DETERMINANTS OF SCHEDULE DELAY AND COST OVERRUNS IN INFRASTRUCTURE PROJECTS IN GHANA

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ABSTRACT

Purpose – *The purpose of this paper is to investigate the determinants of cost overruns and project schedule delay in infrastructure projects in Ghana.*

Design/methodology/approach – *Cross-sectional data on project attributes of 30 road infrastructure projects from secondary sources as well as survey data on causes of cost overruns and schedule delay from 89 stakeholders in the road sector were used. We employed ordinary least square model (OLS) and relative importance index to achieve the research objectives.*

Findings – *The results indicate that the nature of work and funding source have a statistically significant impact on schedule delay while project size has a statistically significant impact on cost overruns at a 5% level of significance. Moreover, reconstruction projects and projects with international funding sources are more prone to schedule delay whereas larger project sizes come with larger cost overruns.*

Originality/value – *Cost overruns and schedule delays are critical issues in public infrastructure projects which require both preventive and management strategies to help mitigate their occurrence. However, scanty literature exists on the significant determinants of cost overruns and schedule delays in road infrastructure projects in Ghana.*

Keywords- Cost Overruns, Ghana, Infrastructure, Schedule Delays.

Paper Type – Research paper

INTRODUCTION

Globally, infrastructure development has been the focus of most countries, especially among developing countries due to its contribution to socio-economic development (Babatunde, 2018). Governments invest considerable amount of resources and currently involve the private sector to accelerate infrastructure development. According to Khabisi (2013), infrastructure projects contribute directly to Gross Domestic Product (GDP); employment; indirectly facilitate the growth of other sectors (e.g. manufacturing, financial and services); and improves the average annual economic growth by over 2.7 percent (World Bank, 2010).

However, success of infrastructure projects is determined by cost, scope and time constraints. Additionally, Shah (2016) noted that infrastructure projects do not only revolve around the construction process but also affected by planning, designing, management, and other activities necessary for project completion. According to Al-Fadhali & Zainal (2017), the quality and success of infrastructure projects depends on the ability of the contracting parties (i.e. contractors, clients and consultants) to meet the objectives as well as complete the project on time and within the budgeted. However, as noted by Al-Fadhali & Zainal (2017), other factors including the "*acts of God*" (such as flood and fire) could also delay the transportation of raw materials and other aspects of projects-leading to cost and time overruns.

As reported by Flyvbjerg et al. (2018), 90 percent of public infrastructure projects are affected by time and cost overruns. According to Kogi & Were (2017), the inability of contractors and consultants to complete projects within the stipulated schedule attracts additional cost and this consequently affects the success of the projects. Meanwhile, factors such as delay in the release of funds, contract management, skills of project managers, government policies, land acquisition challenges and unclear definition of project scope contribute to project delay and cost overruns in most public infrastructure projects (Kogi & Were, 2017). Macroeconomic factors such as inflation and exchange rate changes may also cause cost overruns (Rahman et al., 2013).

In Sub-Sahara Africa, the infrastructure deficit is estimated at about $93 billion annually (World Bank, 2010). However, inefficiencies in infrastructure projects trigger cost overruns and schedule delays (Gitahi & Tumuti, 2019). These deficiencies pose financial, technical, and scheduling risk in infrastructure projects in Africa. Other factors such as the lack of requisite project management skills on the part of contractors and consultants, and unfavorable working conditions are also noted to negatively affect the performance of infrastructure projects (Akomah & Jackson, 2016).

In Ghana, infrastructure development has been the major focus of the government over the past few decades. It is interesting to note that expenditure on infrastructure development averaged GHC 2.8 billion (US$579.7 million) over the past decade, with a 156.68 percent increase in 2019 from the 2018 expenditure of GHC 1.8 billion (US$372.6 million). (PricewaterhouseCoopers, 2018). The 2019 budgeted infrastructure expenditure represents 2.9 percent of the total GDP in Ghana. However, change in government and other contractual issues have stalled most of the projects, increasing the number of incomplete infrastructure projects in the country (Fobi, 2014). As noted by PwC (2018), one-third of infrastructure projects in Ghana stall and this consumes approximately 20 percent of the local government's investment expenditure. Shah (2016) reported that delay in project schedules and overruns in cost in Ghana is mainly caused by the delay in raising payment certificates, and the underestimation of project costs and complexities.

Considering the importance of infrastructure projects and the increasing number of incomplete and stalled infrastructure projects in Ghana due to cost and time overruns, and consequent resource misuse and management, it is prudent to focus attention on the determinants of cost and time overruns in public infrastructure projects in Ghana, hence this study.

The rest of the paper proceeds as follows. Section 2 briefly reviews planning fallacy theory and agency theory as theoretical framework for the study, followed by empirical literature on cost overruns and schedule delays in infrastructure projects. Section 3 discusses data sources, variables under study and specifies the empirical model used to carry out data analysis. Section 4 presents the results from estimation and finally section 5 outlines the conclusion, recommendations for policy and further research.

