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Critical Factors Contributing to Budget Overruns in Ghana's Telecommunication Industry Construction Projects

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Abstract: This study sought to examine the occurrence of and the most critical factors that cause budget overruns in Ghana's telecommunications industry construction projects by applying an exploratory sequential mixed method approach. A multiple case study approach was initially adopted to ensure a greater understanding of the differences and similarities between four cases drawn from companies engaged in the construction of network expansion projects. This was followed by a survey of 230 practitioners responsible for managing construction projects within the industry. The software program, ATLAS.ti, Statistical Package for the Social Sciences (SPSS) and AMOS version 25.0 were used in the data analysis. Exploratory factor analysis and structural equation modelling were performed to test and validate the hypothetical model developed to illustrate the most critical factors that cause budget overruns. The findings resulted in the final model dubbed "Budget Overrun Flowerpot", which provides practitioners with a better understanding of the most critical causal factors that must be managed appropriately to improve project efficiency and budget performance.

Keywords: Construction projects, Budget overruns, Cost overruns, Ghanaian telecommunications industry, Budget Overrun Flowerpot

INTRODUCTION

The Ghanaian telecommunications industry is one of the toughest and most competitive in West Africa. After its liberalisation and deregulation in the 1990s, the sector has seen significant growth and increased technological transformation which has bred intense competition among service providers in the industry, resulting in Ghana becoming one of the leading African countries that promote telecommunication services by exposing its basic industry to private competition (IMANI, 2017). The telecommunications industry contributes enormously to Ghanaian national investment and economic growth. For example, it contributed 7% to national investment, 10% towards government income and 1.9% of total gross domestic product (GDP) in 2010, while in 2013, its GDP contribution rose to 2.4% (Ghana Statistical Service, 2014). In addition, players in this industry pay a yearly tax of USD 650 million, constituting 40% of total revenue in a sector that directly employs more than 5,000 people, while indirectly employing an excess of 1.5 million people involved in servicing and promoting other industries such as banking, media, advertising, agriculture, health, education and construction (GCT [Ghana Chamber of Telecommunications], 2019).

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In recent times, the Ghanaian telecommunications industry has made large investments in construction projects in their quest to embrace technological advancements and to meet the increased demands from subscribers due to the rapid population growth. According to the Ghana News Agency (GNA, 2017), MTN Ghana, the market leader in this industry in Ghana, spent USD2.4 billion on construction projects in the form of cell sites from 2006 to 2014. In addition, MTN spent an additional USD103 million in 2015 and USD143.7 million in 2017 on the construction of more cell sites. In effect, MTN has constructed 197 new 4G sites, adding to its current 475 sites, while its 3G services have also been boosted with an additional 561 sites. Vodafone, ranking second to MTN in terms of market share, spent USD1.7 billion from 2007 to 2014 and USD700 million in 2015, on construction projects. Tigo, the third largest mobile operator in Ghana, spent up to USD24 million on construction projects from 2007 to 2014, adding 114 new cell sites to its existing sites. The fourth largest network, Airtel, spent GHS200 million on construction projects for the same period. However, in 2018, Tigo and Airtel merged as AirtelTigo.

Several factors impact the capability of construction companies in Ghana (Offei, Kissi and Nani, 2019). For example, the occurrence of budget overrun is found to be more prevalent in telecommunication construction projects (Danso and Antwi, 2012). Budget overruns are a common phenomenon experienced repeatedly and substantially in construction projects (Cheng, 2014; Huo et al., 2018; Shehu et al., 2014; Simushi and Wium, 2020). For instance, Shehu et al. (2014) found that while the construction industry drives economic growth in Malaysia, 50% of construction projects are hampered by budget overruns. Also, Danso and Antwi (2012) found that the construction of the Tigo Ghana towers experienced 50% budget overruns. That, in turn, leads to an increase in the actual cost of the project which is one of the relevant dimensions to examine the success of any project as it measures the deviation from the budgeted cost (Annamalaisami and Kuppuswamy, 2019; Balali, Moehler and Valipour, 2020; Olawale and Sun, 2014; Shehu et al., 2014). Olawale and Sun (2014) indicated that project cost control is a starting point for achieving a construction project's key objective of meeting the predetermined cost budget. Martinsuo, Klakegg and Marvick (2019) emphasised the importance of project cost in determining the project's value from the stakeholders' value expectation perspective.

Projects deviating from the budgeted cost are commonly found in construction projects, especially in the telecommunications industry in Ghana (Danso and Antwi, 2012; Rosenfeld, 2014). While construction projects in the Ghanaian telecommunications industry have seen significant investments in recent times, with outcomes that immensely contribute to economic growth, little to no research has recently been conducted to ascertain the occurrence of budget overruns that may be associated with these investments and to determine the most critical factors that cause these overruns within the industry at large. Following the argument by Herrera et al. (2020) that construction projects are linked to huge economic investments due to their magnitude, budget overruns that may result in project failure could adversely affect a country's economy. As a result, this study was aimed at examining the occurrence of and the most critical factors that cause budget overruns in construction projects in Ghana's telecommunications industry.

The findings of this study could be used as a reference point by project practitioners to keep the occurrence of budget overruns to their barest minimum when working on construction projects in Ghana's telecommunication industry. In effect, the profit margins of the players in this industry may increase, resulting in higher tax revenues for Ghana. Furthermore, the findings of this study would add to the body of knowledge. This study sought to fill this gap and aimed to answer the following research questions:

1. What is the concept of budget overrun, its occurrence and impact on the Ghanaian telecommunications industry construction projects?
2. What are the most critical factors that cause budget overruns in Ghanaian telecommunications industry construction projects?

In addressing these research questions, existing literature was reviewed; a case study approach was first used to gain insight followed by a questionnaire survey analysis to validate the case study's findings. The study adopted structural equation modelling (SEM), specifically, a confirmatory factor analysis (CFA) measurement model aimed at measuring and validating the hypothetical model based on the exploratory factor analysis (EFA) findings which also had its foundations in the literature review. The remainder of the paper begins with a literature review, followed by a presentation of the methodology, results and discussion and lastly, the findings which resulted in the final model dubbed "Budget Overrun Flowerpot" that provides practitioners with a better understanding of the most critical causal factors that should be appropriately managed to improve project efficiency and budget performance.

