ISSN 1822-427X/eISSN 1822-4288
2022 Volume 17 Issue 4: 171–188
https://doi.org/10.7250/bjrbe.2022-17.584

THE BALTIC JOURNAL OF ROAD AND BRIDGE ENGINEERING
2022/17(4)

UNEARTHING CAUSATIVE FACTORS OF COST OVERRUN ON GHANAIAN ROAD PROJECTS

OPEOLUWA AKINRADEWO*, CLINTON AIGBAVBOA, AYODEJI OKE, HARRISON COFFIE, BABATUNDE OGUNBAYO

cidb Centre for Excellence & Sustainable Human Settlement and Construction Research Centre, Faculty of Engineering and the Built Environment, University of Johannesburg, Johannesburg, South Africa

Received 20 December 2021; accepted 30 June 2022

Abstract. When determining the success of a road project, cost is one of the most important variables to consider. This is because cost is the project's backbone and driving force throughout the construction process. As a result, to assess the cost performance of a road project, the actual cost is compared to the planned cost. This research aims at uncovering the causal variables that contribute to cost overruns on road projects using Accra, Ghana as a case study. Relevant literature was thoroughly reviewed to extract identified factors. This study adopted a quantitative research approach, using a questionnaire developed to collect data from the target audience. The questionnaire survey was conducted using civil engineers and quantity surveyors working in the Ghanaian construction sector. The data that were retrieved were analysed using descriptive statistics and exploratory factor analysis. According to the findings, the main reasons driving cost overruns on road projects include consultant/contractor-related, environment-related, economy-related, risk/uncertainty-related, technical-related, owner/client-related, and other project-related

* Corresponding author. E-mail: opeakinradewo@gmail.com

Opeoluwa AKINRADEWO (ORCID ID 0000-0002-4462-0960)
Clinton AIGBAVBOA (ORCID ID 0000-0003-2866-3706)
Ayodeji OKE (ORCID ID 0000-0001-6551-8634)
Harrison COFFIE (ORCID ID 0000-0002-2178-3978)
Babatunde OGUNBAYO (ORCID ID 0000-0002-4334-9136)

factors. It was determined that cost overruns in construction projects occurred because of a lack of professionalism on the part of the stakeholders engaged in the construction process from start to finish. Future research may therefore be conducted utilising all of Ghana's regions to obtain a broad view of the research.

Keywords: construction industry, construction projects, cost overrun, Ghana, project cost, road projects.

Introduction

Fragkakis et al. (2015) opine that transport infrastructure is central to modern-day living by providing means of mobility for travelling to work, for example, as well as for moving materials and goods. As the backbone of the transport system, road infrastructure serves as a connection between the populace while keeping the economy of the country flowing and constituting a crucial constituent of the economic, environmental, and social well-being. Odeck (2004) maintains that transportation agency engineers and construction contractors employ a variety of approaches in estimating a project cost ranging from formulating labour crew compositions and quoting labour productivity, equipment needed and material costs and then adding overhead/profit not forgetting to evaluate contingencies before submitting the tender as a set of line-item unit prices. In preparing subsequent cost estimates for construction projects, transportation agency engineers examine bid line-item unit prices for previous projects and the factors affecting these unit prices are analysed to arrive at a preliminary estimate (Fragkakis et al., 2015). Factors affecting the unit prices taken into consideration include project type, size and location among others which are then adjusted accordingly (El Asmar et al., 2011). The major challenge encountered in preparing a preliminary estimate is when it is to be done at the conceptual phase of the project when little project information is available. The preliminary estimate is expected to include not just the construction cost but also the non-construction costs, which are engineering design production cost, right-of-way and moving utilities, and contingencies for uncertainties (El Asmar et al. 2011). According to Swei et al. (2017), a study of building cost estimating patterns over the past five decades reveals a poor degree of accuracy on early estimates compared to actual construction costs (Love & Ahiaga-Dagbui, 2018; Eliasson & Fosgerau, 2013; Molenaar, 2005). When there is growth or an increase in cost or an increase in the budget for a construction project, it is said that there is cost overrun and the opposite is referred to as cost underrun. However, cost overrun must not be misinterpreted as cost escalation, which is an increase in the budget due to inflation.

It is a general view that cost overrun is more frequently experienced in construction projects compared to cost underrun. This has been attributed mostly to underestimation, which is presented at the decision-making phase of construction projects and thus affects proper budgeting for construction projects. It has also been attributed to decision-makers not considering the future value of a project during project viability examination (Love et al., 2013; Odeck, 2004). By adopting an in-depth approach to assessing cost overrun on road projects in the Ghanaian construction industry, this research adds tangibly to the body of knowledge. This is achieved through an extensive review of extant literature on cost overrun factors from developing countries across the world. The outcome of this study will be useful in determining the major factors to reduce the issue of cost overrun on road infrastructure and minimise the number of abandoned or delayed road projects in Ghana. These factors were evaluated by respondents and analysed using factor analysis to cluster them based on their underlying attributes. These clusters will give stakeholders a concise approach to solving the cost overrun menace on road construction projects by focusing attention on the attributes of each cluster.