LITERATURE REVIEW

The determinants of cost and time overruns in construction projects are multi-factored and come with various theories explaining specific aspects. We identified two main theories, namely, the planning fallacy theory and agency theory applicable to this study.

The planning fallacy theory was proposed by Kahneman and Tversky (1979) to support their assertion that most projects and programme timelines are underestimated during their planning stages. Subsequently, the theory has been employed by many researchers in various fields to analyze the rationale for the delay in programmes and projects. According to Pezzo,

Litman & Pezzo (2006), the estimated time and cost of future tasks are mostly influenced by individuals' wishes. The theory has also been employed to reveal the cognitive bias and intentional attitude of individuals in decision making that involves some level of risk (Cantarelli et al., 2010). Individuals tend to be risk-averse when it comes to making decisions that will have some consequences on them. Mentis (2015) claims that although risk and uncertainty cause slippage in projects, projects normally experience cost overruns and delay due to inaccurate projection of project risk, which is oftentimes not integrated into the project planning and implementation process. Flyvbjerg et al. (2018) also assert that project contractors underestimate project cost and completion date to win the contract; whilst others are genuinely due to uncertainty or unforeseen risks.

Recently, Lukale (2018) utilized the planning fallacy theory to link contractors and consultants' optimism to cost and time overruns caused by engineers' estimates, which form the basis for the award of the contract to the lowest bidder. Similarly, Love et al. (2019) utilized the theory to explain how strategic misrepresentation and/or optimism bias leads to cost overruns and schedule delays in infrastructure projects. The relevance of the theory is in its ability to envisage all the reasons behind the underestimation of cost and time in a project contract.

The agency theory originated from Jensen and Meckling's attempt to formulate a theoretical contractual relationship between stakeholders, managers, and employees of a business organization in 1976. In infrastructure projects, agency theory is relevant because of its ability to establish and define the contractual relationship between clients, consultants and contractors (Gitahi & Tumuti, 2019).

However, Al-Fadhali & Zainal (2017) posit that contracting parties occasionally take actions without the knowledge of the other party and this brings conflicts and eventually the implementation of the project. Winch (2010) opines that the contractor or consultant on the other hand can be an opportunist and thus embezzle the project funds without the knowledge of the client or project owner. Meanwhile, the client may be unable to terminate the contract after realizing the act and this may affect the success of the project. Effectually, the agency theory acted as a risk management tool that assisted to regulate the actions of both contractors and project owners for successful infrastructure projects.

Globally, inconsistencies exist on empirical evidence for determinants of cost overruns and schedule delay. Shah (2016) found different factors that causes schedule delay and cost overrun in Ghana, Malaysia and Australia in a single study, with common factor as poor and inconsistent planning. In Australia, construction method and monitoring and evaluation are key factors (Shah, 2016) while contractors' inexperience and poor site management are determinting factors for Malaysia (Rahman et al., 2013; Shah, 2016). In Sub-Sahara Africa, Khabisi (2013) found factors such as change in scope of project, delay in release of funds, ineffective communication and inconsistent planning for South Africa, while in Kenya, Kogi and Were (2017) found contract complexity and contract type, contractor's experience, and land litigation as key factors. Similarly Shah (2016) and Akomah & Jackson (2016) found that delay in raising and honouring payment certificates, underestimation of project cost, communication barrier, uncertain weather conditions and project complexity are key determinants of cost overruns and schedule delays.

Although a number of studies have been conducted on the determinants of schedule delay and cost overrrun, they mainly focus on construction attributes and neglect the contract attributes in Ghana. As reported by Lukale (2018), contract attributes such as project size, project type, implementation period, nature of work and contractor nationality have a significant impact on cost overruns and schedule delays in infrastructure projects.

METHODOLOGY

The study utilized both primary and secondary data. Secondary data was gathered from published documents on thirty (30) completed road infrastructure construction projects from Ghana's Ministry of Roads and Highways and Ghana Highways Authority from 2005 to 2019.

In addition, we obtained primary data on the opinions and attitudes of contractors, clients and consultants in road infrastructure construction projects in Ghana using a semi-structured questionnaire. The sample included professionals in the road construction industry in Ghana. Thus, out of the 390 identified road construction professionals, a stratified sample of 100 was used. This number constitutes 25.6 percent of the total identified project managers, engineers, quantity surveyors, etc in Ghana. According to Mugenda & Mugenda (2003), a sample of more than 20 percent is a valid representation of the population and inferences can be made about the population based on responses from the sample.

Description of Data and Variables

Our study sought to identify determinants of schedule delays and cost overruns in road infrastructure construction projects in Ghana considering both project attributes and construction attributes. We used data from project documents to identify project attributes including project type, nature of work, budgeted cost, actual cost, estimated completion date, actual completion date, contractors' nationality, supervision and funding source(s). The cost information was used to calculate cost overruns whereas information on completion date was used to calculate schedule delays.

