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CIVIL ENGINEERING | RESEARCH ARTICLE

Enhancing the success of Ghanaian public road construction projects

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Abstract: The objective of this research paper is to determine the critical success factors (CSFs) influencing the success of public road construction projects from the perspective of a developing nation. A self-administered questionnaire was used to gather data on the extent to which critical success factors gathered from literature impact the success of public road construction projects from sector practitioners' perspectives in Ghana. The data was then analysed using factor analysis. The study revealed that external environmental factors have the highest influence (46.23%) on public road construction project success, followed by project management factors (12.25%) while procurement-related factors have the least impact (6.97%). Public construction project management organisations and the government will now have a deeper understanding of CSFs that influence the success of public construction projects and use them as a guide to enhance the successful delivery of public road construction projects. Even though numerous studies have been undertaken to enhance the success of construction projects in Ghana, very little



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With more than 18 years of experience working on various civil engineering projects, Ing. Chelteau Barajei is a licensed civil engineering consultant. He is presently a Construction Management PhD candidate at the University of Education, Ghana. Building information modeling (BIM), construction management, and critical success factors are some of his areas of study interest. The Department of Construction and Wood Technology Education at Ghana's Akenten Appiah-Menka University of Skills Training and Entrepreneurship Development is taught by Dr. Emmanuel Appiah-Kubi, Dr. Nongiba A. Kheni, and Prof. Humphrey Danso. BIM, construction management, and construction technology are some of their research interests. Dr. Iddrisu Abdul Wahab teaches at the Ghana Communication Technology University's Department of Mathematics and Statistics. His area of interest in research is working with researchers from different discipline by providing support and research guidance where he has been sole contributor of the statistical content.
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PUBLIC INTEREST STATEMENT

The management of public road construction projects was explored in the current study with reference to the Ghanaian construction sector. To choose pertinent success-related factors from research published in developing countries, a systematic literature review was done using pre-defined criteria in order to fulfill the objectives of the study. Moreover, questionnaires were sent to clients, contractors, and consultants' representatives. Following the collection of the replies, structural equation modeling was used to analyze them. The results of this study are thought to be useful in understanding the key elements that contribute to the success of public construction projects for experts, contractors, policy makers, and regulatory organizations.

attention has been given to procurement-related factors. Thus, the study outcome will add value to sector practitioners and the Government of Ghana in the management of public road construction projects.

Subjects: Construction Management; Building Project Management; Cities & Infrastructure

Keywords: Critical success factors; construction; project success; project management; construction management

1. Background

The construction industry has a significant impact on a country's economy. As evident in many nations, nearly all the key developmental initiatives have some element of construction. The construction sector's contribution to Gross Domestic Product (GDP), total capital assets, and investment in the fixed asset in developing nations is around 10%, 80%, and 50% respectively (Jekale, 2004). For instance, the contribution of the construction industry to GDP in Ghana rose from 7.6% in 1996 to 9.9% in 2011, subsequently increased to 12.6% in 2013 (GSS as cited by Famiyeh et al., 2017) and has decreased to 6.8 (Ghana Statistical Service, 2021) due to the adverse impact of COVID-19 on the construction sector. Global Competitiveness Index (GCI) which is premised on the state of a nation's infrastructure (Mejia et al., 2020) evaluates a nation's capability to offer better living conditions for its citizenry (Schwab, 2018). Infrastructure such as water supply, buildings, transport systems, power, etc contributes to better living conditions in this regard. However, it is worth noting that road infrastructure contributes significantly to trade and improved access to education, health, and social life for citizens of any nation (Amoatey & Okanta, 2017; Santoso & Soeng, 2016). This assertion is corroborated by Samanta (2015) who professed that there is a direct relationship between a nation's development and improved road access. According to Samanta (2015), road infrastructure network enhances the use of pertinent social and other infrastructure and the provision of improved rural roads results in increased agricultural production by expanding existing land use or cultivating new lands which were hitherto inaccessible. Also, Fan et al. (2005) contend that household poverty decreases by 0.22 to 0.33% per kilometer reduction to public road infrastructure access by communities. Thus, road projects improve the socioeconomic condition of beneficiary communities.