1. Cost overrun in the construction industry

Various research studies have been conducted to determine the severity of cost deviation on construction projects across the world. Fouracre et al. (1990) examined fifteen metro systems constructed in developing countries and cost overrun was calculated on eleven projects with three of these having a cost overrun range between 20% and 50%; two metro systems had a cost overrun range between 100% and 500%; and six metro systems had a cost overrun average above 50%. The remaining four metro systems had cost deviation ranging between −10% and +20%. Auditor General Sweden (1994) researched eight road and seven rail projects executed by the Swedish government. A cost deviation of 86% was calculated with a range between −2% and +182% on road projects while 17% was calculated on rail projects with a range between −14% and +74%. Flyvbjerg (2007) calculated a cost deviation of 20.4% for 167 road projects, while Vidalis & Najafi (2002) calculated an average cost deviation of 10.52% for 708 road projects. In an evaluation of 138 road projects, Long et al. (2008) calculated cost overrun of 50% for 131 road projects and the remaining seven projects recorded cost underrun. Ellis et al. (2007) examined 3130 road projects in the USA and found an average cost deviation of 9% while Kaliba et al. (2009) evaluated eight road projects in Zambia and calculated an average cost deviation of 69%.

Table 1. Causes of cost overrun on construction projects

S/N	Causes of Cost Overrun	Sources
1	Unexpected site condition	(Kasimu, 2012; Apolot, 2011; Nega, 2008; Sambasivan & Soon, 2007; Flyvbjerg et al., 2004; Frimpong et al., 2003)
2	Inadequate site investigation/ survey	(Nasir, Gabriel & Choudhry, 2011; Azhar, Farooqui & Ahmed, 2008)
3	Poor site management	(Nega, 2008; Sambasivan & Soon, 2007; Assaf & Al-Hejji, 2006; Acharya, Lee, Kim, Lee & Kim, 2006; Roachanakanan, 2005)
4	Unavailability of resource cost data for estimating	(Elinwa & Silas, 1993)
5	Inaccurate/irrational cost estimation	(Ibironke, Oladinrin, Adeniyi & Eboreime, 2013; Nasir et al., 2011)
6	Change in road project scope/ concept	(Nasir et al., 2011; Kaliba et al., 2009; Nega, 2008; Lee, 2008; Azhar et al., 2008; Assaf & Al-Hejji, 2006; Acharya et al., 2006; Roachanakanan, 2005; Flyvbjerg & ET AL., 2004)
7	Use of unqualified/incompetent contractors/sub-contractors	(Ibironke et al., 2013; Affleck & Freeman, 2010)
8	High overhead cost to contractor due to remote/insecure area	(Zafar, Yousaf & Ahmed, 2016)
9	Non-availability/shortage of skilled labour	(Kasimu, 2012; Apolot, 2011; Affleck & Freeman, 2010; Azhar et al., 2008; Sambasivan & Soon, 2007; Acharya et al., 2006; Assaf & Al-Hejji, 2006; Faridi & El-Sayegh, 2006; Frimpong et al., 2003)
10	Change in foreign exchange	(Nega, 2008)
11	Inadequate communication among professionals	(Nega, 2008; Azhar et al., 2008; Sambasivan & Soon, 2007; Assaf & Al-Hejji, 2006; Acharya et al., 2006)
12	Poor road project planning	(Elinwa & Silas, 1993)
13	Excessive rework and low productivity due to unskilled workforce	(Kasimu, 2012; Apolot, 2011; Nega, 2008; Sambasivan & Soon, 2007; Faridi & El-Sayegh, 2006; Assaf & Al-Hejji, 2006; Roachanakanan, 2005)
14	Economic instability	(Omoregie & Radford, 2006)
15	Cost of providing plants/ equipment	(Kasimu, 2012; Azhar et al., 2008; Assaf & Al-Hejji, 2006)
16	Corruption, fraudulent practices, and kickbacks	(Azhar et al., 2008)
17	Inappropriate procurement system	(Assaf & Al-Hejji, 2006; Acharya et al., 2006)
18	Inadequate project duration	(Park & Papadopoulou, 2012; Aibinu & Jagboro, 2002)
19	Work suspension due to inter-tribal conflicts	(Kasimu, 2012; Nasir et al., 2011; Azhar et al., 2008; Assaf & Al-Hejji, 2006; Acharya et al., 2006))
20	Adverse weather conditions	(Azhar et al., 2008; Lee, 2008; Sambasivan & Soon, 2007; Frimpong et al., 2003)
21	Unsuitable construction method	(Sambasivan & Soon, 2007)
22	Quick impact project resulting in additional cost (e.g., water supply, medical facility etc.)	(Zafar et al., 2016)
23	Dispute on construction site	(Aibinu & Jagboro, 2002)
24	Untimely payment for completed works	(Park & Papadopoulou, 2012)
25	Risk and uncertainties	(Olawale & Sun, 2010)

In a study of 157 road projects in India by Singh (2009), an average cost deviation of 15.84% was calculated. Lee (2008) also evaluated sixteen railway projects and calculated a 50% cost overrun on all the railway projects. Odeck (2004) evaluated 620 road projects and calculated a cost deviation average of 7.9% with a range between −58.5% and +182.7%. More recently, Love et al. (2015) evaluated forty-nine public sector road projects and a cost overrun of 13.55% was calculated. It is, therefore, evident that cost deviation is a common phenomenon associated with construction projects worldwide.

1.1. Global review of factors causing cost overrun on construction projects

Cost overrun has been a significant issue on road projects and numerous researchers have investigated their origins. It has been discovered that it may be due to a variety of variables that vary for building sectors across the globe, as indicated in Table 1.

From the review highlighted in Table 1, the identified causes of cost overrun are generic to construction projects. However, this study is specific to road construction projects which have been noted to have peculiarity compared to other construction projects (Nega, 2008; Ellis et al., 2007).