Data on project attributes was obtained from the contract documents of 37 road infrastructure projects completed as at December 2019 in the records of the Ghana Highway Authority and Department of Urban Roads in Accra. The total contract sum of these projects was GH¢7,591,023,541.92 with the least contract sum of GH¢4,740,649.00 and highest contract sum of GH¢613,374,000.00. The original construction period ranges from eight (8) months to seventy-two (72) months.

With respect to construction attributes, we employed the survey technique using a semi-structured self-administered questionnaire to gather opinions and experiences of clients, contractors and consultants of road infrastructure construction projects in Ghana. The questionnaire comprised 5-point Likert type questions with: 1 – never, 2 – seldom, 3 – sometimes, 4 – often and 5 – very often. The questions on the determinants of cost overruns and schedule delays were based on factors obtained from a desk review of empirical literature. This was categorized under construction planning, construction financing, contractors' experience and supervision. Overall, we used fifteen (15) predetermined contributing factors of schedule delays and cost overruns. We also used a 5-points Likert-type questions to obtain information on the opinions, experiences and attitudes of stakeholders in road construction projects in Ghana.

Model Specification

To assess the determinants of schedule delays and cost overruns, we defined two multiple linear regression models as follows:

$$SD_i = \beta_0 + \beta_1 PT_i + \beta_2 NW_i + \beta_3 PS_i + \beta_4 CP_i + \beta_5 SP_i + \beta_6 CN_i + \beta_7 FS_i + \varepsilon_i \quad \text{(eq 1)}$$

$$CO_i = \beta_0 + \beta_1 PT_i + \beta_2 NW_i + \beta_3 PS_i + \beta_4 CP_i + \beta_5 SP_i + \beta_6 CN_i + \beta_7 FS_i + \varepsilon_i \quad \text{(eq 2)}$$

where SD_i represents the dependent variable (schedule delays), CO_i - represents the dependent variable (cost overruns), β_0 - represents the intercept of the dependent variable, β_i- represents the coefficient of the independent variables (i=1,2,…,7), ε_i - represents the error term, PT_i - represents the independent variable (project type), NW_i- represents the independent variable (nature of work), PS_i - represents the independent variable (project size), CP_i- represents the independent variable (contract period), SP_i - represents the independent variable (supervisors), CN_i- represents the independent variable (contractors' nationality), and FS_i - represents the independent variable (funding source). These models were estimated using the maximum likelihood estimation method in Statistical Package for the Social Sciences (SPSS).

Also, the responses from the Likert-type questionnaire were arranged hierarchically using the Relative Importance Index (RII) as defined mathematically in equation 3:

$$RII = \frac{\sum_{i=1}^{5} WiXi}{A*N} \quad \text{(eq 3)}$$

where: A represents the highest weight given (highest Likert scale = 5), N represents the number of respondents, W_i represents the constant expressing the weight given to i^{th} response, X_i represents the variable expressing the frequency of the i^{th} response, and i *=1,2,3,4,5.* The RII revealed the most significant determinant of cost overruns and schedule delays in infrastructure projects Appendix D.

RESULTS AND DISCUSSION

Determinants of cost Overrun and Schedule Delay: Multivariate Regression Analysis

The analysis procedure adopted includes descriptive statistics and analysis of variance method for schedule delays and cost overruns as presented in the subsequent sub-sections.

Descriptive Statistics

As shown in Table 1, 94.6% of the projects were road works while the rest were bridges. Of the road works, 77.1% experienced cost overruns and 82.9% experienced schedule delays. Again, 59.5% of the projects were reconstruction while 40.5% were rehabilitation. Concerning the nature of work, 68.2% and 86.4% of reconstruction projects experienced cost overruns and schedule delays respectively, while 86.7% and 73.3% of rehabilitation projects experienced cost overruns and schedule delays respectively. In all, 68% and 84% of the entire 37 projects experienced cost overruns and schedule delays respectively, signifying pervasiveness of cost overruns and schedule delays in road infrastructure project in the country.

Table 1
SUMMARY STATISTICS OF PROJECT ATTRIBUTES

Project description	Frequency	Percentage	% Cost overruns	% Schedule delay
Project type				
Road works	35	94.6%	77.1%	82.9%
Bridges	2	5.4%	50.0%	50.0%
Nature of work				
Reconstruction	22	59.5%	68.2%	86.4%
Rehabilitation	15	40.5%	86.7%	73.3%
Contractor's nationality				
Ghanaian	17	45.9%	64.7%	88.2%
Non-Ghanaians	20	54.1%	85.0%	75.0%
Project size				

Less 100 million cedis	29	78.4%	75.9%	75.9%
100 - 200 million cedis	5	13.5%	60.0%	100.0%
More than 200 million cedis	3	8.1%	100.0%	100.0%
Implementing period				
0-24 months	26	70.3%	65.4%	80.8%
25-48 months	7	18.9%	100.0%	71.4%
49-72 months	4	10.8%	100.0%	100.0%
Funding source				
GOG	5	13.5%	100.0%	60.0%
International agencies/partners	32	86.5%	71.9%	84.4%
Supervision				
In-house	3	8.1%	100.0%	33.3%
Consultant	34	91.9%	73.5%	85.3%

Source: Author, 2020

Additionally, the descriptive statistics as evident in Table 2 shows that on average projects delay by 101.92 percent of the schedule time with spread from the mean of 113.90 percent. Cost overruns are 45.02 percent on average with 78.396 variation from the mean, project type and nature of work are 1.0541 percent and 1.4054 percent respectively on average.

