Critical Success Factors (CSFs) for Cost Overrun Minimization in Public Construction Projects in Developing Countries: The Case of Ghana

Abstract

Purpose: It is widely accepted that one criterion for determining if a construction project is successful is whether it is completed within the expected budget. There have been advancements in the management of building projects throughout time; but, cost overruns remain a key concern in the construction sector internationally, particularly in emerging economies like Ghana. The study aims to answer the question, "What are the Critical Success factors that can assist reduce cost overruns in public-sector infrastructure projects?" in the Ghanaian construction industry.

Methodology: The study used a quantitative survey method. Questionnaire was pre-tested by interviewing 15 contractors to ascertain the validity of the content. Factor analysis and multiple regression were adopted to analyse the data.

Findings: The study discovered that the critical factors that can reduce cost overruns in construction projects in Ghana are directly linked to five themes: early contractor involvement in the project planning stage, adequate funding, good project team relations, competent managers/supervisors, and project participant incentives/bonuses. This study identifies indestructible empirically measurable important success criteria for reducing cost overruns in public building projects in Ghana.

Practical implication: When well thought through from the project initiation stage to completion, these critical successes can also be used to deal with damaging economic effects such as allocative inefficiency of scarce resources, further delays, contractual disputes, claims and litigation, project failure, and total abandonment.

Originality: The uniqueness of this research resides in the fact that it is a first-of-its-kind investigation of the critical success factors for reducing cost overruns in public building projects in developing countries.

Keywords: Cost overrun, Cost minimization, Factor analysis, Ghana, Public sector, Construction project.

1. Introduction

Cost is one of the most important and critical aspects of construction projects globally (Aljohan et al., 2017). The relevance of cost estimation stems from the fact that the completion of building projects is highly dependent on the availability of sufficient resources. However, a number of studies highlight the challenges associated with predicting construction costs because of unpredictability and the distinctive nature of projects, which may impact the adequacy of the budget, (Flyvbjerg, Mette, Holm, and Buhl,2003; Arcila, 2012). Earlier studies have discovered that the likelihood of projects being completed above budget is significantly surpassed by the possibility of project completed under budget. It's common to refer to "cost overrun" as "budget increase," "cost growth," or "cost increase." However, a clear explanation of this idea is lacking in the literature on the issue. Hinze et al., (1992), proposed, for instance, that cost overrun is defined as the discrepancy between the contract value at the beginning and the actual cost of completion.

Flyvbjerg et al. (2002) and Odeck, (2004) opined that cost overrun is the discrepancy between projected and actual building costs. In this case, actual construction costs are defined as accounted construction expenses at the time of project completion, and the budget at the time of decision to build is utilized as the reference for calculating the overrun that may be incurred.

The term "actual or final costs" can also mean the percentage of project costs that exceed the estimated or tender costs (Ubani et. al, 2011; Jenpanistub, 2011; Memon, 2013). According to Nega (2008), a cost overrun occurs when a contractor or constructor and a project sponsor agree to use more financial resources than what was initially needed to provide the goods or services under contract. Furthermore, cost overrun is seen by Azhar et. al, (2008) as only an instance in which the actual cost of a project exceeds the projected or initial projections. The percentage of actual or final costs, less the estimated cost over estimated costs of a project, (Memon, 2013; Ubani et. al, 2011).

This is represented mathematically = $\frac{\text{Final Cost} - \text{Projected cost}}{\text{Projected cost}} \times 100$

According to Baloi and Price (2003), a large majority (63%) of 1778 World Bank-funded construction projects exceeded their budgets. The situation is made worse when it comes to major infrastructure projects, like building new roads and trains. According to Flyvbjerg et al. (2003), a significant portion of these projects went over their original budgets, with cost increases of 50% to 100% being typical and increases above 100% being unacceptable. Flyvbjerg et al (2003) not only shed light on the severity of the problem but also on its worldwide consequences by presenting these numbers. The study's data was acquired from a variety of geographical regions between the late 1920s and the late 1990s, including five continents and the countries involved consisted of both developed and developing nations. This demonstrates that the problem of cost overrun is a global issue, and that, while slight changes exist based on geographic location, the issues persist in the construction industry worldwide (Ahwal, et al., 2016). According to studies, the situation is even worse in developing countries, where corruption has a substantial impact on actual costs, accounting for 10-30% of the total value of a single building contract (World Bank, 2012).

Construction expenses can be defined as the total cost of all component activities from the start of a project proposal until its completion. These costs include idea development, investigations, design development, land acquisition, public utility plant modifications, construction, project management, and handover. According to Ofosu (2014), the cost of a project is typically dependent on several uncertainties related to factors such as human resource competence, partner relationships, material quality, and sources, distribution and delivery channels, and general economic conditions, such as inflation within the economy. Subramani et al., (2004), opined that in the process of construction expenditure, issues such as slow decision making, poor schedule management, increase in material and machine prices, poor contract management, poor design and delay in providing design, rework due to wrong work, problems in land acquisition, wrong estimation and estimation method, and long period between design and time of bidding and tendering are the major causes of cost overrun.