2. Research method

Organising investigations to identify variables and their connections with one another is referred to as research methodology. To determine the factors that lead to cost overruns on road construction projects in Ghana, this study used a quantitative research method. To make this achievable, a questionnaire was developed to gather information from the target population. The questionnaire that was developed was administered in Accra, Ghana, which is a middle-income country in West Africa. Ghana's construction industry is dominated by physical infrastructure which helps contribute to the country's expanding economic market in Sub-Saharan Africa. The target audience of the study consists of civil engineers and quantity surveyors who operate in Ghana's construction industry, particularly in the capital city of Accra. As it was expected that the whole target population would not give a response to the questionnaire distributed, random sampling was employed for this study. Due to geographical limitations, respondents were reached through an e-questionnaire (Google form), and contacts were made via their professional institutions. The questionnaire was developed based on a review of extant literature. The questionnaire provided the respondents with factors to rank according to their professional experience. 461 questionnaires were sent out to the target population and a total of 246 were retrieved after 6 months to show a 53.4% response rate, which according to Nulty (2008), was appropriate for an online survey. The retrieved questionnaires were reviewed and cleaned to ensure their usefulness, and all 246 were found to be acceptable for analysis. After the development of the questionnaires using a 5-point Likert scale to elicit respondents' opinions, the obtained data were analysed using descriptive and exploratory factor analysis method. Exploratory factor analysis (EFA) is a statistical analysis tool useful for reducing large data to a smaller data set by exploring the fundamental theoretical structure of the variables. It helps in pointing out the relationship structure existing between the respondents and each variable (Pallant, 2011). The Mann-Whitney U non-parametric test and Cronbach's alpha were also employed in the research to compare the opinions of the respondents and evaluate the reliability of the data collection tool (Tavakol & Dennick, 2011). This non-parametric test is done for small sample groups as it does not make assumptions regarding the population distribution (Pallant, 2011). For the reliability of the data collection instrument, a Cronbach alpha value of 0.905 was achieved. This demonstrates that the data collection instrument is trustworthy, and the results received are accurate.

3. Findings and discussion

Male respondents make up 88.6% of the overall population, according to the 246 answers deemed acceptable for analysis in the questionnaire survey. Only 11.4% of respondents are female. Civil engineers make up 49.4% of those who responded to the questionnaire survey, while quantity surveyors make up the remaining 50.6%. According to the categorization of the respondent's years of experience, there is an indication that a majority of participants have been in the construction industry for about ten years, while the overall average

Table 2. Experience on road project with cost overrun

Have you been involved in road construction that experience cost overrun before?	Frequency	Percent
Yes	139	56.3
Not sure	93	37.9
No	14	5.7
Total	246	100.0

for the respondents is eight years. This is more than enough to give the information needed for this research. According to the results of the analysis concerning the highest academic qualification of the respondents, most respondents have a significant educational level above ordinary national diploma which makes them qualify to participate in this study. According to data analysis related to the organisation which respondents work for, the largest number of respondents work for government organisations. Therefore, their opinion can be relied upon as government is the biggest player in road project execution in the Ghanaian construction industry. Regarding the classification of the number of road projects in which the respondents are involved in, all the respondents have actively completed some road projects and therefore have a fundamental knowledge of what road projects entail.

Respondents were asked to give information on their involvement in previous road projects that had cost overruns (see Table 2). According to the data, most of the respondents have first-hand experience of cost overrun on road projects.

3.1. Descriptive analysis of factors causing cost overrun on road projects

Having carefully reviewed the literature, 46 variables were identified to be the causes of cost overrun on road projects. These variables were ranked by respondents and subjected to the Mann-Whitney U (MWU) test. Opinions of the respondents were sought by ranking of the variables using a five-point Likert scale "where 1 = *Strongly disagree (SD);* 2 = *Disagree (D);* 3 = *Average (Av);* 4 = *Agree (A);* 5 = *Strongly agree (SA)*." In the first position from Table 3 there is an 'adopted construction method' with a mean value of 4.56, and MWU of 906.500 followed by 'variation orders' with a mean value of 4.51, and MWU of 933.00; 'delay in payment by the client to contractor or contractor to suppliers' ranked third with a mean value of 4.45, and MWU of 901.500; in the fourth position there is an 'inappropriate procurement system and contract type' with a mean value of 4.39, and MWU of 944.500; 'change in project scope', 'use of unqualified/incompetent contractors/subcontractors' and 'method of financing bond and payments' all ranked fifth with a mean value of 4.38 each, and MWU of 916.500, 918.000, and 842.5000 respectively. Furthermore, Table 3 showed that 'economic instability' was ranked forty-first by respondents with a mean value of 3.63, and MWU of 677.000; 'inappropriateness of specifications' was ranked forty-second with a mean value of 3.62 and MWU of 772.500; the forty-third ranked variable was 'poor financial/cost control during construction'