Table 2
DESCRIPTIVE STATISTICS OF PROJECT ATTRIBUTES

	Mean (%)	**Std. Deviation**	**N**
Schedule delay	101.92	113.90321	37
Cost overruns	45.0238	78.39675	37
Project type	1.0541	.22924	37
Nature of work	1.4054	.49774	37
Contractor's nationality	1.5405	.50523	37
Project size	1.2973	.61756	37
Implementing period	1.3514	.63317	37
Funding source	1.8649	.34658	37
Supervision	1.9189	.27672	37

Source: Author, 2020

Determinants of Schedule Delay and Cost Overrun

Schedule Delay Estimation

Table 3 presents the results for the parameter estimates of the schedule delay on project attributes. The results indicate that project type, nature of work, contractor's nationality, implementing period, and funding source negatively affect schedule delay whereas project size and supervision positively impact schedule delay. However, only the nature of work and funding source have a statistically significant impact on schedule delay. Project type alone has a negative impact on schedule delay but the impact is not statistically significant. Project type includes road work and bridges. Road work was coded 1 and bridges coded 2. The negative impact indicates that moving from road works to bridges, schedule delays will decrease. The argument is that road work requires more time due to its stretch, and factors such as unexpected soil stability may delay the project. However, such failure may have little or no impact on the time required to complete the work. Nature of work has a statistically significant negative impact on schedule delay. Here, reconstruction was coded 1 and rehabilitation was coded 2, and thus a negative impact shows that rehabilitation comes with shorter schedule delays. This may be because rehabilitation uses the same method to repair existing road while reconstruction

requires a different method to the construction of a new road. Thus, reconstruction is more complex and thus the possibility of being delayed is higher. Besides, the source of funding has a significant negative relationship with schedule delay. The implication is that schedule delay is lower in projects funded by international agencies/partners. It may be argued that international funding sources are secured and hence the possibility of delay in the release of funds which translates into the delay in execution of the project may be minimal.

Table 3
PARAMETER ESTIMATES OF SCHEDULE DELAY MODEL

Model	Coefficients	t-stat
Project type	-0.207	-1.387
Nature of work	-0.463	-3.086***
Contractor's nationality	-0.043	-0.306
Project size	0.112	0.759
Implementation period	-0.093	-0.536
Funding source	-0.496	-2.800***
Supervision	0.134	0.87
Constant		3.412***

Note: We used the Durbin-Watson test to check the presence of first-order autocorrelation, and with DW statistics of 1.505 we confirmed absence of autocorrelation. Using Variance Inflation Factor (VIF) we tested the presence of multicollinearity and confirmed its absence in the model (VIF <10). *** significant at 1%, ** significant at 5%, and * significant at 10%.

Cost Overruns Estimation

Table 4 shows the parameter estimates of cost overruns regression model. The result shows that aside supervision, all other factors have a positive impact on cost overruns. Nonetheless, only project size has a statistically significant impact on cost overruns. Increasing project size may imply increasing complexity and as such a defect or modification in design may require an equivalent cost to successfully complete the project. Hence, a positive impact of project size indicates that higher cost overruns are attributed to bigger projects.

Table 4
PARAMETER ESTIMATES OF COST OVERRUNS MODEL

Model	**Coefficients**	**t-stat**
Project type	0.013	0.086
Nature of work	0.066	0.428
Contractor's nationality	0.004	0.025
Project size	0.539	3.536
Implementation period	0.103	0.571
Funding source	0.136	0.741
Supervision	-0.255	-1.609
Constant		0.801

Note: We used the Durbin-Watson test to check the presence of first-order autocorrelation, and with DW statistics of 1.505 we confirmed absence of autocorrelation. Using Variance Inflation Factor (VIF) we tested the presence of multicollinearity and confirmed its absence in the model (VIF <10). *** significant at 1%, ** significant at 5%, and * significant at 10%.
Source: Author, 2020

Determinants of cost Overrun and Schedule Delay: Ranking based on Expert Opinion

After the analysis of secondary data to ascertain effect of project attributes on cost overruns and schedule delays on road infrastructure projects in Ghana, primary data was also sought to triangulate the results. As such, opinions and experiences of clients, consultants and

contractors were gathered using a closed-ended questionnaire. After, a follow-up was done by administering open-ended questionnaires to the management of the Department of Urban Roads and Ghana Highways Authority. 89 fully completed the questionnaire were retrieved out of the 100 administered questionnaires for analysis. This yielded a response rate of 89% which according to Groves (2006) indicates a minimal chance of bias in results and generalization to the entire population.