LITERATURE REVIEW

Most projects in both developing and developed countries are confronted with budget overruns, making it a chronic problem (Herrera et al., 2020). It is a recurring issue in construction projects regardless of the advancement of the project management profession (Simushi and Wium, 2020). In the management of construction projects, budget overruns are an important issue that is not restricted to specific sectors or countries (Aljohani, Ahiaga-Dagbui and Moore, 2017). It is also anomalous to find completely risk-free construction projects (Taroun, 2014). Durdyev et al. (2017) added that the prevalence of budget overruns exceeding 100% of the estimated project budget is more severe in developing countries as it is indicative of poor resource management and its occurrence has adverse financial impacts on the project. The PMI (Project Management Institute) (2017) maintains that project cost, schedule and quality are interrelated, with a change in one element affecting the others. In effect, budget overruns can negatively impact both project schedule and quality.

Table 1 summarises and maps some academic studies that have investigated factors leading to budget overruns in the management of construction projects. In view of this, Simushi and Wium (2020), in citing previous authors, argued that it is much more challenging to ascertain which of these causal factors are the most critical factors as every author presents their findings differently.

Table 1. Mapping the frequency of factors causing budget overruns, type of study and data analysis statistical tool from previous studies

Budget Overruns Factors from the Extant Literature	**References**										
	Herrera et al. (2020)	**Balali, Moehler and Valipour (2020)**	**Adafin, Rotimi and Wilkinson (2020)**	**Seddeeq et al. (2019)**	**Johnson and Babu (2020)**	**Durdyev et al. (2017)**	**Asiedu, Adaku and Owusu-Manu (2017)**	**Cheng (2014)**	**Memon, Rahman and Azis (2012)**	**Ameh, Soyingbe and Odusami (2010)**	**Freq.**
Price variation of materials	×					×			×	×	4
Scope/ requirement or order changes	×		×	×	×						4
Poor contract/ project management	×					×	×	×			4
Inaccurate time and cost estimate				×	×	×					3
Project team incompetence			×			×	×				3
Inadequate planning and scheduling	×			×	×						3
Design variations or changes	×				×					×	3
Failures in design/ errors in design	×			×							2
Inadequate bidding method or inappropriate procurement	×			×							2
Poor cost control						×		×			2

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Table 1. *Continued*

Budget Overruns Factors from the Extant Literature	References										
	Herrera et al. (2020)	Balali, Moehler and Valipour (2020)	Adafin, Rotimi and Wilkinson (2020)	Seddeeq et al. (2019)	Johnson and Babu (2020)	Durdyev et al. (2017)	Asiedu, Adaku and Owusu-Manu (2017)	Cheng (2014)	Memon, Rahman and Azis (2012)	Ameh, Soyingbe and Odusami (2010)	Freq.
Insufficient funds or mode of financing		×								×	2
Poor communication or coordination						×	×				2
Cultural and political risks	×						×				2
Contractors' cash flow challenges							×		×		2
Late payment by the owner to the contractor						×			×		2
Rework due to poor quality		×				×					2
High cost of imported material						×				×	2
Legal/permit issues	×				×						2
Poor site condition information			×							×	2
Lack of contractor or consultant experience			×							×	2
Delay in decision-making	×										1

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Table 1. *Continued*

Budget Overruns Factors from the Extant Literature	References										
	Herrera et al. (2020)	Balali, Moehler and Valipour (2020)	Adafin, Rotimi and Wilkinson (2020)	Seddeeq et al. (2019)	Johnson and Babu (2020)	Durdyev et al. (2017)	Asiedu, Adaku and Owusu-Manu (2017)	Cheng (2014)	Memon, Rahman and Azis (2012)	Ameh, Soyingbe and Odusami (2010)	Freq.
Poor supervision and inspections		×									1
High land prices						×					1
Type of Study											
Systematic review approach	✓										1
Questionnaire survey analysis		✓	✓	✓			✓		✓	✓	6
Concurrent mixed-methods study					✓						1
Focus group discussion						✓					1
Expert interview method								✓			1
Data Analysis Statistical Tool											
Relative importance index (RII) method	+			+					+	+	4
Delphi and stepwise weight assessment ratio analysis (SWARA) methods		+									1

(*Continued on next page*)

Table 1. *Continued*

Budget Overruns Factors from the Extant Literature	References										Freq.
	Herrera et al. (2020)	Balali, Moehler and Valipour (2020)	Adafin, Rotimi and Wilkinson (2020)	Seddeeq et al. (2019)	Johnson and Babu (2020)	Durdyev et al. (2017)	Asiedu, Adaku and Owusu-Manu (2017)	Cheng (2014)	Memon, Rahman and Azis (2012)	Ameh, Soyingbe and Odusami (2010)	
Descriptive statistics and mean ranking analysis			+								1
Average ranking score method					+						1
Checklist definition						+					1
Severity index								+			1
EFA							+				1

Note: Freq. = Frequency, which shows the number of times a factor appears in different studies; × = Budget overrun factors identified from the extant literature; ✓ = Type of study conducted by the selected authors; + = Data analysis statistical tool used by the selected authors.

This was evident in the literature review as scholars subjectively determined the exact number of factors to retain as the most relevant causal factors because there were no standardised cut-out points. Additionally, the Relative Importance Index (RII)/Severity Index method was identified as a technique most frequently used across different studies to identify the causal factors in construction projects as shown in Table 1.

For instance, as shown in Table 1, Herrera et al. (2020) carried out a study to analyse the frequency and importance of the factors that lead to budget overruns in road construction projects. The study adopted a systematic review method that produced 38 factors classified under 14 categories and then used the Influence Index method to assess the 10 most important factors from the 38.

In addition, Seddeeq et al. (2019) surveyed the main causes of time and cost overruns in Saudi Arabian oil and gas construction projects. Their study used a significant index method to obtain the top five most important factors. The findings are beneficial to organisations planning construction projects in the Saudi oil and gas industry.

Similarly, Johnson and Babu (2020) conducted a concurrent mixed-method study to identify the top five causal factors for time and cost overruns in the construction industry in the United Arab Emirates (UAE). The purpose of this study was to investigate, evaluate and analyse factors that contributed to construction delays and cost overruns to improve project delivery in the UAE construction industry.

While the aforementioned cut-out points may serve as a guide to improve project delivery, it is imperative to explore the various methods that may be statistically robust to produce the most critical factors responsible for budget overruns to attain the desired cost-effective results as argued by Durdyev et al. (2017) because companies embarking on construction projects in developing countries, such as Ghana, may not have necessary resources to address the various factors causing budget overruns as presented in the construction literature. Therefore, they need to focus on the most critical factors that cause budget overruns. This issue is addressed in this study while explicitly considering the context and the particularities of construction projects in Ghana's telecommunications industry.