Table 3. Factors causing cost overrun on road projects

Causes of cost overrun on road projects	Mean	Mann-Whitney U	Asymp. Sig. (2-tailed)	Rank
Adopted construction method	4.56	906.500	0.692	1
Variation orders	4.51	933.000	0.899	2
Delay in payment by client or contractor to suppliers	4.45	901.500	0.661	3
Inappropriate procurement system and contract type	4.39	944.500	0.989	4
Change in project scope	4.38	916.500	0.779	5
Use of unqualified/incompetent contractors/subcontractors	4.38	918.000	0.789	5
Method of financing bond and payments	4.38	842.500	0.331	5
Corruption and fraudulent practices	4.37	922.500	0.821	8
Political interference	4.36	929.500	0.876	9
Price fluctuation	4.34	819.000	0.231	10
Delay in materials/equipment/labour supply	4.34	707.000	0.024	10
Inadequate communication among professionals	4.32	849.000	0.360	12
Legal disputes arising during construction	4.32	866.000	0.443	12
High cost of procuring plants/equipment	4.31	781.500	0.124	14
Contractual management	4.31	944.500	0.989	14
Foreign exchange fluctuation	4.29	937.000	0.933	16
Adverse weather condition	4.26	921.000	0.815	17
Poor site supervision and management	4.25	763.000	0.090	18
Site workers' experience	4.25	809.500	0.205	18
Change in material quality	4.18	743.500	0.064	20
Inadequate insurance cover	4.17	824.000	0.266	21
Liquidated damages on the construction project	4.17	909.500	0.733	21
Natural disasters	4.16	881.000	0.551	23
Differing unexpected site conditions and workability	4.16	843.000	0.340	23
Contractor experience of project type	4.15	772.500	0.108	25
Government regulatory policies	4.11	841.500	0.339	26
Non-availability/Shortage of skilled labour	4.09	854.500	0.401	27
Project/design complexity	4.07	741.000	0.063	28
Excessive rework	3.99	940.500	0.960	29
Health and safety challenges on site	3.92	915.500	0.775	30
Work suspension due to inter-tribal conflicts	3.89	936.500	0.932	31
Risks and uncertainties	3.86	880.500	0.525	32
Insufficient project general information	3.82	915.000	0.771	33
Varied labour/equipment productivity	3.77	829.000	0.264	34
Inaccurate quantities/estimates/budget	3.75	889.500	0.584	35
Social impacts	3.74	837.000	0.313	36
Poor project planning	3.68	691.500	0.023	37
Adopted estimating technique	3.68	832.500	0.304	37
Cultural impacts	3.68	836.000	0.298	37
Clarity and accuracy in project schedule	3.67	778.500	0.139	40
Economic instability	3.63	677.000	0.016	41
Inappropriateness of specifications	3.62	772.500	0.122	42
Poor financial/cost control during construction	3.61	729.500	0.047	43
Remote/insecure area resulting in high overhead cost	3.60	798.000	0.190	44
Additional cost of quick impact project to appease locals	3.60	714.000	0.034	44
Project size	3.43	673.000	0.012	46

with a mean value of 3.61, and MWU of 729.500; 'remote/insecure area resulting in high overhead cost' and 'additional cost of quick impact project to appease locals' ranked forty-fourth with a mean value of 3.60 each, and MWU of 798.00 and 714.000, respectively; and the lowest-ranked variable by the respondents was 'project size', which had a mean value of 3.43 and MWU of 673.000. The ranking of the factors was based on their mean item score values in a descending order.

Non-parametric test carried out alongside the descriptive statistics revealed that only five factors had statistically significant differences in the opinion of the two groups of respondents. These factors include poor project planning, poor financial/cost control during construction, additional cost of quick impact project to appease locals, project size and economic instability which were ranked very low by the quantity surveyors compared to the civil engineers. It is worthy of note that project size was ranked lowest by the respondents. This indicates that professionals do not believe that the size of the road project determines the occurrence of cost overrun on the project, but that careful attention is paid to the adopted construction method and variation orders.

3.2. Exploratory factor analysis for factors causing cost overrun on road projects

The responses of the respondents were further subjected to exploratory factor analysis (EFA) and the appropriateness of the data was determined. The correlation matrix coefficient values are above 0.3. The Kaiser-Meyer-Olkin (KMO) value for the dataset is 0.633 (which is >0.6 – the acceptable threshold), and Bartlett's test value is 0.000 (which is < 0.050), indicating that they are factorable. As depicted in Table 4, the eigenvalues were determined by applying Kaiser's criteria and the total variance. Only eigenvalues greater than 1.0 were considered, indicating that the first seven components fulfilled the requirements in the total column of the initial eigenvalues. These components explain 71.661 cumulative percentage of the identified variables. Values are calculated using the formula indicated below:

$$\mathrm{Cov}(X) = L \times L' + \Psi, \tag{1}$$

where $L = p \times m$ matrix of loadings; $\Psi = p \times p$ diagonal matrix.

The i^{th} diagonal element of $L \times L'$, the sum of the squared loadings, is called the i^{th} communality.

According to the results of Table 5, the forty-six variables factored into seven clusters. These clusters are interpreted based on the theoretical relationship observed among them.

– A total of sixteen variables are loaded onto cluster 1 as shown in Table 3. These variables include "contractor experience of project type" (84.5%), insufficient general project information" (82.5%), "varied labour/equipment productivity" (82.5%), "project/ design complexity" (79.0%), "inaccurate estimate" (74.4%), "poor project planning" (69.2%), "site workers' experience" (68.8%), "inappropriate procurement system and contract type" (67.5%), "adopted construction method" (67.1%), "legal disputes arising during construction" (67.1%), "inadequate communication among professionals" (66.5%), "estimating technique adopted" (64.6%), "health and safety challenges on site" (63.2%), "clarity and accuracy in project schedule" (62.5%), "inappropriateness of specifications" (58.1%) and "delay in materials/equipment/labour supply" (36.7%). All these variables can be observed to relate to project consultant and contractors during the execution of road projects. This factor cluster can, therefore, be termed as *Consultants/Contractors-Related Factors*. This cluster has a total variance of 30.267% which makes it the major factor causing cost overrun on road projects. According to the account of Smith & Bohn (1999), project complexity and unclear contract documents are factors leading to cost overrun on road projects which are in line with some of the factors loaded onto this cluster. Polat & Duzcan (2010) identified 59 factors from literature and classified them into six clusters. The bidding stage-related factor classification aligns with this cluster. Enshassi & Ayyash (2014) also categorised 61 factors into 12 sub-headings which this cluster relate to factors under "related to owner/consultant" and "related to contractor" sub-headings.