Failure of construction projects, especially road projects, continues to be a chronic issue in developing nations even though there have been significant improvements in technology and project management techniques (Famiyeh et al., 2017; Honrao & Desai, 2015; Muhwezi et al., 2014). For example, Elawi et al. (2015) and Mahamid (2017) professed average delays of 39% for construction projects and 48% for road projects in Saudi Arabia and Palestine respectively. Also, Amoatey and Okanta (2017) affirmed that 70% of road projects in Ghana had an average delay of 17 months whereas Damoah et al. (2019) reported on educational construction project abandonment. A plethora of studies have been undertaken in an attempt to address these challenges. However, critical success factors (CSFs) of public road construction projects in emerging economies are under-researched (Damoah et al., 2022). Furthermore, studies that include procurement-related factors as a thematic group of CSFs that influence public road construction projects' success in Ghana are non-existent.

Meanwhile, Mgawe and Masanja (2014), Shehu et al. (2014), Jeptepkeny (2015), and Dagba and Dagba (2019) professed that procurement processes and practices significantly impact the success of public construction projects. For instance, empirical studies (Amoah et al., 2021; Das & Ngacho, 2017; Mwelu et al., 2019; Chan et al., 2004) revealed that procurement factors have a significant influence on public construction project success. According to Dissanayaka and Kumaraswamy (1999), effective procurement systems reduce time and cost overruns. It is further reported that strict adherence to best procurement practices results in the following benefits to project management: reduced transaction cost (Obat, 2016); increased competition (Al-moalla & Li, 2010); reduced procurement cycle times (Patel et al., 2016) and improved efficiency and transparency (Korir et al., 2015).

This study, therefore, seeks to identify procurement-related factors as part of thematic groups of CSFs that influence Ghanaian public road construction projects' success to enable their coherent appreciation and application.

2. Literature review

CSFs play a pivotal role in the successful delivery of construction projects (Han et al., 2012). According to Yong and Mustaffa (2012), CSFs are influenced by factors such as operating environment, policies, and legal constraints and may vary from one region or one industry to the other respectively. CSFs are the inputs to project management systems that must be influenced to achieve project success (Cooke Davies & Arzymanow, 2003; De Wit, 1988). Lidow (1999) further suggests that these inputs are ducks and must be properly prepared and executed to deliver projects successfully. Success factors and failure factors serve the same objective but are opposite (Gunasekera, 2009). This implies that failure factors when addressed, as in the case of this research, result in project success.

2.1. Empirical review

In the Ethiopian construction industry, Belay et al. (2021) looked into the comparative examination of success variables in the public and private sectors. Based on the hierarchical model created through a thorough literature study, a structured questionnaire matrix was created. Then, a panel of specialists from various construction organizations, including clients, consultants, contractors, and academics, completed two rounds of the Delphi- Analytical Hierarchy Process (AHP) survey. According to the findings, the three most important critical success factors (CSFs) for private sector projects are defined project goals, contractor financial capability, and consulting company competence. However, in the public construction sector, the most important CSFs are adequate funding, a favourable political climate, and clearly defined project objectives. This and other similar studies did not logically categorize the CSFs for easy appreciation and application (Jugdev & Müller, 2005). CSFs for Public Private Partnership (PPP) infrastructure project implementation in Vietnam were evaluated by Hai et al. (2022). To represent the effects of these clusters on the implementation of PPP infrastructure projects, a theoretical structural equation model was developed. Views of 216 PPP infrastructure experts and practitioners were gathered through a questionnaire survey. The results showed that the private sector, project information, and procurement process clusters had the most influence on whether PPP infrastructure projects were successfully implemented. Also, Das and Ngacho (2017) carried out a study on Kenyan construction projects using factor analysis. The research revealed six factors namely; project-related, client-related, consultant-related, contractor-related, supply chain-related, and environment-related factors as elements influencing the performance of construction projects. The variables that make up the consultant-related, client-related, and contractor-related factors are generalized as project management factors in project management literature. These thematic groups emphasize the impact of the same variables on construction project success emanating from the actions of different public construction project stakeholder categories. Likewise, the supply chain-related factors are the same as procurement-related factors or project procedures. In addition, research to analyze CSFs for Uganda's public road construction projects by Mwelu et al. (2019) came up with five factors using structural equation modelling. The factors are professionalism of staff, monitoring activities, familiarity with public procurement regulatory framework, perceived inefficiency of public procurement regulatory framework, and compliance with public procurement regulatory framework. Similarly, professionalism of staff and monitoring activities relate to project management factors whereas familiarity with public procurement regulatory framework, perceived inefficiency of public procurement regulatory framework, and compliance with public procurement regulatory framework relate to procurement-related factors. Thus, the most common thematic groups of CSFs that influence the success of public construction projects across developing economies are external environmental factors, project management factors, and procurement-related factors. Most of these studies affirmed that external environmental factors have the biggest impact on public construction projects' success. This could be attributed to the increasing politicization and corruption in emerging economies.