Various other studies as shown in Table 1 have investigated budget overruns in construction projects in different sectors, such as those from Adafin, Rotimi and Wilkinson (2020), Ameh, Soyingbe and Odusami (2010), Asiedu, Adaku and Owusu-Manu (2017), Balali, Moehler and Valipour (2020), Cheng (2014), Durdyev et al. (2017), Memon, Rahman and Azis (2012) and Simushi and Wium (2020). Regardless, none of these scholarly works investigated construction projects in the telecommunications sector.

Furthermore, as shown in Table 1, this study mapped the factors impacting budget overruns, the type of study and the data analysis tool to determine the likelihood of a factor occurring across different construction projects. From Table 1, the frequency shows the number of occurrences in different studies and has been conceptualised as a rating in the adopted illustrative likelihood scale for projects (Deloitte and Touche LLP, 2012) with the anchors: 1 = "Rare" (< 10% chance of occurrence); 2 = "Unlikely" (10% up to 35% chance of occurrence); 3 = "Possible" (35% to 65% chance of occurrence); 4 = "Likely" (65% up to 90% chance of occurrence); 5 = "Almost certain" (90% or greater chance of occurrence). Therefore, the following observations were made:

1. The factors that are likely to occur during and across different construction projects are "Price variation of materials", "Scope/requirement/order changes" and "Poor contract management". These factors have a 65% up to 90% chance of occurrence across different construction projects.

2. The few factors that may occur during and across different construction projects are "Inaccurate time and cost estimates", "Project team incompetence", "Inadequate planning and scheduling" and "Design variations/changes", as they have a 35% up to 65% chance of occurrence.

3. A majority of the factors have a 10% up to 35% chance of occurrence during and across different construction projects. These include "Rework", "High land prices", "Cultural and political risks", "Poor cost control", "Poor communication/coordination" and "High cost of imported material".

4. There are a few factors that rarely occur, as they have a <10% chance of occurrence across different construction projects. These unique factors pertain to project specifics such as "Delays in decision-making", "Poor supervision and inspections" and "High land prices".

Based on Table 1, no factor was found to be almost certain to occur across every project. This outcome supports the argument by Abdellatif and Alshibani (2019) and Durdyev et al. (2017) that differences in the sociocultural, legislative and regulatory environments cause studies within a specific industry in a particular country to not be thoroughly applicable and transferable to other service sectors and geographies. Thus, there is a need to study construction projects in the Ghanaian telecommunications sector to learn their specifics.

METHODOLOGY

This section presents the research methodology selected for the empirical research conducted in this study. An exploratory sequential mixed method approach was adopted in which a qualitative study was first conducted to gather information about the occurrence and factors causing budget overruns in construction projects of the Ghanaian telecommunications industry. The findings served as the foundation upon which quantitative research was conducted to determine the most critical causal factors. This approach was selected to stimulate confidence in the study's findings, as adequate evidence can be provided to allay the weaknesses related to a single-method approach (Creswell, 2014; Saunders, Lewis and Thornhill, 2012).

Qualitative Research: Case Study Approach

This section reports on the case study approach adopted and its implementation. In the absence of studies on construction projects in the Ghanaian telecommunications sector, the study adopted a multiple case study approach as it offers a greater understanding of the similarities and differences between the cases and the findings are considered strong and reliable (Baxter and Jack, 2008).

Sampling and data-collection procedure

The study used four different companies out of a possible eight that work in the construction of network expansion projects, either as the project owner (mobile network operators) or contracting vendors (tower companies and managed-service vendors). The number of case studies conformed to Eisenhardt's (1989) recommendations of the minimum case studies necessary to provide a rich understanding of the subject matter. In the same vein, the minimum sample size for a case study recommended by Creswell (2002) is three to five cases.

Within each company, the study selected two senior practitioners from each network operator and one from each contracting vendor through purposive sampling. Their functional roles ranged from project/rollout manager to programme director and all of whom were widely recommended based on their level of understanding, knowledge and experience in their respective companies.

Yin (2018) argued that the sources of data for a case study may include one or more of the following: documentation, archival records, interviews, direct observation, participant observation and physical artefacts. Given this, the study used semi-structured interviews, via a face-to-face interview method, to delve into the subject matter and probe it to greater depth, while also allowing for the free expression of thoughts by the participants (Chenail, 2011). The interviews were conducted after office hours between 6:00 p.m. and 8:00 p.m. due to the participants' busy schedules which involved regular site visits and meetings. To complement the interviews, the study reviewed the companies' project plans and reports.

Data analysis

The study used Atlas.ti to code the data for analysis because using such software is a faster and more efficient way of storing and locating qualitative data (Creswell, 2014). In line with ethical considerations, the names of the companies and the interviewees were pseudonymised with the letters A to D and D1 to D6, respectively, to protect their identities. In addition, the study used ideas related to concept mapping and innovation concept techniques to develop a model cage to demonstrate the similarities and differences among the overruns' causal factors across all the cases, respectively (Miles, Huberman and Saldana, 2014; Novak and Cañas, 2006). The findings culminated in the design of the questionnaire for the survey.

Quantitative Research: Survey and Statistical Analysis

This section reports on the quantitative approach that was adopted in this study and its implementation.

Sampling and data: Collection procedure

The study obtained 350 names of employees from eight companies in the telecommunications sector in Ghana. The companies were provided with the pseudonyms A to H to maintain their anonymity in the study. In line with sample size, the study used a simplified formula for proportions that was originally developed by Yamane (1967) and is also considered to be among the most commonly used formulae to determine the sample size for a study. It is illustrated as follows:

$$n = N/1 + N(e^2) \qquad \text{Eq. 1}$$

where n = Sample size, N = Known population and e = Level of precision.

Table 2 depicts the employee breakdown for each company. With a total number of 350 employees within the selected companies, the study, therefore, assumed a 5% significance level with a population proportion of 50% and the accessible population sample size is determined as $350/1+320(0.5)^2 = 187$.

Table 2. Sampling

Company	Provided Number of Staff	Proportionate Sampling
Company A	52	28
Company B	66	35
Company C	37	20
Company D	51	27
Company E	52	28
Company F	30	16
Company G	28	15
Company H	34	18
Total	350	187

Note: Company B = 66/350*187 = 35

In sampling the 187 individual employees within these companies who have direct responsibilities in the construction of network expansion projects, the study used a proportionate stratified random sampling technique. This meant that the accessible population was first divided into subgroups (companies) and the employees were then drawn in proportion to their original numbers in their companies via a simple random sampling technique without replacement (Sekaran, 2003). This sampling technique is considered the most efficient among all probability sampling designs and ensures that all subgroups are adequately sampled (Sekaran, 2003).