The construction business, according to Amponsah and Frimpong (2020), is a choleric and vital treasure to any healthy and thriving economy that cannot be ignored. Anyago (2020) also claims that it is a sector that is used as a political tool to implement the public or private infrastructure. This industry is divided into three sectors: Non-Residential which has three sub-sectors (heavy industrial, institutional commercial, road and highway engineering), Residential Construction also with sub-sectors (house construction, multi-unit apartment, and townhouse construction), and specialty trade (Szymanski, 2006). Anyago (2020) states that the industry is pivotal in national socioeconomic growth since infrastructures are essential in producing goods and services in every functioning economy. Asante and Mills (2020) posit that the construction industry is a major Gross Domestic Product (GDP) contributor of both developing and developed nations. According to Ghana Statistical Service, (2019), the industry formed almost 10% of the Ghanaian workforce and supported the GDP by 30%. The impact of the construction industry on the Ghanaian economy cannot be under-emphasized. In the year 2022 the industry faced a declined to 6.2 % according to Ghana Revenue Authority annual report 2022, (GRA, 2022).

Despite the construction industry's enviable data, the construction industry is notoriously known for its cost overrun. Studies show that the problem of cost overrun, especially in the construction industry, is a worldwide phenomenon and very widespread in developing countries of which Ghana is not an exception (Creedy et al., 2010; Mahamid and Dmaidi, 2013; Ofosu, 2014). A construction project is considered successful if it is completed on time, within budget, and to specification or quality standards (Arcila, 2012). The achievement of this objective however is a major problem in the construction industry especially in developing countries (Ofosu, 2014). According to Kaliba et al. (2009), the presence of cost overruns can be a reason for project failure. However, this idea has been refuted by many authors who considered that project success depends on many other factors that should be assessed to conclude the success or failure of a project (Chan, et al., 2004). Moreover, there have been many studies that suggest that the success of a project depends on the presence of certain critical factors which can also change depending on the objective to be met (Iyer and Jha, 2005). In other words, Salleh, (2009) ascertained that; some critical success factors help to improve cost performance and prevent cost overruns.

Although there have been studies focused on Critical Success Factors (CSF's) that helped improve the cost performance of projects in some developed countries like the United Kingdom, Australia, Malaysia, China, and Singapore (Hwang and Lim, 2012; Arcila, 2012; Mahmood, 2021), however, there is a paucity of similar research in developing countries, particularly Ghana, as much of the existing research is not focused specifically on those critical success factors that influence the cost performance of construction projects (Imbeah, 2012; Fobi, 2014). Also, researchers maintain that important factors vary from one geographical region to another (Apolot et al., 2011); the critical factors identified by researchers in other countries may not be relevant in the Ghanaian scenario due to the different socio-cultural, political, and economic environments in Ghana. The aforementioned justifications support the study's goal and objective of finding what the key critical success factors (CSFs) are that can reduce cost overrun in public infrastructural projects in the Ghanaian construction industry.

2. Overview of Construction Cost Overrun

Construction is a crucial business for emerging economies because it provides critical infrastructure for considerable economic and social development. The construction industry contributed 30% to GDP in the year 2019, (Ghana statistical service, 2019) and 6.2% in 2022

according to Ghana Revenue Authority immediately after the impact of Covid-19, (GRA, 2022). As a result, construction projects account for a larger proportion of Ghana's GDP, necessitating the need to pay close attention to project performance in the construction industry in order to ensure efficient use of taxpayers' money.

Particularly in emerging economies with fiscal issues, key performance indicators (KPI) are used in the construction industry to assess project performance. These KPIs, which comprise time, cost, and quality, are referred to as the iron triangle by (Pollack et. al, 2018). However, most definitions of project management performance, particularly success, include the cost criterion. Though the concept of project success has been expanded to include additional factors, according to Papke-Shields (2010), the cost aspect remains key. Lim and Mohammed (1999) expand the (KPI) to include time, cost, quality, performance, safety, customer's satisfaction, utility and operation to measure project success in the construction industry.

The Project Management Institute (PMI) has listed project cost management as one of the ten knowledge areas that every project manager must master, recognizing it as a major risk factor (PMI, 2000). In a comparative assessment of construction cost overrun case study of regional distribution done in Ghana by Coffie and Aigbavboa (2020), as shown in table 1, revealed that construction project in Ghana experienced cost overrun during the period under investigation. Their study further showed that the average length of construction for the 911 construction projects in the study was little over nine months with an average cost overrun of Gh₵172,462 per project equivalent to ($30,796.79). 874 projects representing 95.9% experienced construction cost overruns, 35 projects were completed within budget and two were completed under budget.

Table 1: Comparative assessment of construction cost overruns: A case study of regional distribution in Ghana.