Numerous studies to determine CSFs that influence the success of public construction projects in Ghana have also been carried out. Kissi et al. (2019) used structured questionnaires to elicit the opinions of project experts in the Ghanaian construction industry as they investigated the effect of project monitoring and evaluation (M&E) procedures on project success criteria. The hypothesis-based impact of project M&E practices (constructs) on project success was established in this paper using partial least square-structural equation modeling. The findings demonstrated a direct relationship between M&E practices and the success criteria for construction projects. Likewise, Amoah et al. (2021) examined the combined influence of six factors on construction project success using qualitative comparative analysis. The study showed that combinations of human-related factors, project-related factors, project procedures, project management factors, project support factors, and external environmental factors have a direct influence on construction project success. Also, Damoah and Kumi (2018) identified leadership, management and administrative practices, resources, and external forces as factors that influence the success of public construction projects in Ghana. The composition of leadership and external resources factors are related to external environment and the management and administrative practices and resources factors are project management related. These factors were extended by Damoah et al. (2019) to include cultural factors as the study focused on educational construction projects. It is worth mentioning that local communities may resist the construction of school facilities due to their religious and traditional belief systems, unlike public road construction projects. Asiedu and Adaku (2019) investigated the causes of public construction project failure in Ghana. The study classified these failure factors as poor contract planning and supervision; change orders; weak institutional and economic environment of projects and lack of effective coordination among the contracting parties. Furthermore, Dagba and Dagba (2019) evaluated contract management procedures and procurement methods to determine how they impact Ghanaian road construction projects' performance. The study discovered that competitive, restricted, and shopping methods have a significant influence on the success of public road construction projects. The study focused on only four (4) districts in only one (1) out of the 16 regions in Ghana and only investigated the impact of procurement methods on public road construction project performance. Furthermore, the study did not capture the views of the staff of consulting firms and road agencies who are key stakeholders of public road construction projects in Ghana. Finally, Famiyeh et al. (2017) in their study identified client-related factors, consultant-related factors, contractor-related factors, and material-related factors as independent variables of project success. Again, these factors can be broadly classified as project management, external environmental, cultural, and procurement-related factors. Thus, the most common thematic groups of CSFs that influence construction project success in Ghana are external environmental and project management factors. Even though most studies in Ghana either contained vague or one (1) or two (2) variables related to procurement, not enough studies have interrogated procurement-related factors as part of thematic groups of CSFs that influence construction projects' success. Furthermore, such studies on public road construction projects do not exist. Meanwhile, there is no chance of delivering a public construction project without going through procurement as enshrined in public procurement regulations across nations. Also, Beleiu et al. (2015) postulate that success factors should be adapted to the type of project.

In light of the benefits of procurement systems, the challenge with public road construction management literature, and the significant impact of road infrastructure on nations' economies and GCI, it is imperative that studies that thoroughly probe and identify CSFs of public road construction projects in Ghana are considered.

3. Research methodology

This section discusses the sampling, questionnaire design, and inferential tool employed for the study.

3.1. Sampling method

The study population is public road construction projects completed within the last five years. Given the relatively small number of the study population (i.e., 290 projects) as gathered from the road departments and the high number of responses required to use factor analysis for data analysis, the census sampling technique was employed for this study. The respondents for the study were project management team members (i.e., engineers and quantity surveyors) of consultants, contractors, and clients involved in the management of the completed road projects under the road agencies.