The study over-recruited by 23%, resulting in the administration of a total of 230 questionnaires. Islam (2018) argued that the sample size could also be increased up to 30% to make provision for no responses in proportion to each company's selected size. In view of this, a total of 230 questionnaires were administered online to these individual employees via the simple random sampling technique without replacement. In addition to the demographic details of the participants, the questionnaires also contained 21 items that were coded with C01 to C21. These items are the factors that have been found to cause budget overruns from the case study and encompassed Likert-scale measurements grounded on a five-point rating system, with anchors such as: "Strongly disagree" = 1; "Disagree" = 2; "Neither agree nor disagree" = 3; "Agree" = 4; "Strongly agree" = 5 (Sekaran, 2003).

Data analysis

The study used multivariate data analysis techniques, specifically EFA and SEM through the application of IBM Statistical Package for Social Sciences (SPSS) and AMOS version 25.0. These techniques are considered statistically robust techniques and were carried out to ascertain the most critical factors that cause budget overruns.

1. Descriptive analysis: Of the 230 questionnaires administered, 81% (consisting of 187) of the respondents returned the completed questionnaires resulting from constant engagement with the employees through their bosses, phone calls, text messages and personal visits. The refusal of 19% of the respondents to complete the questionnaires could be attributed to fatigue, a lack of willingness to answer the questions and a lack of time to answer the questions (Garson, 2008; Field, 2005). In examining the presence of common method biases in the data, the study used Harman's single-factor test which is considered to be a straightforward and widely used statistical tool for detecting common method biases (Fuller et al., 2016). Using this method, the researchers entered all the scale items into an exploratory factorial analysis and examined the unrotated factor solution to determine the number of components with eigenvalues greater than one that explain the aggregate variance. If common method bias exists, the assumption is that only one component will account for more than 50% of the covariances between the items and the criterion constructs (Podsakoff, MacKenzie and Podsakoff, 2012). The study found a single factor component accounting for 16.5% of the total variance. Since 16.5% is far less than the 50% threshold, it can be concluded that there is no existence of common method biases. Consequently, a response of 81% which coincidentally represents the original sample size determined for the study, does not violate the multivariate analysis assumptions for factor analysis (Kishabale and Hassan, 2018). The study found that of the 187 employees with responsibility for the construction of network expansion projects, 84% are male and 16% are female. Most of them are aged above 32 years old, with 55% holding bachelor's degrees and 41% holding master's degrees. Also, with respect to their positions, 75% are managers/engineers, 11% are unit heads and 9% are directors. Most of these participants have a minimum of five years of experience with their current companies. Judging from the positions held by the participants and their level of experience, they were the right people for the study (ranging from project managers to project directors) as per an assertion by PMI (2017).

2. EFA: the study employed the maximum likelihood estimate (MLE) method as a normality test was ensured. The study used a parallel method, along with the Kaiser criterion and Scree plot methods to determine the number of factors to be kept. The application of the parallel method helped allay issues of locating several factors for retention with the Kaiser criterion and circumvented the confusion of interpreting Scree plot cases which show several drops and likely cut-off points. The study also used Kaiser-Meyer-Olkin (KMO) and Bartlett's test of sphericity to establish sampling adequacy and data suitability for EFA. Additionally, Promax with the Kaiser

Normalisation Rotation method was used to minimise the number of items with high loadings to more than one factor and to retain items with factor loadings of ≥ 0.50. The Cronbach's alpha coefficient was used to analyse the reliability test of internal consistency and content validity.

3. SEM: According to Byrne (2010), SEM is a statistical methodology that employs a confirmatory approach (hypothesis-testing) to assess how well a proposed model fits a set of collected data and to investigate the structural relationships between the latent variables. In view of this, the measurement models, structural models and path analysis are considered to be the three main types of SEM (Byrne, 2010, Hair et al., 2010). This suggests that each type of SEM can be conducted separately without combining them. Hameme (2017) argued that the measurement models and structural models are the most commonly cited types of SEM in the field of Social Sciences. Therefore, the study used SEM, specifically the measurement model, to evaluate and validate how well the proposed model borne out of EFA findings could fit the set of collected data. Byrne (2010) added that CFA is used as part of the measurement model.

4. SEM-CFA: CFA is the measurement aspect of SEM, which displays relationships between latent variables and their indicators. In this study, the measurement model was utilised to assess the validity and reliability of the variables to test and verify how well the observed variables were related to a set of latent variables (Hoyle, 2011; Kline, 2011; Byrne, 2013). The study utilised the MLE method to evaluate the consistency of the measures and the nature of the constructs. Moreover, the variance of each scale dimension was constrained to 1.0 and the modification index was fixed to 4. A modification method was used to propose model parameters that could be released to enhance the model specification, but it was not done excessively to spoil the structure it initially planned to measure (Hair et al., 2010; Koyuncu and Kılıç, 2019). The goodness-of-fit indices and their acceptable values used to assess the measurement model in this study are summarised in Table 3.

Table 3. Summary of model fit indices

Fit Indices Statistics	**Acceptable Values Interpretations**	**References**
Absolute fit index (χ^2/df)	≤ 5.0 or 1.0 to 4.0	Hair et al. (2010), Kline (2011) and Rosseni (2014)
Goodness of fit index (GFI)	> 0.90	Hair et al. (2010) and Hooper, Coughlan and Mullen (2008)
Incremental fit index (IFI)	> 0.90	Hair et al. (2010) and Kline (2011)
Tucker Lewis index (TLI)	> 0.90	Hair et al. (2010)

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Table 3. *Continued*

Fit Indices Statistics	**Acceptable Values Interpretations**	**References**
Comparative fit index (CFI)	> 0.90	Hair et al. (2010) and Rosseni (2014)
Root mean square error of approximation (RMSEA)	< 0.08	Hair et al. (2010), Kline (2011) and Rosseni (2014)
Root mean square (RMR)	≤ 0.050	Hair et al. (2010) and Kline (2011)

Furthermore, Saunders, Lewis and Thornhill (2012) maintained that to ensure that a study can stand the test of time, it should focus on the validity and reliability of its research design. In view of this, the study utilised the most considered validity measures used in SEM-CFA, as illustrated in Table 4 and expounded on in subsequent discussions.