Table 4. Total variance explained

Cluster	Initial eigenvalues			Extraction sums of squared loadings			Rotation sums of squared loadings
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	13.923	30.267	30.267	13.923	30.267	30.267	10.732
2	5.870	12.761	43.028	5.870	12.761	43.028	7.406
3	3.583	7.788	50.817	3.583	7.788	50.817	5.445
4	3.190	6.935	57.751	3.190	6.935	57.751	5.272
5	2.482	5.395	63.146	2.482	5.395	63.146	5.372
6	2.115	4.598	67.744	2.115	4.598	67.744	2.334
7	1.802	3.917	71.661	1.802	3.917	71.661	4.018

- In cluster 2, there are five variables loaded onto it. These variables include "liquidated damages on the construction project" (92.9%), "economic instability" (86.7%), "price fluctuation" (86.5%), "foreign exchange fluctuation" (86.4%) and "high cost of procuring plants/equipment" (73.6%). The common factor to the variables in this cluster is the economic position of the country. The cluster is therefore labelled *Economy-Related Factors*. With a total variance of 12.761%, this cluster is behind cluster 1 as factors causing cost overrun on road projects. Bagaya & Song (2016) also identified price fluctuation and liquidated damages on the construction project factors as some of the financial factors causing delays on construction projects, thereby leading to cost overrun. Several researchers (Nega, 2008; Omoregie & Radford, 2006; Elinwa & Silas, 1993; Al-Khaldi, 1990) also agree with the factors ranked in this cluster.
- Cluster 3 has nine variables loaded unto it and these variables include "differing Unexpected site conditions and workability" (69.0%), "government regulatory policies" (66.6%), "non-availability/shortage of skilled labour" (65.3%), "remote/insecure area resulting in high overhead cost" (65.0%), "work suspension due to inter-tribal conflicts" (62.6%), "cultural impacts" (58.3%), "political interference" (52.8%), "social impacts" (51.4%) and "corruption and fraudulent practices" (47.8%). These variables relate largely to the environmental characteristics of the project location and are labelled *Environment-Related Factor* cluster. This cluster gathered 7.788% of the total variance to be ranked the third classification of factors causing cost overrun on road projects. According to Assaf & Al-Hejji (2006), these factors are grouped as the external factors causing cost overrun on a construction project. These factors include differing unexpected site condition, changes in government laws and regulations and the effect of cultural and social factors. Polat & Duzcan (2010) also argue that qualified workforce unavailability within the country, bribery, security problems, and regulations/law changes are country-related factors causing cost overrun on construction projects.
- The fourth cluster consists of four variables which are "risks and uncertainties" (88.1%), "inadequate insurance cover" (86.0%), "natural disasters" (84.5%) and "adverse weather condition" (81.2%). All these factors relate to occurrences that cannot be accurately predicted which gives the cluster the label of *Risk/Uncertainty-Related Factors*. This cluster had a total variance of 6.935% to making it the fourth-ranked classification of factors causing cost overrun on road projects. Bagaya & Song (2016) classified adverse weather conditions under external factors causing cost overrun on

Table 5. Pattern matrix

	Clusters						
	1	2	3	4	5	6	7
Contractor experience of project type	0.845						
Insufficient general project information	0.825						
Varied labour/equipment productivity	0.825						
Project/design complexity	0.790						
Inaccurate estimates	0.744						
Poor project planning	0.692						
Site workers' experience	0.688						
Inappropriate procurement system and contract type	0.675						
Adopted construction method	0.671						
Legal disputes arising during construction	0.671						
Inadequate communication among professionals	0.665						
Estimating technique adopted	0.646						
Health and safety challenges on site	0.632						
Clarity and accuracy in project schedule	0.625						
Inappropriateness of specifications	0.581						
Delay in materials/equipment/labour supply	0.367						
Liquidated damages on the construction project		0.929					
Economic instability		0.867					
Price fluctuation		0.865					
Foreign exchange fluctuation		0.864					
High cost of procuring plants/equipment		0.736					
Differing unexpected site conditions and workability			0.690				
Government regulatory policies			0.666				
Non-availability/Shortage of skilled labour			0.653				
Remote/insecure area resulting in high overhead cost			0.650				
Work suspension due to inter-tribal conflicts			0.626				
Cultural impacts			0.583				
Political interference			0.528				
Social impacts			0.514				
Corruption and fraudulent practices			0.478				
Risks and uncertainties				−0.881			
Inadequate insurance cover				−0.860			
Natural disasters				−0.845			
Adverse weather condition				−0.812			
Poor financial/cost control during construction					0.845		
Use of unqualified/incompetent contractors/subcontractors					0.804		
Poor site supervision and management					0.756		
Contractual management					0.745		
Change in material quality					0.729		
Project size						0.719	
Excessive rework						0.670	
Additional cost of quick impact project to appease locals						0.579	
Method of financing bond and payments						0.557	
Variation order							0.827
Change in project scope							0.688
Delay in payment by client or contractor to suppliers							0.414

construction projects, while Polat & Duzcan (2010) classified them as construction stage-related factors. However, Abdullah et al. (2018) classified adverse weather, natural disasters and risk/uncertainties as other related factors in their study.