Reliability test

The Cronbach alpha test of reliability is a popular statistical test used to ensure the internal consistency of research instruments. Questions were grouped under the contributing factors of cost overruns and schedule delays as well as the severity of the factor of cost overruns and schedule delays. The Cronbach alpha tests the extent to which the questions in a particular group measure the same concept or construct and ranges from zero (0) to one (1). According to Taber (2018), Cronbach's alpha value of 0.9 and above is excellence, 0.8 is reliable, 0.7 is high and 0.6 is satisfactory. The result from the Cronbach test is presented in Table 5 below.

Table 5
CRONBACH'S ALPHA TEST OF RELIABILITY

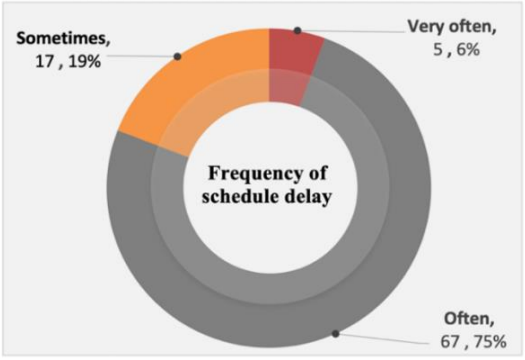
Category	N	Mean	Cronbach's alpha
Cost overruns factors	15	3.179	0.922
Schedule delay factors	14	3.061	0.871
Severity of cost overruns and schedule delay	15	3.036	0.899

Source: Author, 2020

The results in Table 5 shows that the Cronbach alpha for all the constructs were higher than 0.70, specifically above 0.8. This confirmed the internal consistency and reliability of the constructs in the questionnaire.

Causes of schedule delays and cost overruns

In the pursuance of identifying causes of schedule delays and cost overruns in road infrastructure projects in Ghana, respondents' opinions and experiences were gathered. The results in Figure 1 show that 5 (representing 6%) of the respondents indicated that schedule delays occur '*very often'* in road infrastructure construction projects, 67 (representing 75%) indicated that schedule delays occur 'often' and 17 (representing 19%) indicated that schedule delays occur '*sometimes*'. Again, the result in Figure 1 shows that the majority of the respondents (50, representing 56%) indicated that cost overruns '*often*' occurred, while 33 (representing 38%) indicated that cost overruns occurred '*very often*' and 6 (representing 6%) indicated that cost overruns occurred '*sometimes*' in road infrastructure projects.



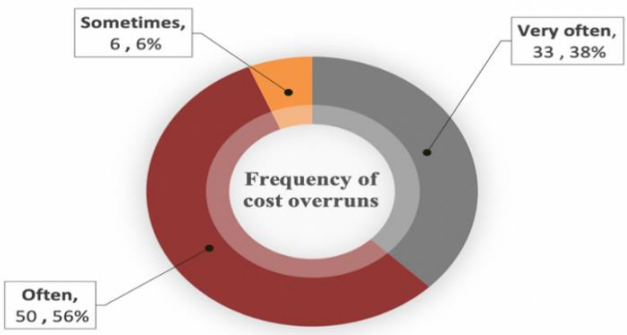


Figure 1
FREQUENCY OF SCHEDULE DELAY AND COST IN ROAD PROJECTS IN GHANA
Source: Author, 2020

The result also implies that all respondents attested that schedule delays '*sometimes*' to '*very often*' occur in road infrastructure projects in Ghana. The indication is that even though schedule delays occur in road infrastructure construction projects in Ghana, not all such projects experience schedule delays.

Subsequently, respondents were asked to express their opinions and experiences on the causes of schedule delays and cost overruns in road infrastructure projects in Ghana based on predetermined causes obtained from the literature review. A thorough reconciliation of causes identified in literature yielded fourteen (14) and sixteen (16) key causes of schedule delays and cost overruns respectively. These were rated on the Likert scale from never (1) to very often (5). The responses were analysed using the RII. Additionally, the factors were ranked from "*most important*" to "*least important*" based on the outcome of the RII as presented in Table 6.

Table 6
RELATIVE IMPORTANCE INDEX AND RANKING OF CONTRIBUTING FACTORS OF SCHEDULE DELAYS AND COST OVERRUNS

Contributing factor	Schedule delay		Cost overrun	
	RII	Rank	RII	Rank
Delay in honouring payment certificates	0.725	1	0.825	1
Modification in contract	0.713	2	0.800	2
Inadequate credit facilities	0.713	3	0.788	3
Inflation	0.700	4	0.775	4
Exchange rate	0.675	5	0.763	5
Underestimation of completion time/budget cost	0.663	6	0.688	6
Project design error	0.575	7	0.650	7
Government interference	0.525	8	0.575	9
Lack of pre-designing and pre-tendering inspections	0.513	9	0.650	8
Lack of project knowledge	0.500	10	0.450	14
Shortage of experienced labour on site	0.475	11	0.438	15
Poor site management	0.475	12	0.438	15
Inadequate technical know-how of contractors	0.450	13	0.488	11
Poor communication	0.450	14	0.463	13
Unexpected weather condition			0.500	10
Shortage of experienced labour on site			0.488	11