Table 4. Summary of validity and reliability analysis

Measures	**Statistical Techniques and Cut-Off Points**	**References**
Measures of Validity		
Construct validity	Factor loadings must be ≥ 0.50 to show the factorability of the items on the construct.	Hair et al. (2010)
Convergent validity	AVE estimates must be ≥ 0.50 or AVE estimates below 0.50 but has a square root of AVE (composite reliability, CR) estimates ≥ 0.60 should be considered as showing convergent validity.	Fornell and Larcker (1981) and Hair et al. (2010)
Discriminant validity	A square root of AVE (composite reliability, CR) estimates must be more than the correlation coefficient values or correlation coefficient values must be < 0.70	Fornell and Larcker (1981) and Hair et al. (2010)
Unidimensionality	Overall model fit	López, Peón and Ordás (2006)
Measures of Reliability		
Internal consistency	Cronbach's alpha greater than 0.60 shows a strong correlation between the measurement variables.	Patel (2015) and Saunders, Lewis and Thornhill (2012)

Note: AVE = Average variance extracted.

RESULTS

Findings from the Qualitative Analysis

The general assertion across the cases suggests that budget overruns can be seen as spending more money on the project than is estimated in the budget. In Company A, it is described as additional costs beyond the original budget. Company B explains it as the actual cost being higher than the budgeted cost. According to Company C, it entails spending more money than the estimated budget. In Company D, it is described as scope creep which leads to exceeding the project budget. The construction of network expansion projects is also found to sometimes experience a budget overrun to the tune of USD100,000. The amount of the budget overrun is often self-inflicted and deliberately caused by the companies to achieve strategic objectives, as exemplified by #D6:

> A clear example I had is the project we needed to deliver within six months and based on some pre-discussions and pre-planning, we realised that based on the timeliness we were working in and based on the budget that we had already agreed upon, to beat the timeliness, we needed to bring in some type of connectors and there was a discussion with the project sponsor and because we did not want to miss the timeliness, we had to exceed the budget by somewhere around USD100K. So, we had to bring prefabricated connectors to be able to meet a certain installation requirement on site.

Stated differently, the finding indicates that although a budget overrun has a financial impact on the construction of network expansion projects' expected revenue projections, however, if a self-inflicted budget overrun is supported by the project's business case, it will be accepted by the business, as #D2 opined: "Every site must pay for itself, so if there is budget overrun and the business case proves positive, we still go ahead".

The occurrence of budget overruns has a financial impact on the revenue realisation by the operators and the profit rate of the suppliers; it increases cost, extends schedule and affects service quality. In Company A, it impacts the profit rate of the supplier. In Company B, it affects service quality, availability and expected revenues in the business case. In Company C, it may impact the project schedule. Nevertheless, in Company D, due to a strategic decision, a budget overrun is sometimes caused deliberately by the company in order to achieve its strategic objectives.

As the budget overrun causal factors were known, it was possible to develop a Model-cage diagram to illustrate the differences and similarities across the cases, as shown in Figure 1. A total of 21 factors were found to cause budget overruns.

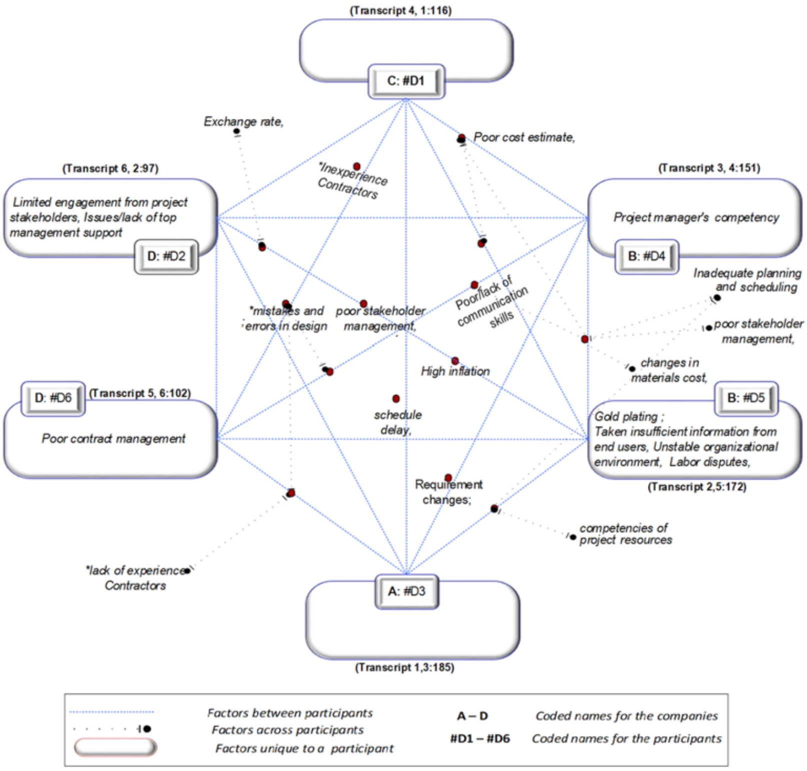

Figure 1. Model-cage for budget overrun causal factors

Exploring these factors, some of them are only associated with a specific company and these include "Gold plating", "Taking insufficient information from end-users", "Unstable organisational environment", "Labour disputes" and "Project manager's competency", which were all found in Company B. Also, the following factors were found in Company D: "Limited engagement from project stakeholders", "Lack of top management support" and "Poor contract management". No distinctive factors were found in Company A and C (as shown in Figure 1).

Conversely, the inter-connections and linkages among the causal factors represent the similarities across the companies. In view of this, the factors appearing in two different companies involved: "Competencies of project resources", "Poor/lack of communication skills", "Exchange rate" and "High inflation", all found in Company B and D; "Requirement changes" and "Inadequate planning and scheduling" appeared in Company A and B; and "Schedule delays" were found in Company A and C. More so, the factor found in three different companies (Company A, C and D) was "Lack of experienced contractors". No factor was found across all cases.

Findings from the Quantitative Analysis

Tests for assumptions of parametric data and reliability analysis

The study carried out tests for assumptions of parametric data and reliability analysis. This consists of normality and multi-collinearity tests to assess the data validity and reliability to conduct EFA and SEM-CFA. In line with this, Koyuncu and Kilic (2019) advocated that the tests of normality and multi-collinearity should be preceded by the EFA and CFA to select an appropriate rotation and parameter estimation method for effective interpretation and conclusion.

1. Normality test: data normality indicates the shape of data distribution for the variables in the study (Hair et al., 2010). The two most widely used methods to measure data normality are skewness and kurtosis tests (Mishra and Mishra, 2019; Patel, 2015). To showcase the normal distribution of the data, skewness statistics should be ≤ 2 and kurtosis statistics should be ≤ 5 (Kishabale and Hassan, 2018). The normality test carried out shows that all 21 items retained in the study were within the acceptable statistics showing normal distribution. Therefore, this data is suitable for performing EFA and SEM-CFA.