3.2. Questionnaire design

To define and categorize the variables, the researchers used a quantitative survey methodology. This made it possible to employ much bigger samples and helps forecast the relationship between independent and dependent variables using statistical information. This allows for the generalization of a phenomenon to a larger population (Bryman, 2016; Creswell & Creswell, 2017). The design of the research questionnaire started with the review and shortlisting of success factors from literature. The compiled list was subsequently critiqued through focused group discussion by nine (9) experts in public road construction management from academia, construction firms, consultancy firms, and the public sector. The list of nine (9) experts comprised two (2) experts each from the public sector, consulting firms, and academia whilst the remaining three (3) came from construction firms. The panel was also allowed to take out irrelevant factors and also add other relevant ones that were not included in the compiled list. This is rightly so because projects are special (Mir & Pinnington, 2014) and are dependent on geographic location and socio-cultural settings (Ahsan & Gunawan, 2010). The experts were to have not less than 15 years of experience in public road construction management (Hallowell & Gambatese, 2009) and should have managed a completed public road construction project within the last five years. At the end of this exercise, 26 factors were shortlisted for the study.

The carefully developed questionnaire through a review of literature and feedback from the pilot study was issued to respondents. The seven-point Likert scale (Kim, 2010) on which the variables in the questionnaire were ranked are: 1 - strongly insignificant; 2 - partially insignificant; 3 - insignificant; 4 - neutral (uncertain); 5 - partially significant; 6 - significant; and 7 - strongly significant. Respondents were to rank the extent to which the 26 variables affected the success or failure of the completed road project they managed.

3.3. Factor analysis

Factor analysis is a statistical interrelationship tool used to describe the primary structure among variables of a research (Bandalos & Finney, 2018). The technique reduces information from a huge number of variables to smaller subsets of meaningful clusters (Hair et al., 2014; Pallant, 2020).

The use of factor analysis in construction management studies is not new. Studies such as Asiedu and Adaku (2019) and Pongpeng and Liston (2003) employed factor analysis in their analysis. The most important criterion for its consideration is the suitability of data. Fidell et al. (1996) contend that sample size and strength of association among variables are the two key issues to be examined. Considering the large number of factors for the study and the need to group the factors for meaningful interpretation, factor analysis was used as an inferential tool for this study. In this regard, the KMO and Bartlett test of Sphericity was undertaken to determine the suitability of data for this study (Hair et al., 2014). The technique uses principal components analysis and extracts factors with eigenvalues greater than unity using Varimax rotation (Lin et al., 2011). Also, the use of a scree plot further confirms the optimum number of research factor components based on eigenvalues. The Scree plot is obtained by plotting the latent roots against the number of factors in their extraction sequence and the resulting curve used to determine the cut-off point (Hair et al., 2014). According to Fellows and Liu (2021), factors with eigenvalue values greater than one are retained for further interrogation.

4. Results and analysis

This section discusses the response rate, background of respondents, descriptive and inferential analyses for the study.

4.1. Response rate

Out of the 606 questionnaires distributed, 457 questionnaires (75.4%) were retrieved. Eight (8) responses (1.3%) were discarded during the data cleaning process, resulting in 449 (74.1%) valid responses for data analysis. Thus, the number of valid responses is sufficient for factor analysis given that a ratio of at least 5 observations per variable is the minimum sample size requirement (O'rouke et al., 2005). The sufficient response rate is attributable to the researcher's strong network in the road sector as well as the continuous e-mail reminders, calls, and visits to respondents. The sufficient response rate may also be attributable to the clarity of the questionnaire.

4.2. Background of respondents

Hallowell and Gambatese (2009) opined that background information such as education and years of experience in the construction industry are good indicators of professional expertise as well as guarantee the validity and the reliability of study outcome (Cresswell & Cresswell, 2017 and Dainty, 2008). The summary of respondents' characteristics is shown in Table 1.