Source: Author, 2020

The results show that delays in honouring payment certificates was the most important contributing factor to schedule delays in road infrastructure projects in Ghana with RII of 0.725, followed by modification in contract with RII of 0.713. Next is inadequate credit facilities with RII of 0.713, then inflation with RII of 0.700, then exchange rate with RII of 0.675 and the sixth important contributing factor was the underestimation of completion time with RII of 0.663. The results also show that four out of the fourteen factors were not important contributing factors to schedule delay since their RII were not below 0.5. These factors include the shortage of experienced labour on-site (RII=0.475), poor site management (RII=0.475), insufficient technical know-how of contractors (RII=0.45) and poor communication (RII=0.45).

Additionally, 5 out of 15 predetermined factors did not contribute to cost overruns as their relative importance indexes were below 0.500. These include poor site management (RII=0.438), lack of project knowledge (RII=0.45), poor communication (RII=0.463), inadequate technical know-how of contractors (RII=0.488) and shortage of experienced labour

on-site (RII=0.488). However, delay in honouring payment certificates (RII=0.825), modification of contract (RII=0.800), inadequate credit facilities (RII=0.788), inflation (RII=0.775), and exchange rate (RII=0.763) were found to significantly contribute to cost overruns in road infrastructure projects.

Moreover, the contributing factors to schedule delays were categorized under their respective headings of construction planning, construction financing, contractor's experience, and supervision and the responses ranked using RII as presented in Table 7. The rationale was to ascertain the broad category of schedule delay factors for an informed decision at the macroeconomic level by policy decision-makers. The results in Table 7 show that construction financing is the leading factor for schedule delays in road infrastructure construction in Ghana with an RII of 0.703, followed by construction planning with an RII of 0.616. Meanwhile, the contractor's experience' and supervision were viewed as insufficient in contributing to schedule delays since the RII of 0.475 and RII of 0.483 respectively are below the threshold of 0.5.

Table 7
RANKING OF FACTORS OF SCHEDULE DELAY

Factors	RII	Rank
Construction financing	0.703	1
Construction planning	0.616	2
Supervision	0.483	3
Contractor's experience	0.475	4

Source: Author, 2020

Severity of factors on cost overruns and schedule delays

While evaluating the severity of factors on cost overruns and schedule delays, respondents were asked to indicate their opinions and experiences on encoded contributing factors of cost overruns and schedule delays. These fifteen (15) factors were assessed on the Likert scale from '*very low*' – 1, to '*very high*' – 5. The responses were then analysed and the factors ranked from first to fifteenth as presented in Table 8 below.

Table 8
RELATIVE IMPORTANCE INDEX AND RANKING OF THE SEVERITY OF FACTORS ON COST OVERRUNS AND SCHEDULE DELAY

Severity of effect of cost overruns and schedule delay	RII	Rank
Delay in honouring payment certificates	0.713	1
Inadequate credit facilities	0.713	2
Inflation	0.625	3
Exchange rate	0.613	4
Modification in contract	0.588	5
Government interference	0.588	6
Underestimation of completion time	0.525	7
Project design error	0.513	8
Lack of pre-designing and pre-tendering inspections	0.513	9
Shortage of experienced labour on site	0.513	10
Inadequate technical know-how of contractors	0.513	11
Poor communication	0.513	12
Unexpected weather conditions	0.475	13

Lack of project knowledge	0.475	14
Poor site management	0.475	15

Source: Author, 2020

The results in Table 8 shows that the six (6) key factors that affect cost overruns and schedule delay mostly include delay in honouring payment certificates (RII=0.725), inadequate credit facilities (RII=0.725), inflation (RII=0.625), exchange rate (RII=0.613), modification in contract (RII=0.588) and government interference (RII=0.588). However, unexpected weather conditions, lack of project knowledge and poor site management do not significantly affect cost overruns and schedule delays since their RII of 0.475 each was below the average of 0.5.

Qualitative data on schedule delays, cost overruns and severity of factors on cost overruns and schedule delays

Considering the fact that schedule delays and cost overruns affect the quality of projects, the researchers further gathered qualitative data from the management of Ghana Highway Authority and Department of Urban Roads in Accra, Ghana. The data obtained from the respondents fell into four categories: causes of schedule delays; causes of cost overruns; strategies to minimize schedule delays and cost overruns; and strategic measures to ensure successful delivery of road infrastructure construction projects. The respondents were selected purposively through the assistance of the Directors of Roads at the respective institutions. The researcher sent the questionnaire to the respective directors, which they distributed to the key management staff to be completed and returned to the researcher through email. In all, thirteen (13) management staff were contacted and responded accordingly to the questionnaires. The responses were then analyzed using the content analysis procedure.