2. Multi-collinearity test: multi-collinearity is performed to show the extent to which a variable in a study is explained by others (Kline, 2016). The two key measures to establish a multi-collinearity assumption are the variance inflation factor (VIF) and tolerance values. To avoid the violation of the multi-collinearity assumption, the VIF value should be < 10 and the tolerance value should be > 0.10 (Hair et al., 2010; Kline, 2016). The findings from the multi-collinearity test show the VIF value of 2.937, which is less than 10 and the tolerance value of 0.340, which is greater than 0.10. Hence, there is no violation of multi-collinearity assumptions, making the data appropriate for performing EFA and SEM-CFA.

EFA for budget overruns causal factors

The findings as presented in Table 5, indicate that 18 out of 21 items forming two principal components and contributing to a total explained variance of 46.303%, were retained. The remaining three items with poor factor loadings of less than 0.50 on their respective latent variable were deleted.

Table 5. EFA for budget overrun

Factors Extracted	Codes	Item Names (Budget Overrun's Causal Factors)	Factor Loadings 1	Factor Loadings 2	No. of Items
2	CO03	Mistakes and errors in design	0.846		12
	CO17	Taken insufficient information from end-users (requirement gathering)	0.836		
	CO21	Project manager's competency	0.782		
	CO14	Competencies of project resources (resources' ability to estimate)	0.762		
	CO20	Poor contract management	0.721		
	CO05	Supplier is unable to commit adequate qualified resources	0.710		
	CO04	Limited engagement from project stakeholders	0.695		
	CO19	Poor supervision and inspections	0.660		
	CO01	Inexperienced contractors	0.630		
	CO18	Unstable organisational environment	0.600		
	CO15	Gold plating or over-specification	0.528		
	CO11	Poor stakeholder management	0.509		
	CO12	Changes in materials cost (Inflation)		0.718	6
	CO08	Lack or poor communication skills		0.717	
	CO07	Forex exchange or exchange rate		0.675	
	CO09	Inadequate planning and scheduling		0.654	
	CO10	Inaccurate time and cost estimate		0.572	
	CO06	Issues with top management support		0.561	
Eigenvalue			6.917	2.806	
Cronbach's alpha			0.920	0.802	
% of explained variance			32.939	13.364	
Total explained variance = 46.303%					
Kaiser-Meyer-Olkin measure of sampling adequacy (KMO) = 0.900					
Bartlett's test of sphericity:					
		Approx. chi-square = 19,943.370 df = 210 Sig. = 0.000			
Goodness-of-fit test = 0.000					

The values of Kaiser-Meyer-Olkin (KMO) = 0.900 and Bartlett's test of sphericity as significant at (χ^2(2,100) = 1,994.370, $p < 0.05$) were deemed adequate to support the appropriateness of factor analysis on the data. The factor loadings ranging from 0.509 to 0.846 were significantly robust to support the construct validity of the scales. Also, all the causal factors had acceptable content validity and reliability, with alpha values ranging from 0.802 to 0.920 (Hair et al., 2010; Koyuncu and Kilic, 2019; Patel, 2015). The assigned names given to these two principal components are "Control cost factors" and "Plan and estimate cost factors", respectively, based on their relations (PMI, 2017) and an assertion by Bryman and Cramer (2011), who argued that a logical interpretation should be given to the underlying constructs of what they are measuring.

Theoretical framework and hypothesis development

The SEM has its strong foundations on a theory, or a model emanated from a theory or concept (Byrne, 2013). In brevity, this study conceptualised the theoretical framework developed as a model to be tested with SEM-CFA. In view of this, Hameme (2017) explained that there are five ways by which a model can be developed for SEM. They are (1) a review of literature through document analysis, (2) a theory postulated by previous studies, (3) adopt-and-adapt techniques from previous studies, (4) a theory postulated through a grounded theory approach and (5) a review of literature and EFA. Based on the foregoing, this study developed a model (as shown in Figure 2) based on the EFA findings (as shown in Table 5) which had its foundation in the literature review.

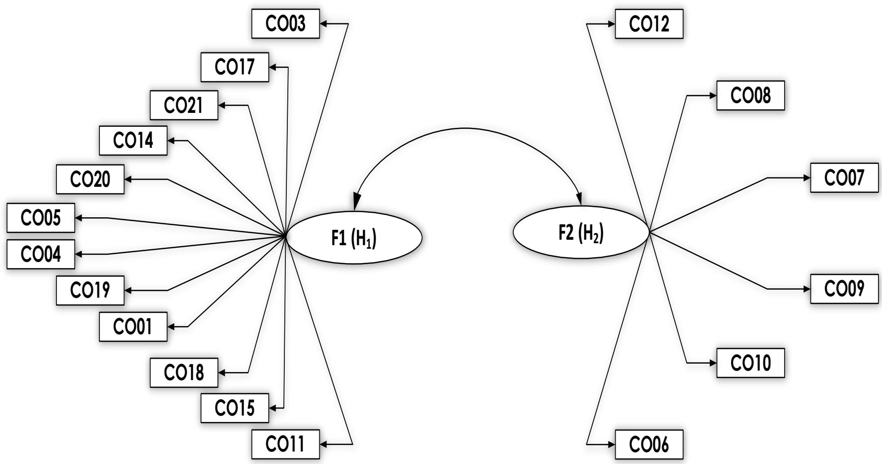

Figure 2. Proposed budget overrun's causal factors model

Note: F1 = Cost control factors; H_1 = Hypothesis 1; Cost control factors codes = CO03, CO17, CO21, CO14, CO20, CO05, CO04, CO19, CO01, CO18, CO15, CO11; F2 = Plan and estimate cost factors; H_2 = Hypothesis 2; Plan and estimate cost factors codes = CO12, CO08, CO07, CO07, CO09, CO10, CO06.

In addition, Byrne (2013) argued that SEM begins with a model specification which describes that hypothesised relations exist among the observed measures and the underlying factors. Following the proposed model specified in Figure 2, hypotheses are set forth for testing and validation:

$H_{1:}$ The critical budget overruns causal factors that relate to the "Cost control" component are CO03, CO17, CO21, CO14, CO20, CO05, CO04, CO19, CO01, CO18, CO15 and CO1.

$H_{2:}$ The critical budget overruns causal factors that relate to the "Plan and estimate cost" component are CO12, CO08, CO07, CO09, CO10 and CO06.

Therefore, this section sought to answer the second question of the study by measuring and validating the hypothetical model as shown in Figure 2 with SEM, specifically, the CFA measurement model to ascertain the most critical budget overruns causal factors in the Ghanaian telecommunications industry construction projects.