Region	Number of projects	Average cost overrun (%)	Standard deviation	Average cost overrun (GH₵)	Dollar equivalent ($)	Standard deviation
Greater Accra	271	48.8	600.7	175835.8	31399.25	436715.1
Ashanti	148	12.2	5.9	169930.9	30344.64	203381.2
Brong Ahafo	35	12.1	7.9	203547.1	36347.70	359401.5
Central	27	9.7	4.3	222457.3	39724.52	342689.4
Eastern	119	11.7	6.6	145194.8	25927.64	186028.5
Northern	62	11.5	7.3	208386.3	37211.84	322492.2
Upper East	38	35.2	144.2	159744.3	28525.77	308789.8
Upper West	16	10.1	5.1	104396.1	18642.16	124109.7
Volta	127	12.2	13.9	140318.7	25056.91	202868.9
Western	68	10.1	4.9	120247.8	21472.82	179298.1

Source: Coffie and Aigbavboa (2020)

Despite project managers' acknowledgment of budgets as vital to project success for more than half a century, building projects continue to overshoot their budgets. As a result, researchers have attempted to understand the causes of the ongoing cost overruns in order to develop a long-term solution to the hazards connected with them (Jennings, 2012; Love et al., 2012; Vu et al., 2016; Ullah et al., 2018). According to Flyvbjerg et al. (2003), cost overruns occurred in 258 projects in about 20 countries, accounting for 90 percent of all road and rail projects. The authors concluded that, while road projects experienced an average of 20% budget overruns, rail projects experienced an average of 45 percent budget overruns, and thus concluded that the risk of construction cost overrun has not decreased over the past 70 years, despite the literature and practice debate on its causes and potential solutions. According to Ameyaw and Oteng (2010), the average cost overrun of 62 building projects surveyed in Ghana was 23%. According to Asiedu and Alfen (2014), 72 percent of 321 public building projects in Ghana experienced cost overruns. Aside the plethora of evidence showing the occurrence of cost overruns, experts and practitioners cannot agree on the origins of this unfavourable global phenomenon. The risk's triggers appear to be complex, dynamic, and sector- and country-specific. Despite the fact that multiple studies have attempted to identify the reasons of cost overruns in various nations, prior authors have treated the components in isolation, placing little attention on the interrelationships between the factors, particularly in developing nations such as Ghana.

2.1 Factors Influencing Cost Overruns in Public Sector Construction Projects

The completion of the project on time and within budget is an important criterion for project success (Flybjerk, 2004). In every undertaking, cost performance is the most important indicator of an organization's efficiency and gains (Olawale and Ming, 2010). The discrepancy between the budgeted cost estimate and the actual construction cost on completion is referred to as a construction project cost overrun.

In an Indian study, Iyer and Jha (2005) found that the following risk events contributed to cost overruns: difficult socioeconomic conditions, delayed timely decision, unrealistic low bid, inadequate tender preparation, incremental weather, conflict among project participants, lack of capacity, availability of poor project unique project attribute, and poor cooperation. Poor contract management, pricing volatility, material shortages, scope creep, weather, late payments, and insufficient finance were identified as the key cause agents of cost overrun in a separate study conducted in Nigeria by Omorgie and Radford (2006). The elements that influence cost overruns in public sector project execution in Ghana are summarized in Table 2.

Summary of Factors Influencing Cost Overruns in Public Sector Construction Projects in Ghana.

Table 2**:** Cost overruns in Ghana are primarily due to the following factors

Factors	**Frimpong et al. (2003)**	**Laryea (2011)**	**Abban and Allotey (2014)**	**Ofosu (2014)**
Increase of cost of the materials	√			
Poor contractor management	√			
Funding/delay payment	√		√	√
Poor technical performance	√			

Inaccurate estimation of cost	√			
Tight project schedule		√		
Design Variation		√	√	
Excessive approval procedures		√		
High performance/quality expectations		√		
Lack of adequate designs before contract award		√	√	√
Use of line diagrams for highway construction projects				√
Underestimation of quantities in BOQ				√
Inadequate contingency	√			√
Allowance in BOQ	√			
Fluctuations	√			

Adapted from Frimpong et al, (2003); Laryea, (2011); Amoa-Abban and Allotey, and Ofosu, (2014)

2.2 Impact of Cost Overruns

Costs are regarded as the most important aspect that contributes to a project's success, and are, in fact, the only factors on which everything hang, and are the most important factors in determining whether a project will begin or be shelved. Cost overruns, according to Amoa-Abban (2014), have evident consequences for key players in particular and building construction in general. Cost overruns simply added expenditures above and beyond those agreed upon during the pre-contract period, resulting in lower returns on investment for the client. The additional expenditures are passed on to the end-user in the form of higher rental or leasing charges. Cost overruns, in the eyes of experts, signify a failure to give value for money, which could destroy their reputations and cause clients to lose faith in them. If the contractor is found to be at fault, it entails a loss of profit due to non-completion as well as defamation, which could endanger future contract opportunities. Cost overruns could result in project abandonment and a decline in construction activity, a bad reputation, and an inability to acquire project finance or secure projects at higher costs as a result of the increased risks (Mandisa, 2015). All of these implications jeopardize the building construction industry's long-term viability and success.