- Cluster 5 has five variables loaded unto it and these variables are "poor financial/cost control during construction" (84.5%), "use of unqualified/incompetent contractors/subcontractors" (80.4%), "poor site supervision and management" (75.6%), "contractual management" (74.5%) and "change in material quality" (72.9%). These variables talk about the technicality of the road project and are therefore labelled *Technical-Related Factors* cluster. This cluster gathered 5.395% of the total variance to be ranked fifth in the classification of factors causing cost overrun on road projects. This cluster relates to the classification by Bagaya & Song (2016) and Polat & Duzcan (2010). They classified them as consultant-related factors. However, Assaf & Al-Hejji (2006) and Ali & Kamaruzzaman (2010) classified them as technical factors.
- In cluster 6, there are four variables loaded. These variables are "project size" (71.9%), "excessive rework" (67.0%), "additional cost of quick impact project to appease locals" (57.9%) and "method of financing bond and payment" (55.7%). These factors can be labelled *Project-Specific Factors* as there is a qualification to use in categorising all of them together. This cluster had a total variance of 4.598% to make it second to the lowest-ranked classification of factors causing cost overrun on road projects. Bagaya & Song (2016) and Assaf & Al-Hejji (2006b) believe that excessive rework is the responsibility of the project team as they are expected to do adequate supervision and coordination of work executed on site. However, Polat & Duzcan (2010) agree with Ghanaian professionals that the approach taken to finance payment to the contractor on a construction project plays a major role in determining whether there will be cost overrun in the project. Zafar et al. (2016) also maintain that quick impact projects always result in additional cost and these quick impact projects include water supply, medical facilities, and the like.
- The last cluster consists of three variables, which are "variation order" (82.7%), "change in project scope" (68.8%) and "delay in payment by client to contractor or contractor to supplier" (41.4%). These factors relate mainly to the client/owner of the project which gives the cluster the label *Owner/Client-Related Factors*. This cluster being the least ranked among the factors causing cost overrun on road projects had a total variance of 3.917%. According to Amoatey & Ankrah (2017), client-related factors play a major role in construction

project cost since there can be variation order at any time as well as a change in project scope. Assaf & Al-Hejji (2006) also posit that delay in progress payment by the owner causes cost overrun on construction projects as it sometimes results in liquidated damages which are paid by the client to the contractor.

Conclusion and recommendation

Cost overrun is one of the major challenges facing the construction industry globally which needs to be addressed. The study established that consultant/contractor-related, environment-related, economy-related, risk/uncertainty-related, technical-related, owner/client-related and other project-related factors are the major factors causing cost overrun on road projects. All these variables, which respondents rated higher than the average score, contribute significantly to cost overruns on road projects. It may be inferred that cost overruns in construction projects occur because of a lack of professionalism on the part of one or more of the stakeholders engaged in the construction process from start to finish. As a result, this research suggests that construction project professionals/stakeholders include economic considerations into the execution of construction projects to identify the prevalent reasons driving cost overruns on building construction projects. The study encountered some distinct limitations as there was little time available to collect primary data from respondents and the difference in location of the researcher. Based on this limitation, the primary data obtained cannot be generalised for the total population of civil engineers and quantity surveyors in the Ghanaian construction industry. Future study can be carried out using all the regions in Ghana for a general opinion to be gathered.

Funding

The authors would like to acknowledge the financial support provided by 2019 Global Excellence Stature Masters Bursary, School of Postgraduate Studies, University of Johannesburg to fund this research.

REFERENCES

Abdullah, M. S., Alaloul, W. S., Liew, M.S., & Mohammed, B. S. (2018). Delays and cost overruns causes during construction of palm oil refinery projects. *MATEC Web of Conferences*, *203*, Article 02004. https://doi.org/10.1051/matecconf/201820302004

Acharya, N. K., Lee, Y. D., Kim, S. Y., Lee, J. C., & Kim, C. S. (2006). Analysis of construction delay factor: A Korean perspective. In: *7th Asia Pacific Industrial Engineering and Management Systems Conference*, 883–895.

Affleck, R. T., & Freeman, R. (2010). *Challenges for engineering design, construction, and maintenance of infrastructure in Afghanistan (ERDC/CRREL SR-10-2)*. Engineer Research and Development Center, Hanover, NH Cold Regions Research and Engineering Lab.

Aibinu, A. A. A., & Jagboro, G. O. G. (2002). The effects of construction delays on project delivery in Nigerian construction industry. *International Journal of Project Management*, *20*(8), 593–599. https://doi.org/10.1016/S0263-7863(02)00028-5

Al-Khaldi, Z. (1990). Factors affecting the accuracy of construction costs estimating in Saudi Arabia [Master Thesis, King Fahd University of Petroleum & Minerals], Saudi Arabia. https://core.ac.uk/download/pdf/146512569.pdf

Ali, A. S., & Kamaruzzaman, S. N. (2010). Cost performance for building construction projects in Klang valley. *Journal of Building Performance*, *1*(1), 110–118. https://www.researchgate.net/publication/267968294_Cost_performance_for_building_construction_projects_in_Klang_valley

Amoatey, C. T., & Ankrah, A. N. O. (2017). Exploring critical road project delay factors in Ghana. *Journal of Facilities Management*, *15*(2), 110–127. https://doi.org/10.1108/JFM-09-2016-0036

Apolot, R. (2011). *Investigation of the causes of delay and cost overrun in construction projects in Uganda's public sector* [Master thesis, Makerere University].