Of the total 449 valid responses retrieved, 133 respondents (29.6%) were Geomatic Engineers, 165 respondents (36.8) were Civil Engineers and 151 respondents (33.6%) were Quantity Surveyors. Therefore, it can be concluded that the categories of respondents' perceptions of the study variables are balanced. The data on the highest level of academic achievement of respondents showed that the respondents were highly qualified academically with a bachelor's degree as the least qualification. It also implies that respondents understood the completion of the questionnaires. Two hundred and nine (209) respondents (46.5 %) held bachelor's degrees whilst 240 respondents (53.5%) held master's degrees. Only 7 respondents (1.6%) had 6–9 years of professional experience; 268 respondents (59.7 %) had between 10–19 years of professional experience and the remaining 174 respondents (38.7%) had over 20 years of professional experience. The above table indicates the rich experience and qualification of respondents in the area of the study.

4.3. Descriptive analysis

Standard deviation is a degree of consistency and changeability concerning the understanding of variables by the respondents for a given statistical data (Motulsky, 2003). It is therefore considered important when it comes to the validity and reliability of research data (Motulsky, 2003). A standard deviation of less than 1.00 implies a low changeability and high consistency. A small standard deviation (less than 1.00) associated with the mean scores of the variables/attributes being measured suggests a low variability and high uniformity in the interpretation of variables by respondents and vice versa (Field, 2005). Thus, it can be said that the responses of the study participants were of low variability and high consistency as the standard deviations were less than 1.00 for all the variables interrogated. The details are shown in Table 2.

4.4. Inferential analysis

A value of 0.600 for the Kaiser—Meyer—Olkin (KMO) measure of sampling adequacy is considered acceptable for data to be considered for factor analysis (Hair et al., 2014). Therefore, the KMO value of 0.720 for this study is considered more than adequate to merit factor analysis. In addition, the Bartlett test of sphericity recorded an Approximate Chi-Square of 13,698.749 with an associated significance of 0.000. This is clear evidence of probable relationships among the variables. Also, it is an indication of possible groupings of variables and the population matrix not being an identity matrix (Hair et al., 2014).

The variables for the study were subsequently extracted into components through Exploratory Factor Analysis (EFA). From the Scree plot shown in Figure 1, it is evident that three-factor

components were expected from the EFA. These are the components with eigenvalues greater than one.

Table 3 shows the three components with eigenvalues greater than one (i.e., 7.741, 3.120, and 1.409) and further indicates that the three components account for 65.5% of public road construction project success.

Table 1. Profile of respondents			
Variable	Frequency	Percent	Mean (SD)
Gender of respondent			N/A
Male	402	89.5	
Female	47	10.5	
Total	449	100	
Highest level of academic achievement			N/A
Diploma	0	0	
Bachelors	209	46.5	
Masters	240	53.5	
Total	449	100	
Designation of respondent			N/A
Geomatic Engineer	133	29.6	
Civil Engineer	165	36.8	
Quantity Surveyor	151	33.6	
Total	449	100	
Training in construction or project management?			N/A
Yes	426	94.9	
No	23	5.1	
Total	449	100	
Role in project delivery			N/A
Client	41	9.1	
Contractor	293	65.3	
Consultant	115	25.6	
Total	449	100	
Years of field experience in construction			19.85 (7.117)
0–9 years	7	1.6	
10–19 years	268	59.7	
20 years and above	174	38.7	
Total	449	100.0	