2.3 Minimising Cost Overrun

Construction project, characterised by high risk, may lead to cost overrun. Hence, contractors should apply systematic approaches to minimise these potential risks, or probably manage them appropriately. Such factors are missing for public construction projects in developing countries, particularly Ghana, where cost overrun is a prevalent issue. As a result, potential success factors (SF) for minimising cost overrun in construction project execution have been identified via literature review. Table 3, therefore, highlights the study done in literature on success factors (SF) of minimizing cost overrun in project executions in the developed world. It shows the similarities and differences in viewpoints on the essential success criteria for reducing cost overruns. This study adopts these success factors for the study of the Ghanaian construction industry.

Table 3: Comparison of the Potential SFs by

Factors	**Hwang and Lim (2012)**	**Kog and Loh (2012)**	**Arcila (2012)**	**Mahmood (2021)**
Adequate of funding/Fulfilling contract obligation	√	√		√
Adequate plans and specifications	√	√		
Adequate planning and control techniques	√			√
Budget updates	√	√		
Constructability of the project	√	√		√
Contractual motivation/incentives				√
Economic risk	√	√		
Client involvement and frequent feedback	√			
Owner's commitment to established schedules and budget			√	
PM commitment and involvement		√	√	
PM competency/experience	√	√		√
Realistic obligations/clear objectives	√	√		√
Risk identification and management		√		√
Pioneering status			√	
Contractor's competency/training			√	
Good relations between project parties			√	√
Accuracy of plans and initial information.			√	√
Early involvement of the contractor			√	
Initial identification of all the risks			√	
Architects competency			√	

(Hwang and Lim, (2012), Kog and Loh (2012), Arcila, (2012) and Mahmood, (2021)

Table 4. Main effects of cost overrun in construction projects through previous studies

Effect / **Authors**	Less profit to client	Less profit to contractor	Cash flow problems	Disputation	End user satisfaction	Company failure
Mbachu et al. (2004)	✓	✓	✓	✓	✓	
Zainuddeen et al. (2008)		✓	✓			
Arditi et al. (1985)			✓			
Ahmed et al. (2003)			✓	✓		
Charoennmgam et al. (2001)						✓
Nega (2008)	✓	✓	✓	✓	✓	

Mahamid, I. and Dmaidi, N. (2013)

From table 4 above six identifiable effects of cost overrun in construction in previous studies revealed that cost overrun leads to the following effects; less profit to client, less profit to contractor, cash flow problems, disputation, end user dissatisfaction, company failure. According to According to Nega, (2008), the effects of cost overruns include, but are not limited to: project delays, extra costs, budget shortfalls, tense relationships between project participants, damage to the consultant's reputation, project owners viewing the consultant as incompetent, delayed payments to contractors, dissatisfaction from project owners and subsequently from end users, and a weakening of the growth of the construction industry by undermining mutual trust and respect and causing frustration among stakeholders.

Owens et al. (2006) states that there are three components involved in cost management, namely;

- Cost budgeting which is described as gathering the cost estimates and integrating them to get a baseline and total cost.
- Cost controlling which is also explained as overseeing and regulating variables that alter or impact the budget.
- Cost estimating that is Calculating the prices and quantities required for resource to finish the tasks and activities involved in the project.

One of the crucial responsibilities for attaining a successful project completion is managing the cost of construction but it is quite infrequent that efficient cost control can be accomplished; instead, a considerable proportion of cost overruns must frequently be encountered (Azis et al., 2013). It will be impossible to finish the project within the allocated budget if real costs are not monitored over the project's duration (Susana, 2012).

3. Research Method

Twenty (20) potential SF were identified and examined from literature review by combining relevant studies: Hwang and Lim (2012), Kog and Loh (2012), Arcila (2012), and Mahmood (2021) in Table 3. Scopus and Google Scholar were used to search for keywords; “cost overrun in construction”, “developing countries”, “developed countries”. This study adopted a quantitative method to identify critical success factors that can prevent cost overruns in the Ghanaian construction industry.

A pilot study was conducted by contacting construction professionals, including construction managers and supervisors, to review the identified potential SF, as well as revising the instrument to achieve the reliability and validity standard. The entry criteria were based on the study’s objective. The background of the contractors, consultants, supervisors and project managers was investigated to select participants for the study. Contractors with experience with public construction projects from D1K1, D2K2, D3K3 and D4K4 classification from the ministry of works and housing in addition to contractors in the road’s subsector who fall within the following classification; class A, class B, class C and class D were chosen for the study. With this, 12% of the participants were selected to validate and verify the list of the potential SF. Hence, achieving 15 potential SFs out of the initial 20 potential SFs (Table 3).

Table 5: Potential 15 Success Factors (SFs) as identified.

