction estimates are regional issues in terms of organisation, estimating approaches and nature of construction practice. None withstanding these differences, certain sources of construction estimating risks are consistent with past studies namely: experience and expertise of estimator, project conditions and cost data.

5.1. Cost Data

Cost data are a source of construction estimating risk when the estimators fail review the context of the past project before applying historical data to the current project. Cost management encompasses a large volume of qualitative and quantitative cost data (information) utilised to generate project estimates (Jaggar and Ross, 2003). However, cost data are laden with uncertainties; as a result, building services trade contractors in the UK relied minimally on historical cost (Al-Hassan et al., 2005). Despite pertinent concerns raised about the credibility of cost data, the opinion of building services contractors in the UK disagrees with the vast application of cost information services in that region. The findings in a later study in Malaysia however, contrasted the perception that cost data should be relied upon minimally (Azman et al., 2013). According to Azman et al. (2013), diligent application of historical cost enhances the accuracy of building estimates. The relevance of this risk component also agrees with a Tanzanian survey (Elufioo, 2018); where the quality of cost data emerged as the third most important factor affecting estimate accuracy. Quality and quantity of cost data are therefore a significant construction estimating risk affecting the performance of construction estimating. The developing countries and some developed nations unlike the UK, lack a fully developed and up-to-date cost database for obtaining cost information such as building cost information service. The magnitude of risk in cost data becomes glaring when reprising pricing policy for large and small quantities. Construction operations with large quantities attract economies of scale and this benefit eludes projects with small quantities. The implication is that large quantities attract fairly lower rates, while the rate for small quantities is relatively higher. Cost information lacks discrete details about the quantity of each operation and the cost variance created by pricing policy contributed to bias in estimates. Cost data also emerged as a front-end factor driving biases in construction estimates because; historical costs are derivatives of lowest tender. Only data for successful tender are analysed and modelled and cost benchmarks from the lowest tender are loaded with irregularities.

5.2. Geographic Factors

The important threat in geographic factor is government regulations (factor loading, 0.781). This result is consistent with that of Enshassi et al. (2005), which found that the political situation of a region is one of the top five factors influencing the accuracy of estimates. Different regions operate with varying governance variables and the nexus between the construction sector, national economy and governance quality is seminal. Critical risk factors in this category include variation in the cost and availability of resources (labour, materials, and plant), taxes, and freight charges, variation in overhead cost components such as insurance for hazards and builder's risk and demand and supply. Wright (2014) and Dell'Isola (2003) insisted that variations in market conditions are correlates of geographic factors that must be critically analysed. In the Malaysian study, Azman et al. (2013) reported state-to-state biases in public work estimates. Instability of government regulation induces instability in economic policies, market conditions, inflation and foreign exchange fluctuations. Political and governance quality of a region are critical risks events in this study. The respondents in Oyewobi et al. (2012) rated these risks very high among the significant concerns affecting contractors' estimates. Governance quality concerns such as corruption are significant notably in public sector construction projects in many places (Shan et al., 2017).

5.3. Market Condition

This component deserves a separate in-depth analysis even though it is interrelated to the economic dimension. According to Doloi (2011), the market condition is one of the recurrent themes amongst the problems linked with cost estimation. Dell'Isola (2003) affirmed that market condition follows the prevailing economic situation of a region. Market condition is concerned with the structure of the construction market and is subject to fluctuations with the season and time of the year. This factor was a critical regulator of contractors' profit margin in tender (Menches et al., 2008). There are procurement seasons, favorable construction boom periods and downturn and each of these conditions influences costs directly. Certain items of works such as landscaping for instance are executed at the end of the project and the implications of late execution on cost escalation (inflation) must be factored into their cost estimating (Wright, 2014). Dell'Isola (2003) identified two dimensions of market competition namely positive and reduced competition. In a period of positive competition, the work demand is high and firms' overhead and profit could see a decline to enhance the success rate of tenders. Reduced competition results in a reduced number of bidders and there is a high expectation of profit. Appropriate awareness of these dynamics is important to construction estimating, failure of which can vitiate the viability of the cost estimate generated. Findings in Adafin and Rotimi (2016) validated that market condition is a significant risk that induces cost increases in construction resources. Laryea and Hughes (2008) also found that level of competition determines the scope of risk allowance included in the tender. Respondents in the research of Enshassi et al. (2005) prioritised inflation in the cost of materials as one of the major sources of vitiating factors affecting estimates. Aibinu and Pasco (2008) also found that failure to build market sentiments' into construction estimates could predict unsuccessful completion. The results also agree with the findings of Serrado et al. (2019) that market risks can trigger budget and productivity failures. However, the perception towards this component of risk varies with modification in a country's economic and political fortunes.

5.4. Economic Condition

Important risk factors in this category deal with fluctuation, inflation and an increase in the interest rate and economic situation among others. The perspectives of fluctuation and inflation are not new to cost management practice. In fact, most estimate review in contracting organisations culminates in tasks, which focus on these issues. Two types of inflation are readily recognised namely: construction and tender inflations. Cost managers have expressed concerns about the inability to capture comprehensively, economic variables and that much project failure occurs due to changes in economic variables. Kaplinski (2013) recognised the need to forecast the precarious nature of the economy using utility theory in risk analysis. Between May 2015 and January 2016, sharp increases in inflation rates and foreign exchange ratio generated unfavorable ripples in on-going and planned projects in Nigeria. This condition is consistent in most developing country's settings as seen in the Tanzanian survey (Elufioo, 2018).