Concerning the causes of schedule delay in road infrastructure projects, respondents described seven distinct causes, some are already embedded in the predetermined factors in the literature review and other emerging ones as listed:

1. Relocation of utilities such as electricity, water and telephone connectivity;
2. Lack of quality project managers;
3. Lack of pre-design geotechnical studies;
4. Encroachment and payment of compensations;
5. Non-availability of geo-location data of utilities;
6. Delay in the compensation of project-affected persons; and
7. Change of governments.

The findings implied that schedule delays are caused by the non-availability of geo-location data on utilities, which make relocation of such affected utilities difficult and time-consuming and sometimes leads to poor predesign geotechnical studies. Moreover, encroachment on projects sites requires compensation to project-affected persons, which is mostly delayed due to inadequate pre-design assessment and value engineering.

In addition, the respondents provided three detailed or sourced causes of cost overruns in road infrastructure projects aside those identified in previous empirical literature. These factors include:

1. Compensation to farmers and property owners;
2. Underestimation of cost of relocation of utility services; and
3. Underestimation of bill of quantities.

In the quest to win contracts, some contractors and consultants undercut estimates of bill of quantities this leads to cost overruns during the project implementation phase. Moreover, underestimation of compensation for project-affected persons also accounts for cost overruns.

Given the strategies to minimize cost overruns and schedule delays, the respondents suggested six (6) main factors to be considered. These include proper value engineering, honouring payment certificates, effective project monitoring, enforcement of the performance bond, improvement in process payment and prompt inspection, and release of funds. These factors will ensure that key contributing factors to schedule delays and cost overruns are predicted and managed ahead of its occurrences.

To mitigate the effects of cost overruns and schedule delays of road infrastructure construction projects in Ghana, the respondents proposed five (5) factors to be incorporated in the pre-design, design, implementation and monitoring of the projects. These factors include:

1. Consultants should be given adequate time to produce detailed design and value engineering reports;
2. Sufficient geotechnical investigation should be done;
3. Secure project finance before awarding contracts;
4. Projects must not be politicized; and
5. Enforcement of the performance bond.

These factors, as recommended by respondents, should minimize the cost deviations, schedule delay and the severity of the effect of cost overruns and schedule delay of road infrastructure projects.

DISCUSSION

This paper assesses the contributing factors to schedule delays and cost overruns in road infrastructure projects in Ghana. The researchers employed project type, nature of work, contractor's nationality, project size, implementing period, funding source and supervision as independent variable and cost overrun as dependent variable on one hand and schedule delay as dependent variable on the other hand. The results indicated that majority (84%) of road projects experience schedule delays with few being completed as scheduled. This confirms the assertion of Fobi (2014) and Fugar & Agyakwah-Baah (2010) who recounted that most infrastructure projects in Ghana are accompanied by schedule delays emanating from both human and non-human factors. Meanwhile, completion time is planned at the planning and design stage of every construction project. The result of this research on the underestimation of completion time supports the planning fallacy theory as opined by (Buehler et al., 2010). Buehler et al. (1994) averred that the rationale for underestimating completion time may be deliberately done to win the contract; or unintentional due to lack of project knowledge and experience. However, the schedule delays attributed to the underestimation of completion could be deliberate since the analysis of personal information of respondents suggests that the contractors and consultants were experienced with adequate knowledge in road infrastructure construction projects.

The results also indicated that while project size significantly impact cost overruns; nature of work and funding source significantly negatively impact schedule delays. On the account of Fobi (2014), unsecured funding sources and poor communication are key contributing factors to schedule delays in Ghana's road infrastructure construction projects. The results of this research is therefore consistent with that of Fobi (2014) on unsecured funding sources in the form of inadequate credit facilities and delays in honouring of payment certificate. However, a contradiction to Fobi's results according to this study was that poor communication was not an important cause of schedule delays. Others who support unsecured funding sources include (Shah, 2016; Akomah & Jackson, 2016; Amoatey & Ankrah, 2017). Thus, funds are not readily available for timely execution of the project due to the delay in honouring payment certificates, in addition to the unavailability of adequate credit facilities. Moreover, macroeconomic indicators such as inflation and exchange rate have a significant

impact on the prices of inputs for construction projects. As explained by Khabisi (2013), inflation and exchange rates negatively impact the availability of funds for the project. As a result, funds meant for a particular phase of a project will be diverted into other phases or funds will not be available for ensuring the continuity of the project. This will amount to spending extra time to reorganize funds for procuring materials to ensure that projects are continued and consequently completed.

The results from the opinions and experiences of stakeholders on the causes of cost overruns and schedule delays included poor site management, lack of project knowledge, poor communication, inadequate technical know-how of contractors and shortage of experienced labour on-site in that order. Contrarily, Rahman et al. (2013) averred that poor site management is a determinant of cost overruns, while Gbahabo & Ajuwon (2017) maintained that lack of project knowledge, inadequate technical know-how of contractors and shortage of experienced labour on site are undermining factors of cost overruns in infrastructure projects in Sub-Sahara Africa.