NO.	Success Factors	REFERENCES
1.	Adequate of funding/Fulfilling contract obligation	Hwang and Lim (2012, Kog and Loh (2012), Mahmood (2021)
2.	Adequate of plans and specifications	Hwang and Lim (2012), Kog and Loh (2012)
3.	Adequate planning, schedule of work and control techniques	Hwang and Lim (2012), Mahmood (2021)
4.	Budget updates	Hwang and Lim (2012), Kog and Loh (2012)
5.	Contractual motivation/incentives	Mahmood (2021)
6.	Owner's commitment to established schedules and budget	Arcila (2012)
7.	Project Management team competency, experience commitment and involvement	Hwang and Lim (2012), Kog and Loh (2012), Arcila (2012), Mahmood (2021)
8.	PM competency/experience	Hwang and Lim (2012), Kog and Loh (2012), Mahmood (2021)
9.	Risk identification and management	Kog and Loh (2012), Mahmood (2021)
10.	Contractor's competency/training	Arcila (2012)
11.	Good relations between project parties	Arcila (2012), Mahmood (2021)
12.	Accuracy of plans and initial information.	Arcila (2012), Mahmood (2021)
13.	Early involvement of the contractor	Arcila (2012)
14.	Initial identification of all the risks	Arcila (2012)
15.	Architects competency	Arcila (2012)

Hwang and Lim, (2012), Kog and Loh, (2012), Arcila, (2012), Mahmood, (2021)

Questionnaires were then distributed to contractors electronically to identify the critical success factors (CSFs). The respondents were implored to evaluate the 15 potential SFs for improving construction cost performance in Ghana, using a five-point Likert scale: 1= Not critical, 2= Least critical, 3= Neutral, 4= critical, and 5= Most critical. Due to a lack of precise, up-to-date data on the list of registered contractors in Ghana, the study used the snowball technique of the non-probability sampling approach to identify the respondents. A total of 380 questionnaires were sent out to respondents. Snowball sampling is a quick and easy way to collect data. When accessing participants with the desired features is challenging, this strategy is used. Existing research subjects recruit future study subjects from their connections using this strategy. Sampling will continue until the data is saturated (Naderifar, 2017).

The study considered construction professionals in Ghana who are responsible for planning, estimating, monitoring, and managing the cost of public infrastructural projects in the Ghanaian construction industry. The projects used for this study was Government of Ghana project, which is funded by the central government; the traditional method of procurement was adopted for these projects for the study, often known as bid build or design bid build, the conventional procurement approach is a widely employed technique for construction projects. According to Davis et al.,

(2008), an accurate conventional technique is a two-step contract approach that enables early start-up capability and lower cost security by carrying out design and construction work concurrently. According to Larmour (2011), the conventional procurement method's sequential approach to construction and design leads to exorbitant costs based on negotiation and hypothetical knowledge. This method requires the client to design the project, produce a tender that includes all necessary papers, and submit it all at once in a competitive manner. In the conventional method, the employer views design work as distinct from construction. Subcontractors and suppliers shoulder the majority of the duty after consultants handle cost control and design. Usually, a competitive tender is used to select the contractor. But the contractor is also chosen ahead of time on the basis of negotiations and hypothetical data. The research was conducted in two locations (i.e Accra and Kumasi). The study's focus was on these two locations because of their geopolitical significance. Accra is Ghana's capital region and the country's most populous region, followed by the Ashanti Region (Ghana Statistical Service, 2021). As a result, Accra has a larger proportion of the country's public project being executed, followed by Ashanti region, Ashanti region similar to Accra is experiencing infrastructural development across the region and by virtue possesses similar characteristics like Accra. The demographics component of the survey collected information on gender, qualification, professional experience, position, and the number of projects completed within the years of professional experience.

Finally, the collected data was analysed using frequency, factor analysis and multiple regression. Frequency was used to analysed the demographic data of the respondents; factor analysis was used to categorize the 15 factors into themes based on their semantic similarity; and the multiple regression was used to analyze the relationships between the dependent variables and independent variables in relation to the study.

4. Analysis and findings

4.1 Background Analysis of Respondents

Out of the 380 questionnaires distributed, 206 responses were received with 194 being usable due to various inaccuracies in responses. Hence, 12 of the questionnaires were considered invalid.

The study found that the vast majority of the 194 responders were men, with 180 males and 14 females. When it came to evaluating the respondents' professional qualifications, 92 percent of all respondents had a higher degree of professional certification from professional certified organisations that train and govern construction and engineering practitioners. 37 respondents have fewer than five years of job experience, whereas 157 have more than five years of work experience. This indicates that the bulk of the respondents have more work experience, which is a need in the construction industry; and that the data elicited is based on reliable sources. Also, senior level managers accounted for 39 out of the 194 respondents; Mid-level managers accounted for 114 of the respondents, and supervisors accounted for 41 of the respondents.