El Asmar, M., Hanna, A. S., & Whited, G. C. (2011). New approach to developing conceptual cost estimates for highway projects. *Journal of Construction Engineering and Management*, *137*(11), 942–949. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000355

Assaf, S. A., & Al-Hejji, S. (2006). Causes of delay in large building construction projects. *International Journal of Project Management*, *24*(4), 349–357. https://doi.org/10.1016/j.ijproman.2005.11.010

Auditor General Sweden. (1994). *Infrastrukturinvesteringar: En kostnadsjämörelse mellan plan og utyfall i 15 storre prosjekt innöm Vägverket og*. Stockholm.

Azhar, N., Farooqui, R. U., & Ahmed, S. M. (2008). Cost overrun factors in construction industry of Pakistan. *First International Conference on Construction In Developing Countries (ICCIDC–I) "Advancing and Integrating Construction Education, Research & Practice*", 4–5. https://www.academia.edu/29783031/Cost_Overrun_Factors_In_Construction_Industry_of_Pakistan

Bagaya, O., & Song, J. (2016). Empirical study of factors influencing schedule delays of public construction projects in Burkina Faso. *Journal of Management in Engineering*, *32*(5), Article 05016014. https://doi.org/10.1061/(asce)me.1943-5479.0000443

Eliasson, J., & Fosgerau, M. (2013). Cost overruns and demand shortfalls – Deception or selection? *Transportation Research Part B: Methodological*, *57*, 105–113. https://doi.org/10.1016/j.trb.2013.09.005

Elinwa, A. U., & Silas, A. B. (1993). Construction cost factors in Nigeria. *Journal of Construction Engineering and Management*, *119*(4), 698–713. https://doi.org/10.1061/(ASCE)0733-9364(1993)119:4(698)

Ellis, R., Pyeon, J., Herbsman, Z., Minchin, E., & Molenaar, K. (2007). *Evaluation of alternative contracting techniques on FDOT construction projects* (Final report). University of Florida. https://fdotwww.blob.core.windows.net/sitefinity/docs/default-source/research/reports/fdot-bdc51-rpt.pdf

Enshassi, A., & Ayyash, A. (2014). Factors affecting cost contingency in the construction industry – Contractors' perspective. *International Journal of Construction Management*, *14*(3), 1–25. https://doi.org/10.1080/15623599.2014.922729

Faridi, A. S., & El-Sayegh, S. M. (2006). Significant factors causing delay in the UAE construction industry. *Construction Management and Economics*, *24*(11), 1167–1176. https://doi.org/10.1080/01446190600827033

Flyvbjerg, B. (2007). Cost overruns and demand shortfalls in urban rail and other infrastructure. *Transportation Planning and Technology*, *30*(1), 9–30. https://doi.org/10.1080/03081060701207938

Flyvbjerg, B., Glenting, C., & Ronnest, A. (2004). *Procedures for dealing with optimism Bias in transport planning*. London: The British Department for Transport, Guidance Document. https://ssrn.com/abstract=2278346

Flyvbjerg, B., Holm, M. K. S., & Buhl, S. L. (2004). What causes cost overrun in transport infrastructure projects? *Transport Reviews*, *24*(1), 3–18. https://doi.org/10.1080/0144164032000080494a

Fouracre, P., Allport, R., & Thomson, J. (1990). *The performance and impact of rail mass transit in developing countries*. Transport and Road Research Laboratory, Wokingham, Berkshire, UK.

Fragkakis, N., Marinelli, M., & Lambropoulos, S. (2015). Preliminary cost estimate model for culverts. *Procedia Engineering*, *123*, 153–161. https://doi.org/10.1016/j.proeng.2015.10.072

Frimpong, Y., Oluwoye, J., Crawford, L., Yaw, F., Jacob, O., & Lynn, C. (2003). Causes of delay and cost overruns in construction of groundwater projects in a developing countries; Ghana as a case study. *International Journal of Project Management*, *21*(5), 321–326. https://doi.org/10.1016/S0263-7863(02)00055-8

Ibironke, O. T., Oladinrin, T. O., Adeniyi, O., & Eboreime, I. V. (2013). Analysis of non-excusable delay factors affecting contractors' performance in Lagos, Nigeria. *Journal of Construction in Developing Countries*, *18*(1), 53–72. https://core.ac.uk/download/pdf/199244816.pdf

Kaliba, C., Muya, M., & Mumba, K. (2009). Cost escalation and schedule delays in road construction projects in Zambia. *International Journal of Project Management*, *27*(5), 522–531. https://doi.org/10.1016/j.ijproman.2008.07.003

Kasimu, M. A. (2012). Significant factors that causes cost overruns in building construction project in Nigeria. *Interdisciplinary Journal of Contemporary Research in Business*, *3*(11), 775–780.