Table 2. Mean scores for scales

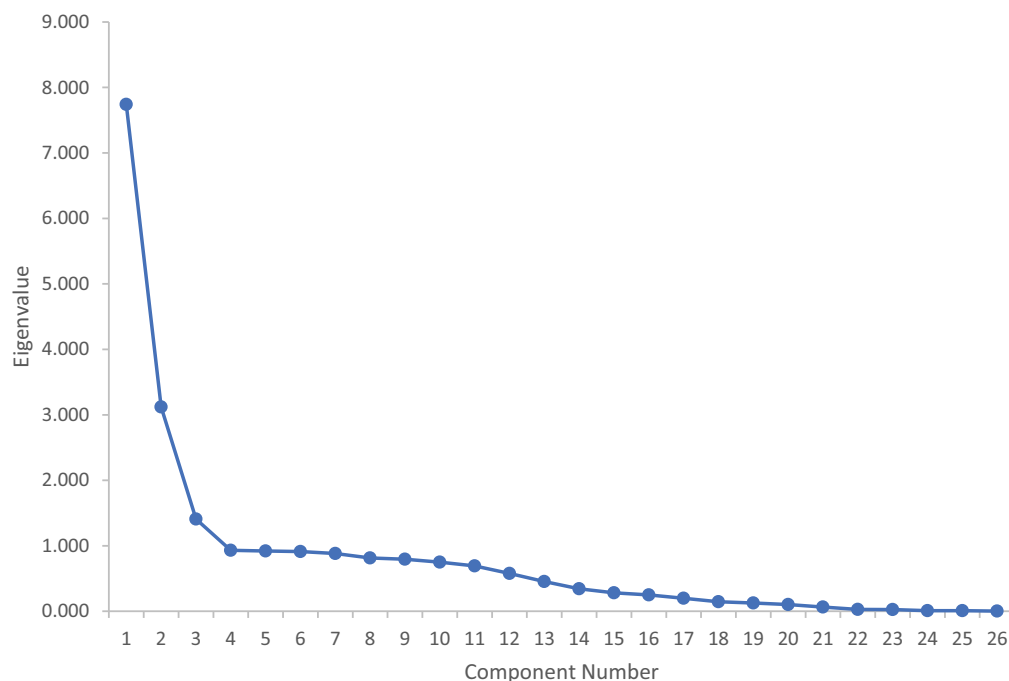
Notation	Scale Item	Minimum	Maximum	Mean	Std. Deviation
SF1	Top management support	2.00	7.00	6.5479	.57325
SF2	Team capability	2.00	7.00	6.8396	.49202
SF3	Effective planning	2.00	7.00	6.6414	.62190
SF4	Controlled political interference	5.00	7.00	5.7483	.63133
SF5	Communication	2.00	7.00	6.1002	.80524
SF6	Team members commitment	2.00	7.00	6.3987	.64024
SF7	User involvement	5.00	7.00	5.8686	.69956
SF8	Stable government	4.00	7.00	5.4098	.59122
SF9	Availability of equipment	2.00	7.00	5.9599	.66022
SF10	Economic (stable economic conditions and economic policy)	4.00	7.00	5.8241	.63228
SF11	Transfer of experience and best practice	2.00	7.00	5.5256	.76175
SF12	Fighting corruption	4.00	7.00	5.6080	.60321
SF13	Project management structure	2.00	7.00	6.7817	.62072
SF14	Availability of resources/materials	4.00	7.00	5.8619	.70305
SF15	Feasibility study	2.00	7.00	5.8486	.65414
SF16	Minimize bureaucratic procurement process	2.00	7.00	6.0200	.76008

(Continued)

Table 2. (Continued)

Notation	Scale Item	Minimum	Maximum	Mean	Std. Deviation
SF17	Adequately defined task	2.00	7.00	6.7261	.60744
SF18	Transparent procurement process	2.00	7.00	6.0290	.76565
SF19	Works specifications	2.00	7.00	6.0245	.76288
SF20	Project requirements	2.00	7.00	6.7929	.57813
SF21	Procurement method	2.00	7.00	6.2918	.68266
SF22	Cashflow	2.00	7.00	6.9577	.30690
SF23	Contractual terms and conditions	2.00	7.00	6.0223	.76149
SF24	Adequacy of design	4.00	7.00	6.3185	.77841
SF25	Favourable weather	4.00	7.00	5.7082	.59907
SF26	Effective supervision	2.00	7.00	6.8486	.48574

Figure 1. Scree plot.



External environmental, project management, and procurement-related factors were the components with eigenvalues greater than one. Confirmatory Factor Analysis (CFA) was conducted to confirm the validity and reliability of the factors identified from the EFA. For model confirmation based on CFA; factor loading values should be higher than 0.4 (Peterson, 2000), Cronbach's alpha (α) acceptable threshold is 0.7 (Hair et al., 2014), composite reliability (CR) values should be higher than 0.7 and average variance extracted (AVE) values should be greater than 0.4 (Nunnally & Bernstein, 1978). Thus, α values above the 0.7 thresholds for all the constructs α show that the factors extracted from the analysis are deemed adequate in the successful implementation of public road construction projects. The results of the factor analysis and the reliability analysis are shown in Table 4.