SEM: CFA for critical budget overruns causal factors

The study used the set of model fit indices, validity and reliability techniques, presented in Tables 3 and 4, respectively, to examine and validate how well the proposed model (as shown in Figure 2) fit the set of collected data.

In achieving the best model fit of the data, some budget overruns causal factors were deleted: 7 out of 12 causal factors found in Factor Component 1 (CO03, CO17, CO14, CO04, CO01, CO15 and CO11) and 3 out of 6 causal factors found in Factor Component 2 (CO12, CO07 and CO06) (as shown in Figure 3).

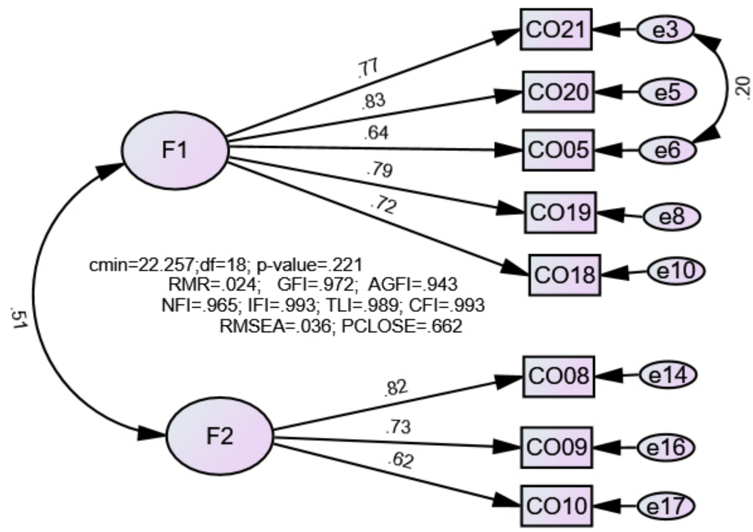

Figure 3. Standardised solution of the measurement model: Budget overrun

These deletions were necessitated on observation of the low factor loadings, non-significant factor contribution, extreme standardised residual values and path estimates. The smaller number of variables retained conforms to the item response theory (IRT), which states that the fewer the items, the better the measures provided (Bongomin, 2016). Again, covariance was drawn between e3 and e6 in the form of modification to enhance the model fit achievement (as shown in Figure 3).

The final measurement model fit statistics are: χ^2/df =1.237, *p*-value = 0.221 > 0.05, GFI = 0.972, AGFI = 0.943, NFI = 0.965, IFI = 0.993, TLI = 0.989, CFI = 0.993, RMR = 0.024 and RMSEA = 0.036 as summarised in Table 6. The findings meet all their respective recommended values, which displays the unidimensional validity of the construct (López, Peón and Ordás, 2006).

Table 6. SEM-CFA fit indices: Budget overrun causal factors

Goodness of Fit Measures	χ^2/df	*p*-value	RMR	GFI	AGFI	NFI	IFI	TLI	CFI	RMSEA
Recommended value	≤ 5.0	> 0.05	≤ 0.05	> 0.90	> 0.90	> 0.90	> 0.90	> 0.90	> 0.90	< 0.08
Measurement model	1.237	0.221	0.024	0.972	0.943	0.965	0.993	0.989	0.993	0.036

Note: χ^2 = 22.257; df = 18; LO = 0.000 and H = 0.078; PCLOSE > 0.000 = 0.662

The findings also showed (as shown in Figure 3 and Table 7) that the factor loadings or the retained variables loaded well onto the latent variables, ranging from 0.620 to 0.834 exceeding the threshold value of 0.50, demonstrating factorability of the items on the construct, that is, the construct validity (Hair et al., 2010).

More so, as shown in Table 7, the findings presented convergent validity as AVE values of 0.753 and 0.725 for both Factor Component 1 and Factor Component 2, respectively, and surpassed the threshold of > 0.50. Equally, discriminant validity was ensured with CR estimates of 0.868 and 0.851 > 0.70 and correlation coefficient value (F1 ⇄ F2) of 0.506 < 0.70 (Fornell and Larcker, 1981; Hair et al., 2010).

Table 7. Standardised regression weights (Group number 1: Default model)

Factor Naming	Codes	Item Names	Estimates	AVE	CR
Factor 1: Cost control factors	CO21	Project manager's competency	0.768	0.753	0.868
	CO20	Poor contract management	0.834		
	CO05	Supplier is unable to commit adequate qualified	0.638		
	CO19	Poor supervision and inspections	0.788		
	CO18	Unstable organisational environment	0.721		
Factor 2: Plan and estimate cost factors	CO08	Lack or poor communication skills	0.815	0.725	0.851
	CO09	Inadequate planning and scheduling	0.728		
	CO10	Inaccurate time and cost estimate	0.620		
		F1 ⇄ F2	0.506**		

Note: AVE = Summation of squared factor loading/Summation of squared factor loading + Summation of error variances; CR = Square root of AVE (Fornell and Larcker, 1981); ***p* < 0.01; F1 ⇄ F2 = Correlation coefficients between the factors.

DISCUSSION

The findings, as extensively presented above, have been summarised and illustrated in Figure 4 entitled "Budget Overrun Flowerpot" using the innovation concept which states that a researcher should not be limited by a format to display the outcome but innovate what works best for the study (Miles, Huberman and Saldana, 2014). This "Budget Overrun Flowerpot" stemmed heavily from the tested and validated hypothetical model developed for the study.