Lee, J.-K. (2008). Cost overrun and cause in Korean social overhead capital projects: roads, rails, airports, and ports. *Journal of Urban Planning and Development*, *134*(2), 59–62. https://doi.org/10.1061/(ASCE)0733-9488(2008)134:2(59)

Long, L.-H., Lee, Y. D., & Lee, J. Y. (2008). Delay and cost overruns in Vietnam large construction projects: A comparison with other selected countries. *KSCE Journal of Civil Engineering*, *12*(6), 367–377. https://doi.org/10.1007/s12205-008-0367-7

Love, P. E. D., & Ahiaga-Dagbui, D. D. (2018). Debunking fake news in a post-truth era: The plausible untruths of cost underestimation in transport infrastructure projects. *Transportation Research Part A: Policy and Practice*, *113*, 357–368. https://doi.org/10.1016/j.tra.2018.04.019

Love, P. E. D., Wang, X., Sing, C., & Tiong, R. L. K. (2013). Determining the probability of cost overruns in Australian construction and engineering projects. *Journal of Construction Engineering and Management*, *139*(3), 321–330. https://doi.org/10.1061/(ASCE)CO.1943-7862.0000575

Love, P. E. D, Sing, C.-P., Carey, B., & Kim, J. T. (2015). Estimating construction contingency: Accommodating the potential for cost overruns in road construction projects. *Journal of Infrastructure Systems*, *21*(2), 1–10. https://doi.org/10.1061/(ASCE)IS.1943-555X.0000221

Molenaar, K. R. (2005). Programmatic cost risk analysis for highway megaprojects. *Journal of Construction Engineering and Management*, *131*(3). https://doi.org/10.1061/(ASCE)0733-9364(2005)131:3(343)

Nasir, A. R., Gabriel, H. F., & Choudhry, R. M. (2011). Cost and time overruns in highway projects in Pakistan. *Sixth International Conference on Construction in the 21st Century (CITC-VI) "Construction Challenges in the New Decade"*, Kuala Lumpur, Malaysia, 69–76.

Nega, F. (2008). *Causes and effects of cost overrun on public building construction projects in Ethiopia* [Master thesis, Addis Ababa University], Ethiopia. http://etd.aau.edu.et/handle/123456789/1246

Nulty, D. D. (2008). The adequacy of response rates to online and paper surveys: what can be done? *Assessment & Evaluation in Higher Education*, *33*(3), 301–314. https://doi.org/10.1080/02602930701293231

Odeck, J. (2004). Cost overruns in road construction – what are their sizesand determinants? *Transport Policy*, *11*(1), 43–53. https://doi.org/10.1016/S0967-070X(03)00017-9

Olawale, Y. A., & Sun, M. (2010). Cost and time control of construction projects: inhibiting factors and mitigating measures in practice. *Construction Management and Economics*, *28*(5), 509–526. https://doi.org/10.1080/01446191003674519

Omoregie, A., & Radford, D. (2006). Infrastructure delays and cost escalation: Causes and effects in Nigeria. *Proceedings of the 6th International Postgraduate Research Conference in the Built and Human Environment,* International Council for Research and Innovation in Building and Construction, 45–55.

Pallant, J. (2011). *SPSS survival manual: A step by step guide to data analysis using IBM SPSS*. Routledge, London, UK.

Park, Y. I., & Papadopoulou, T. C. (2012). Causes of cost overruns in transport infrastructure projects in Asia: Their significance and relationship with project size. *Built Environment Project and Asset Management*, *2*(2), 195–216. https://doi.org/10.1108/20441241211280873

Polat, G., & Duzcan, M. (2010). Factors affecting cost contingency in international projects. *PM-05 – Advancing Project Management for the 21st Century*, Heraklion, Crete, Greece, 29–31. https://www.irbnet.de/daten/iconda/CIB18327.pdf

Roachanakanan, K. (2005). *A case study of cost overruns in a Thai condominium project* [Doctoral dissertation, Texas A&M University]. https://core.ac.uk/download/pdf/147124044.pdf

Sambasivan, M., & Soon, Y. W. (2007). Causes and effects of delays in Malaysian construction industry. *International Journal of Project Management*, *25*(5), 517–526. https://doi.org/10.1016/j.ijproman.2006.11.007

Singh, R. (2009). Delays and cost overruns in infrastructure projects – An enquiry into extents, causes and remedies. *Economic and Political Weekly*, *45*(21), 43–54. http://re.indiaenvironmentportal.org.in/files/Delays%20and%20Cost%20Overruns%20in%20Infrastructure.pdf

Smith, G. R., & Bohn, C. M. (1999). Small to medium contractor contingency and assumption of risk. *Journal of Construction Engineering and Management*, *125*(2), 101–108. https://doi.org/10.1061/(ASCE)0733-9364(1999)125:2(101)

Swei, O., Gregory, J., & Kirchain, R. (2017). Construction cost estimation: A parametric approach for better estimates of expected cost and variation. *Transportation Research Part B: Methodological*, *101*, 295–305. https://doi.org/10.1016/j.trb.2017.04.013

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education*, *2*, 53–55. https://doi.org/10.5116/ijme.4dfb.8dfd

Vidalis, S. M., & Najafi, F. T. (2002). Cost and time overruns in highway construction. *Canadian Society for Civil Engineering – 30th Annual Conference: 2002 Chellenges Ahead*, 2799–2808.

Zafar, I., Yousaf, T., & Ahmed, D. S. (2016). Evaluation of risk factors causing cost overrun in road projects in terrorism affected areas Pakistan – a case study. *KSCE Journal of Civil Engineering*, *20*(5), 1613–1620. https://doi.org/10.1007/s12205-015-0348-6