5. Discussions of results

This section discusses the critical success factors of public road projects identified by this study.

5.1. External environmental factors

External environmental factors are the most significant factors that influence the success of public road construction projects in Ghana. They account for 46.23% of public road construction projects' success. It comprises fighting corruption, favourable weather, controlled political interference, economic (stable economic conditions and economic policy), stable government, availability of materials, and availability of equipment based on the rotated factor pattern. This confirms the findings of Damoah et al. (2022), Chan et al. (2004), Das and Ngacho (2017), Damoah et al. (2019), Amoah et al., (2021), Damoah and Kumi (2018) and Famiyeh et al. (2017). Public construction projects especially road projects are highly politicized given their socioeconomic impact on communities and credit given to the government that initiated them. In this regard, a change of government negatively impacts the performance of the project leading to possible abandonment as the new government becomes more interested in pursuing its programmes and projects to win the next election (Damoah et al., 2019). Again, they report in their study that corruption and political interference are an integral part of government project implementation in Ghana and have become the norm. Payment of huge bribes to facilitate contract awards or evade regulations

Table 3. Total variance explained for success factors

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	7.741	46.233	46.233	7.741	46.233	46.233	4.564	27.554	27.554
2	3.120	12.245	58.479	3.120	12.245	58.479	3.319	22.767	50.320
3	1.409	6.974	65.452	1.409	6.974	65.452	3.287	15.132	65.452
4	.932	5.986	71.438						
5	.921	5.791	77.229						
6	.912	4.903	82.132						
7	.882	3.602	85.734						
8	.815	2.668	88.402						
9	.796	1.978	90.380						
10	.750	1.599	91.980						
11	.694	1.389	93.369						
12	.578	.982	94.351						
13	.454	.891	95.242						
14	.344	.852	96.094						
15	.282	.658	96.752						
16	.250	.481	97.233						
17	.199	.463	97.696						
18	.147	.377	98.072						
19	.126	.333	98.405						
20	.102	.318	98.723						

(Continued)

Table 3. (Continued)

Component	Initial Eigenvalues		Extraction Sums of Squared Loadings		Rotation Sums of Squared Loadings	
	Total	% of Variance	Total	% of Variance	Total	% of Variance
21	.065	.974				
22	.029	.113				
23	.027	.103				
24	.010	.040				
25	.009	.033				
26	.004	.015				
		Cumulative %				Cumulative %
		99.697				
		99.810				
		99.913				
		99.953				
		99.986				
		100.000				

Note:

Component 1: External Environmental Factors

Component 2: Project Management Factors

Component 3: Procurement-related Factors

is the order of the day even though there is empirical evidence of corruption being one of the leading causes of project failure. Bad weather such as rain and hot weather affects the performance of construction projects (Asiedu & Adaku, 2019; Famiyeh et al., 2017). Hot weather negatively impacts the productivity of workers due to exhaustion whereas rains disrupt contractors' work programme (Asiedu & Adaku, 2019; Famiyeh et al., 2017). Asiedu and Adaku (2019) and I. S. Damoah et al. (2019) professed that unstable economic condition is a major cause of construction project cost overrun in Ghana. The constant fall of the local currency against the dollar and pound results in high project costs of fuel, equipment, and materials which are mostly imported (Asiedu & Adaku, 2019; Famiyeh et al., 2017). Also, adverse effects of scarcity of equipment on construction project success have been reported (Damoah & Kumi, 2018; Damoah et al., 2019). Road construction equipment is very expensive and most contractors in Ghana cannot afford them, resulting in the demand for equipment by contractors exceeding the equipment supply (Akomah & Jackson, 2016). The equipment shortages undermine project success (Akomah & Jackson, 2016; Sami Ur Rehman et al., 2022). Furthermore, the use of substandard materials (Osei-tutu et al., 2010; Yap et al., 2021) and scarcity of materials (Famiyeh et al., 2017; Damoah & Kumi, 2018; Damoah et al., 2019) have all been identified as critical factors that undermine the success of public construction projects. Substandard materials affect the quality and lifespan of projects after completion.