5.5. Quality of Design Information

Although this component emerged the least dimension of risk inhibiting estimate's efficiency, the significance of related risks are very high (TTI > 70 percent). Design factors ranked 4th in the recent Australian survey (Adafin and Rotimi, 2016) and 12th in Akintoye (2000), the UK study. In the Tanzanian survey (Elufioo, 2018), factors related to incomplete scope definition emerged the most significant construction estimating risk. Related factors in other studies with high rating include inadequate tender documentation (Odusami and Onukwube, 2008; Odeyinka et al., 2012). Inadequacies in design information are sources of variation and claims during the project development phase. Variation and claims adjust the project cost and time and lead to cost/time overrun. Similarly, the conclusion in Enshassi et al. (2005) also affirmed that clarity, accuracy and quality of drawn information are significant influences on building work estimate.

5.6. Expertise of Estimators/ Estimating Resources

The significance of years of experience, professional, and educational qualification was expected. This component and the sixth component (estimating resources) are related. The component features the importance of resource efficiency and availability in organisation performance. Respondents in Enshassi et al. (2005), strongly linked resource efficiency factor to accurate cost estimation and their findings also showed that the availability of the qualified technical team, experience, equipment and tools are indicators of an accurate estimate. Similarly, the role of resource efficiency also emerged as an important factor in stakeholders' conception of risk impact and probability (Agyakwa-Baah and Chileshe, 2010). The implication is that lengthy service period (years of experience), increases the understanding of the contingent risk factors in construction estimating. Estimating team must blend young and experience estimators since cost management experience is importantly tacit. This is appropriate to help firms improve estimating experience across the firm's strata (Aibinu and Pasco, 2008). A survey of pre-tender accuracy in Kaduna, Nigeria also confirmed that estimator skills level and experience could determine the accuracy of pre-tender estimates (Saidu et al. (2014) (see also Enshassi et al., 2005; Elufioo, 2018).

5.7. Project Related Factors

Multiple variables underscore project-related factors influencing construction-estimating risks. However, the result of project complexity and scope of project lead other factors in this category. Project and design (see the quality of design above) complexity create misunderstanding and inaccurate quantification of scope and specific project requirements. Interviewees in the study of Doloi (2011) also found project-related factors significantly structured problems in cost estimation. Azman et al. (2013) also found that the types of schools and contract period were imperative drivers of bias in public work estimates in Malaysia. Enshassi et al. (2005) settled that the method of construction and complexity of design are two most important project related variables influencing the accuracy of construction estimate. Tender period and access to the site were also the second and fourth most important risk factors affecting estimate for building works in Tanzania (Elufioo, 2018).

In sum, the result of this study showed that the performance of construction estimates would improve when quantity surveyors incorporate these dimensions of risks into project costing. The study may have tackled practices using the experience of Nigerian quantity surveyors, but the results portray global relevance. Construction estimating is universal with ubiquitous practices tailored to established standards in different industries. Even though the scope and influence of estimating risks may vary along with regional contexts, contingent sources of primary risks would remain correlates of estimating resources, construction knowledge, design information, economic condition, the expertise of estimator, geographic factor, cost data and project factors. This generalization emerged from the agreement between the perceptions of cost managers in the study with other local and international literature on risk sources, frequency and significance as seen in the discussion section. The results of the study, therefore, provide the navigation compass for understanding construction-estimating risks across varying construction settings and practices by future studies.

6. Conclusion

The study closed the gap in knowledge related to the scope of construction estimating risks, which instruct cost growths. The study jettisoned customary penchant to generic assumptions about construction risks in the literature to evaluate the sources, frequency and significance of critical construction estimating risks. Multiple analyses of survey data provided the register of 29 most frequent and significant construction estimating risks, which originates from eight principal sources. The top five risks are low construction knowledge, unstable market conditions, change in government regulations, inadequate expertise and low competition (TTI, 69-87 > 65 percent). These risk factors are contingent on multiple sources, which principal attributes showed affinity to estimating resources, construction knowledge, design information, economic condition, the expertise of estimator, geographic factor, cost data, and project-related factors. Even though the risk factors are frequent across the sample, participants' conceptions about their significance vary. Accurate assessment of these risk dimensions into project costs conveys enormous beneficial opportunities to reduce incidences of cost overrun in the construction project delivery. The study recommends synergies between projects' internal/ external environments for proper scoping of these risks into project estimates. The premise that the study is explorative research relying on the perceptual knowledge and experiences of quantity surveyors in the study area points to the possible limitation that may not reflect interpretive conditions in the practice domain. However, the data analyses, qualification and inferences arising thereof are large without influences of fussiness due to the applied transformation matrix, the results obtained are therefore satisfactory. Future studies may consider exploring related assumption using alternative research approach or mixed methods.

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