However, delay in honouring payment certificates, modification of the contract, inadequate credit facilities, inflation, and exchange rate were found to significantly contribute to cost overruns. This result suggests that macroeconomic factors as well as inadequate planning and funding issues are the most important contributing factors to cost overruns in road infrastructure projects in Ghana. This result conforms to the findings of Offei-Nyako et al. (2016) on the part of changes in project design and delay in honouring payment certificates as key factors of cost overruns in capital projects and contradicts the aspect that macroeconomic instability causes cost overruns. The deviation from Offei-Nyarko et al. (2016) assertion that economic stability insignificantly causes cost overruns could be explained by the fact that they focused on capital projects in totality while this research considered road infrastructure projects only. As noted by Chileshe & Berko (2010), Gbahabo & Ajuwon (2017) and Lukale (2018), macroeconomic indicators such as exchange rate and inflation affect the cost of material required for the construction of road infrastructure projects. With the progressive deterioration of the cedi against major international currencies (especially the dollar), input prices should definitely increase and this will contribute to the deviation of the budget cost from the actual cost of capital projects in Ghana.

On the descriptive statistics of project attributes, the nationality of contractors was largely non-Ghanaians with enough experience in road construction. This could imply that most road construction projects in Ghana are awarded to foreigners with experience. This may account for the insignificance of such factors as contributing factors to cost overruns in road infrastructure projects. Kogi and Were (2017) asserted that unqualified contractors come with contract or project management issues such as poor site management and consequently lead to cost overruns due to errors and omissions in the work done. The implication is that the important contributing factors to schedule delays and cost overruns, in addition to government interference in projects, have a significant effect on cost overruns and schedule delays simultaneously. Government interference is a contributing factor to cost overruns and schedule delays in Ghana. This is in tandem with the findings of Larsen, Shen, Lindhard and Brunoe (2015), which asserted that similar factors of cost overruns and schedule delays affect the quality of infrastructure construction projects. Likewise, Jamaludin, Mohammad and Ahmad (2014) attributed the quality of projects to cost variation or deviation minimization. Thus, when cost overruns are minimal, the quality of the project becomes reliable and sustainable. Likewise, Belay and Torp (2017) opined that longer projects have higher cost variations.

CONCLUSIONS AND RECOMMENDATIONS

The results revealed that the Government of Ghana needs to invest adequate time into pre-design, design, award of contract, funding, and monitoring of road infrastructure construction projects. It was noted that reconstruction projects are more prone to schedule delays and projects that require international funding sources are less prone to schedule delays, whereas larger projects come with larger cost overruns. Government's role will be to secure funding to help minimize the negative impact of lack of funding or the delay of its release on the schedule. Moreover, the government needs to ensure that adequate economic and time resources are available for pre-design activities to minimize the uncertainties or risk of project modification.

The results further revealed that shoddy geotechnical investigation of soil accounts for schedule delays and cost overruns. It is recommended therefore that consultants carry out thorough geotechnical investigations and present a report for scrutiny ahead of the contract award to ensure adequate funds are allocated to such risk at the contract award stage. With this, little or no additional cost will emerge from uncertainties or risk of geotechnical failure. With the knowledge of negative effects of cost overruns and schedule delays of road infrastructure construction projects in Ghana, strict enforcement of the performance bond should be embarked on by the Government of Ghana, and consultants alike. Likewise, the government should ensure the continuity of infrastructure construction projects, especially when there is a change of government.

Policies on contract administration and road project implementation should be reviewed and reinforced. Consultants will appreciate the flexibility to indicate accurately the length of expected completion time considering the nature of work. This is due to the knowledge that larger projects come with higher cost overruns and more work, and insecure funding sources come with higher schedule delays. Government policy on performance bond should be taken into consideration and the politicization of government infrastructure projects should be minimized since it leads to cost overruns and schedule delays of road infrastructure construction projects in Ghana.

Appendix D: Data analysis results

Table D.1
ANALYSIS OF VARIANCE TABLE FOR SCHEDULE DELAY MODEL

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	46.133	7	6.590	4.192	.003[a]
	Residual	45.591	29	1.572		
	Total	91.725	36			

a. Predictors: (Constant), Supervision, Implementing period, Project type, Contractor's nationality, Project size, Nature of work, Funding source

b. Dependent Variable: Natural logarithm of schedule delay
Source: Author, 2020

Table D.2
ANALYSIS OF VARIANCE TABLE FOR COST OVERRUNS MODEL

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	32.271	7	4.610	3.657	.006[a]
	Residual	36.560	29	1.261		
	Total	68.831	36			

a. Predictors: (Constant), Supervision, Implementing period, Project type, Contractor's nationality, Project size, Nature of work, Funding source		
b. Dependent Variable: Natural logarithm of cost overruns		

Source: Author, 2020

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