4.2 Factor Analysis of the Success Factors (SFs) for Project Cost Overrun Minimisation

The factor analysis approach was used to categorise the 15 SFs into significant latent variables. The 15-variable correlation matrix demonstrates that 84 of the 105 correlations (81 percent) are significant at the 0.01 level, indicating that the data matrix has enough correlations to justify factor

analysis (Hair et al., 2003). According to Hair et al. (2003), the KMO statistic has a value of 0.732, which is good for factor analysis. At the *p* 0.01 level, Bartlett's test of sphericity, which evaluates the hypothesis that the variables are collinear, was significant (see Table 7). Communalities of 0.60 or greater were also achieved (see Table 7). In a summary, these experiments demonstrate that factor analysis is a good method for extracting factors.

Principal component analysis (PCA) was used as the extraction method for minimizing the dimensionality of the datasets, maximizing interpretability while reducing information loss by creating new uncorrelated variables that successively increase variance. Table 7 displays the rotated component matrix after the PCA.

Table 7 shows that the 15 SFs could be categorised into underlying themes of five primary factors, according to the rotated component matrix (using a cut-off point of 0.50). With a factor loading of (0.862), the contractor's early involvement came out on top, followed by planning, scheduling, and budgeting (0.753), the initial identification of all risks (0.714), and adequate specification (0.670), in that order. The above variables have a combined effect of 23.190% on project cost performance. (See Tables 6 and 7 for more information.) With a loading of (0.816), good project team relations came out on top, followed by successful project participant engagement (0.779), and client involvement and commitment (0.668), in that order. The above variables have a combined effect of 16.690 percent on project cost performance. With a loading of (0.926), the supply of enough funding came out on top for factor 3, followed by prompt payment of completed job (0.898). The above variables have a combined effect of 12.926% on project cost performance. With a factor loading of (0.811), the project manager's capability came out on top, followed by the architect's competency (0.680), plan accuracy (0.669), and accurate budgeting (0.522) in that order. The above variables have a combined effect of 11.146% on project cost performance. With a loading of (0.971), the provision of incentives/bonuses to employees emerged as the most important element, followed by proper employee training (0.969). The above variables have a combined effect of 9.325% on project cost performance. The five important success criteria together account for 73.277% of the variance.

Because the majority of the characteristics in factor 1 are associated with successful adequate planning, the researcher decided to call this component adequate planning related. Factor 2 is considered collaboration-related since the variables are directly linked to effective collaboration. Factor 3 contains factors that are directly related to financing; as a result, this factor is viewed as financial-related. Factor 4 is considered as project team capability–related because the variables are directly linked to acceptable project team capability. A brief examination of 5 components revealed that the variables are directly related to motivation; as a result, the researcher designated it as motivation–related. As a consequence of the findings, the essential success factors for project cost performance in Ghana may be divided into five major categories: proper planning, effective collaboration, financing, project team capacity, and motivation.

Table 6: KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.732
Bartlett's Test of Sphericity	Approx. Chi-Square	297.286
	Df	96
	Sig.	.000

Table 7: Rotated component matrix after the PCA

Code	Success factors	Communalities	Components				
			1	2	3	4	5
SF1	Early involvement of the contractor	0.864	**0.862**				
SF2	Planning, schedule of work, and budgeting	0.740	**0.753**				
SF3	Initial identification of all risks	0.604	**0.714**				
SF4	Adequate specifications	0.786	**0.670**				
SF5	Good project team relations	0.714		**0.816**			
SF6	Effective interaction between project participants	0.654		**0.779**			
SF7	Client involvement and commitment	0.609		**0.668**			
SF8	Provision of adequate funding	0.881			**0.926**		
SF9	Timely payment of work done	0.835			**0.898**		
SF10	Project manager's competency	0.701				**0.811**	
SF11	Architect's competency	0.682				**0.680**	
SF12	Accuracy of plans	0.737				**0.669**	
SF13	Accurate budgets	0.624				**0.522**	
SF14	Incentives/bonuses	0.956					**0.971**
SF15	Training of employees	0.955					**0.969**

Extraction Method: Principal Component Analysis (PCA).
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 6 iterations.

Table 8: Total Variance Explained (CSF)

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.478	23.190	23.190	3.478	23.190	23.190	2.475	16.499	16.499
2	2.503	16.690	39.880	2.503	16.690	39.880	2.252	15.012	31.511
3	1.939	12.926	52.806	1.939	12.926	52.806	2.139	14.262	45.773
4	1.672	11.146	63.952	1.672	11.146	63.952	2.110	14.067	59.840
5	1.399	9.325	73.277	1.399	9.325	73.277	2.015	13.436	73.277
6	0.962	6.411	79.688						
7	0.782	5.215	84.903						
8	0.569	3.795	88.698						
9	0.478	3.184	91.882						
10	0.379	2.523	94.405						
11	0.291	1.942	96.347						
12	0.242	1.612	97.959						
13	0.148	0.988	98.947						
14	0.100	0.669	99.615						
15	0.058	0.385	100.000						

Extraction Method: Principal Component Analysis.