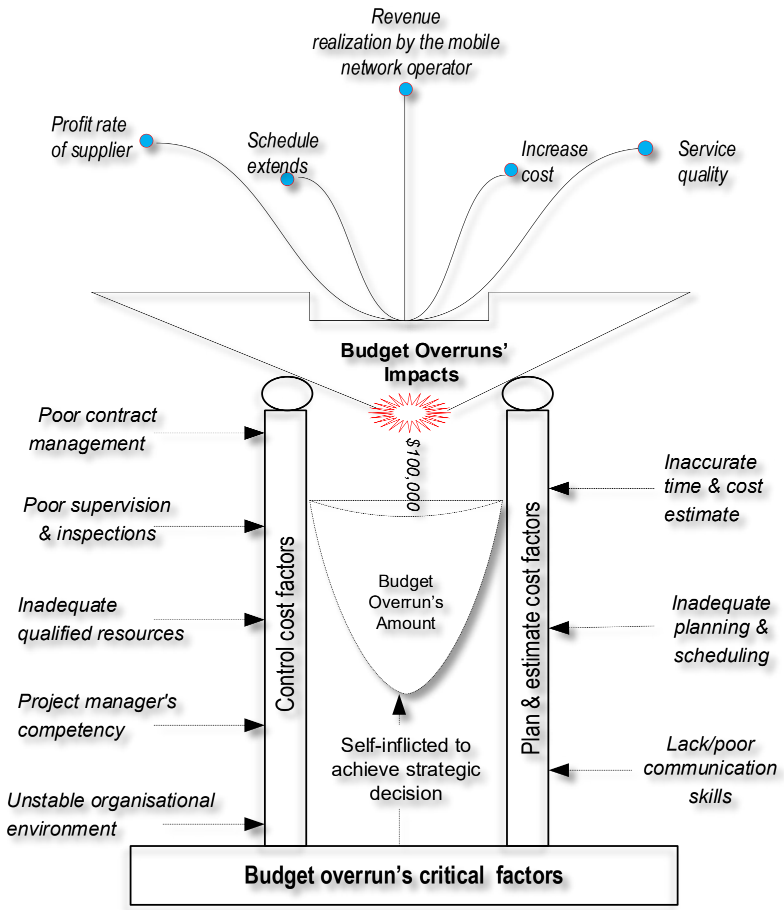

Figure 4. "Budget Overrun Flowerpot" in the construction of network projects

In answering the first question of the study: What is the concept of budget overruns, their occurrence and impact on the Ghanaian telecommunications industry construction projects? Figure 4 posits that budget overruns are seen as spending more money on the project than its estimated budget. Budget overruns are found to occur sometimes and may amount to the tune of USD100,000. This finding is consistent with the literature that budget overruns are a common phenomenon across construction projects regardless of the industry (Cheng, 2014; Herrera et al., 2020; Huo et al., 2018; Shehu et al., 2014; Simushi and Wium, 2020; Taroun, 2014) and its trend is more prevalent in developing countries (Durdyev et al., 2017). As a new knowledge to the literature, the findings revealed that the occurrence of budget overruns is often self-inflicted and deliberately caused by companies to achieve strategic objectives. The repercussions are that the profit rate of suppliers and revenue expectations of the mobile network operators are impacted, project schedules extended, costs increased and service quality eroded. The latter finding confirms an assertion that budget overruns have a financial impact on the project (Durdyev et al., 2017) and its occurrence affects project schedule and quality (PMI, 2017).

Furthermore, in answering the second question of the study: What are the most critical factors that cause budget overruns in Ghanaian telecommunications industry construction projects? The aim was to measure, test and validate the hypothetical model developed with SEM, specifically the CFA measurement model. Figure 4 further postulates that there are eight most critical budget overruns factors found from the SEM-CFA instead of the initially hypothesised 18, which formed two-factor components, namely, "control cost" and "plan and estimate cost" as follows:

1. The "control cost component" is defined in this study as the ability to make good use of the project budget and guard it to yield the benefits that justify the project investment. The project team's skill set and competency gaps are indicative of the factors outlined in Figure 4, that bring about cost expansion resulting in budget overruns in Ghana's telecommunications construction projects.

2. This study again defines "plan and estimate cost component" as the ability to clearly outline project activities with a high level of precision while accurately estimating the associated costs. As indicated in Figure 4, these factors were found to impede the ability to plan and estimate costs effectively, resulting in cost overruns.

These most critical budget overruns factors were further mapped against the extant literature to ascertain their consistencies and similarities as shown in Table 8. From Table 8, the following observations were made:

1. Six out of the eight most critical factors are consistent with the findings from the extant literature. These factors are "Poor contract management", "Inaccurate time and cost estimates", "Inadequate planning and scheduling", "Lack/poor communication skills", "Project manager's competency" and "Supplier is unable to commit adequate qualified resources".

2. On the contrary, the two remaining most critical factors ("Unstable organisational environment" and "Poor supervision and inspections") are found to be uniquely related to only the construction of network expansion projects in the Ghanaian telecommunications sector. Therefore, within the context of this study, these factors can be perceived as a new addition to the knowledge of construction project management.

Table 8. Mapping of budget overrun most influential causal factor in the extant literature

Budget Overruns' Factors in the Extant Literature	References										
	Herrera et al. (2020)	Belali et al. (2020)	Adafin, Rotimi and Wilkinson (2020)	Seddeeq et al. (2019)	Johnson and Babu (2020)	Durdyev et al. (2017)	Asiedu, Adaku and Owusu-Manu (2017)	Cheng (2014)	Memon, Rahman and Azis (2012)	Ameh, Soyingbe and Odusami (2010)	Freq.
Poor contract management	+					+	+	+			4
Inaccurate time and cost estimate				+	+	+					3
Inadequate planning and scheduling	+			+							2
Lack/poor communication skills						+	+				2
Project manager's competency			+			+					2
Supplier is unable to commit adequate qualified resources										+	1
Unstable organisational environment											–
Poor supervision and inspections											–

CONCLUSION AND RECOMMENDATIONS

The study adopted an exploratory sequential mixed method approach to investigate issues of budget overruns in construction projects in the Ghanaian telecommunications industry.

Subsequent to the findings from the study, the following recommendations are made to mitigate the occurrence of such overruns. With the "Plan and estimate cost factors", this study advocates that project management practitioners should be keen on managing the factors that have been found to likely occur over the life of the projects. Also, to improve the level of precision and accuracy of cost estimates, the companies in this sector can adopt project management software applications to reduce overreliance on the practitioners' judgment and previous project experience, as found in the study. As argued by Taroun (2014), construction professionals generally depend on their experience instead of tool usage.

Additionally, it can be inferred that all the control cost factors are connected to inexperienced project resources. Therefore, companies in the telecommunications sector should ensure that only qualified and experienced people are involved in construction projects to better manage, monitor and control the work performed against the funds expended.

In conclusion, the amount of budget overruns in construction projects in the telecommunications sector are quite substantial and cannot be ignored. Therefore, through the "Budget Overrun Flowerpot", the practitioners could gain a better understanding of the impact of budget overruns and the most critical causal factors that must be properly managed to improve the project's budget performance and achieve budgetary efficiency.

The methodological implication is that this study went through a statistical validation by rigorously testing the consistency and validity of the factors that cause budget overruns. This research methodology can aid and facilitate the conduct of any such study in any industry.

In the absence of extant literature on budget overruns in construction projects of the Ghanaian telecommunications sector, this research bridges the gap and serves as a benchmark to conduct further research in different countries' telecommunication sectors. However, this study focuses solely on construction projects within the context of the telecommunication industry in Ghana. This limits the generalisability of the findings to telecommunications projects as a whole and may not always be transferable to other service industries. Future studies can explore "Control cost factors" as well as "Plan and estimate cost factors" that cause budget overruns and their impacts on construction projects' performance in different countries' telecommunication sectors and compare the findings.

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