4.3 Analysis of Multiple Regressions: Impact of the Success Factors on Construction Project Cost Performance

The findings of the principal component analysis revealed the existence of a link between the identified important success factors and the project cost performance of public-sector building

projects, but not their contribution. The Stepwise Multiple Regression (SMR) technique was used to determine the effect of the relationship between the identified most critical factors and the respondents' project cost performance in the application of the factors, and to predict the variables involved in the mediation.

Table 9 shows the results of the multiple linear regression between the selected success variables and project cost performance, along with standardized betas and t – statistics (t), both of which indicate the relative relevance of each variable in the model. The R2 adjusted value was 0.854, as shown in Table 9. This means that the five most important success criteria from table 11; (early contractor involvement, good contract relations, Proper funding money, good project team interactions, project management competence, and employee incentives/bonuses) together can explain 85.4 percent of the variation in respondents' cost performance as a dependent variable. 144.002 (p 0.01) was the F- ratio. Hence, termed as the critical success factors cost overrun minimization in public construction projects. This shows that the adjusted R-squared indicates that the regression of project managers' project cost performance on the factors studied is statistically significant.

The beta coefficient, also known as the standardized regression coefficient, is used to compare the relative explanatory power of different coefficients for the dependent variable. With a beta coefficient of 0.317 (p<0.05), early contractor involvement had the greatest impact on the project cost performance of public sector construction projects (dependent variable). The regression weight indicates that the contractor's early involvement in building projects influences the cost performance of public sector construction projects by 31.7 percent.

With a beta coefficient of 0.275 (p<0.05), proper funding had the second highest impact on the cost performance of public sector building projects. The regression weight indicates that providing enough funding influences the cost performance of public sector building projects by 27.5 percent.

With a beta coefficient of 0.272 (p<0.05), good project team interactions had the third-largest impact on the cost performance of public sector building projects. The regression weight indicates that the supply of good contract relations influences the cost performance of public sector building projects by 27.2 percent.

With a beta coefficient of 0.154 (p<0.05), the deployment of competent managers made the fourth acceptable contribution to the cost performance of public sector building projects. The usage of a competent manager/supervisor accounts for a 15.4 percent variation in impacting the cost performance of public sector building projects, according to the regression weight.

With a beta coefficient of 0.141 (p<0.05), providing incentives/bonuses to staff was the fifth acceptable contribution to the cost performance of public sector construction projects. The regression weight indicates that the usage of a competent manager/supervisor influences the cost performance of public sector building projects by 14.1 percent.

Table 9: Model: Summary of Multiple Regression Analysis between Most Critical Success factors and Cost Performance.

Dependent Variable	R	R-Square	Adjusted R Square	Standard Error
Cost Performance	0.927	0.860	**0.854**	1.187

Table 10: Analysis of Variance

	Sum of squares	Df	Mean square	F	Significance
Regression	1013.839	1	202.768	**144.002**	**0.000**
Residual	169.747	85	1.408		
Total	1178.585	86			

Table 11: Standard Coefficients

				Collinearity Statistics	
	Beta	T	Significance	Tolerance	VIF
EINVC	**0.317**	6.379	**0.000**	0.658	3.577
PAF	**0.275**	5.223	**0.000**	0.431	2.319
GCR	**0.272**	4.843	**0.000**	0.638	1.520
PMC	**0.154**	3.957	**0.000**	0.794	1.259
PI/B	**0.141**	2.227	**0.028**	0.300	3.334

EINVC= Early involvement of the contractor; AF= Provision of adequate funding; GCR = Good contract relations; PMC= Project manager's competence; PI/B=Provision of incentives/bonuses

Discussion

The underlying construct of the success factors for public construction project cost performance in the eyes of project managers, as revealed by the factor analysis, is directly linked to five (5) main constructs: adequate planning-related, effective collaboration-related, financing-related, adequate project team capability-related, and motivation-related.

According to the respondents, adequate planning is the most crucial success factor for public sector construction projects, having a 23.19 percent effect on construction project cost performance. This study shows that early contractor involvement (particularly during the design phase of the project), planning/scheduling and budgeting, sufficient specifications, and early identification of all risk help to improve the cost performance of construction projects. This conclusion supports the claims of other authors, including (Hwang and Lim, 2012; Arcila, 2012 and Mahmood, 2021). Effective collaboration, according to the respondents, should be the second most important success factor for public sector building projects, with a 16.17 percent effect on cost performance. This research suggests that solid project team relationships, effective project participant interaction, and client involvement/commitment all have a major impact on construction project cost performance. This discovery is in line with the findings of (Hwang and Lim, 2012; Arcila, 2012). Adequate resources and financing-related in the opinion of the respondents should be the third most critical success factor for public sector construction project with effect of 12.93% on construction project cost performance. This finding implies that provision of adequate funds and timely payment of work done influence construction project cost performance. This finding is consistent with the findings of (Mahmood, 2021; Arcila, 2012; Hwang and Lim, 2012). According to the respondents, adequate project team capability should be the fourth most crucial success factor for public sector

construction projects, with an impact of 11.15 percent on project cost performance. This means that using competent project managers/supervisors or experts, competent Architects, accurate plans/initial information, and accurate budgets have an impact on the cost performance of building projects. This discovery is also consistent with the findings of (Arcila, 2012). According to the respondents, motivation is the fifth most important success factor for public sector construction projects, having a 9.33 percent impact on project cost performance. This conclusion implies that providing incentives/bonuses and employee training have an impact on the cost performance of building projects. This conclusion supports the claims of (Mahmood, 2021; Arcila, 2012; Mahamid and Dmaidi, 2013).

This research provides long-term, verifiable success criteria for reducing cost overruns in Ghanaian public building projects. When well thought out from the project initiation stage to completion, these critical successes can also be used to deal with damaging economic and cooperate image effects such as allocative inefficiency of scarce resources, further delays, contractual disputes, claims and litigation, project failure, and total abandonment. The study contributes to theory by elucidating the key success factors for decreasing cost overruns in public building projects in Ghana, responding to calls to better understand the critical elements that lead to cost overruns. As a result, the study will be able to assist in the development of a clear roadmap for dramatically minimizing cost overruns in public construction projects. This is especially relevant because there is no existing research on the key success factors for decreasing cost overruns in Ghanaian public building projects.

5. Conclusion

Construction cost overruns are caused by a variety of circumstances, including financial challenges, a poorly stated project scope, client-initiated changes, consultant underestimation of project cost, and poor inspection monitoring of projects by consultants. The study adds to the literature on cost overruns in Ghanaian public construction projects on a theoretical level.

The underlying construct of the critical success factors for public construction project cost performance in the perspectives of project managers is directly linked to five (5) main constructs ranked from most influential to least influential: adequate planning-related, effective collaboration-related, financing-related, adequate project team capability-related, and motivation-related, as revealed by the factor analysis.

The results of the main component analysis showed that there was a link between the selected important success variables and the project cost performance of public sector construction projects, but they did not show how much each item contributed. The Stepwise Multiple Regression technique was used to determine the effect of the relationship between the identified most critical factors and the respondents' (86 good cost performance firms) project cost performance in the application of the factors; and to predict the variables involved in the mediation.

The following recommendations are given based on the study's examination of the results and conclusions for improving project cost performance in Ghana. These suggestions could serve as the foundation for interventions aimed at improving the cost-effectiveness of public-sector construction projects. To increase project participants' managerial skills, training courses and workshops should be held. As far as feasible, change orders and design flaws should be avoided. If the work has been done, these considerations might be costly and time consuming. Rework

might also have an impact on work sequences. This issue could be mitigated by integrating contractors during the project's conception phase; the client or funding agency should verify that sufficient cash and other sources of funds are available before construction work begins. This would ensure that contractors are paid in accordance with the contract agreement; during all project phases, there should be better communication and coordination between project participants; Contractors should be chosen based on their competence, financial standing, capability, and experience, rather than on inexpensive bids or fraternal relationships and political lines. The study considered Ghana as a case study of the developing countries, but the findings provide a lesson that can be extrapolated to private projects, as well as other developing countries. Future research could focus on applying emerging technologies such as Building Information Modeling to reduce cost overruns in public construction projects.

5.1 Recommendations

The research's main conclusions include the following recommendations, which can be applied to strengthen the areas that have been found to contribute to building project cost overruns and open the door for more research in a related setting. In order to prevent or minimize overspending during the construction project delivery process, clients, consultants, and contractors involved in cost estimation, management, and control should educate themselves about the critical variables that cause construction cost overruns. This can be done by starting with the various types of procurement methods that are available, which will enable clients, consultants, and contractors to make well-informed decisions regarding the procurement method selection. Hiring qualified quantity surveyors, procurement personnel, professional project managers, and contractors with a solid track record is essential. These individuals will focus on a number of key areas, including sufficient scope planning, stakeholder collaboration, risk identification, project financing, staff training and capacity building for cost overrun minimization, and inspiring all project participants to meet cost targets. To prevent cost overruns on public and commercial construction projects, it is advised to repeat this study every five years in order to identify a more current and pertinent pattern of cost overruns.

5.2 Implication of the study

Appropriate cost control measures such as; Early involvement of the contractor (EINVC); Provision of adequate funding (AF); Good contract relations (GCR); Project manager's competence (PMC); Provision of incentives/bonuses (PI/B) play a key role as the Critical Success Factors (CSFs) for Cost Overrun Minimization in Public Construction Projects in Developing Countries. This situation is worsening day by day creating a larger risk for the client which should be avoided in future. This study will assist clients, legislators, consultants, and contractors in making well-informed decisions that will reduce the likelihood of cost overruns in public building projects. Construction cost overruns in the construction business, generate delays and have a bad influence on the quality of the project aim. Being fully aware of and appreciating the effects of cost overruns on public projects would enable proactive response to factors leading to construction cost overrun. Furthermore, all stakeholders now have a thorough understanding of how to respond in order to meet the goal of a sustainable project cost. Future research areas could be identified by researchers and policy makers using the recommendation and conclusion.

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