5.2. Project management factors

Project management factors account for 12.25% of public road construction project success. They consist of six (6) factors namely top management support, team capability, effective planning, project management structure, cash flow, and effective supervision. These factors largely depict the essence of personnel competence and a strong administrative system in the execution of the project. According to Aje (2012) and Larson and Gray (2018), the competence of a project team is a key factor that influences project success. However, the independence of technocrats in the delivery of public construction projects is questionable (Asiedu & Adaku, 2019). Appointments in public institutions are highly political and leaders of these institutions have to act in the interest of their appointer in order not to incur their wrath (Asiedu & Adaku, 2019). Thus, even qualified technocrats are unable to follow best practices in the management of public construction projects, resulting in the acceptance of substandard jobs by consultants and clients (Damoah & Kumi, 2018; Osei-tutu et al., 2010). Also, the over-politicization of public sector organizations has led to "square pegs in round holes" and its attendant negative consequences (Asiedu & Adaku, 2019; Damoah et al., 2019). The politicization of public projects especially roads given their socio-economic impact on communities has further exacerbated the already bad situation. Governments in their attempt to please electorates by far exceed budget for road construction projects, resulting in severe payment challenges. According to Omopariola et al. (2020), cash flow is the lifeblood of construction projects and is the foremost source of project success. However, irregular cash flow is the biggest problem in the Ghanaian road sector due to the government's inability to honor interim payment certificates of contractors and consultants (Asiedu & Adaku, 2019; Damoah & Kumi, 2018; Damoah et al., 2019). The payment issues adversely affect the cost and duration of public construction projects. Payment delays result in contractors abandoning site leading to time overruns and accrued interest on delayed payments. Again, the finding that project management factors significantly influence public road construction success is corroborated by I. Damoah et al. (2022), Chan et al. (2004), Das and Ngacho (2017), Mwelu et al. (2019), Damoah et al. (2019), Amoah et al. (2021), Damoah and Kumi (2018) and Famiyeh et al. (2017).

5.3. Procurement-related factors

The study identified procurement-related factors as having the least impact on public road construction project success with a percentage of 6.97%. However, this finding is considered very significant given that effective procurement systems help to curb corruption, minimize bureaucracy and enhance auditing and transparency, resulting in efficient and effective management of public construction projects. This is more so, especially when public road construction projects are heavily prone to corruption due to their huge cost. The study established minimized bureaucratic procurement process, transparent

Table 4. Factor loadings of variables, construct cronbach's alpha values, composite reliability values and average variance extracted

Notation	Construct	Variables	Factor Loading	α	CR	AVE
SF1	Project Management Factors	Top management support	0.594	0.762	0.838	0.5
SF2		Team capability	0.764			
SF3		Effective planning	0.671			
SF13		Project management structure	0.585			
SF22		Cash flow	0.683			
SF26		Effective supervision	0.775			
SF24		Adequacy of design	0.295			
SF6		Team members commitment	0.301			
SF11		Transfer of experience and best practice	0.285			
SF15		Feasibility study	0.271			
SF17	Adequately defined task	0.212				
SF5	Communication	0.2				

(Continued)

Table 4. (Continued)

Notation	Construct	Variables	Factor Loading	α	CR	AVE
SF4	External Environmental Factors	Controlled Political interference	0.623	0.766	0.836	0.5
SF8		Stable government	0.623			
SF9		Availability of equipment	0.656			
SF10		Economic (stable economic conditions and economic policy)	0.603			
SF12		Fighting corruption	0.687			
SF14		Availability of materials	0.58			
SF25		Favourable weather	0.767			
SF7		<i>User involvement</i>	0.233			
SF16	Procurement-related Factors	Minimize bureaucratic procurement process	0.977	0.935	0.95	0.8
SF18		Transparent procurement process	0.973			
SF19		Works specifications	0.973			
SF21		Procurement method	0.972			
SF23		Contractual terms and conditions	0.462			
SF20		<i>Project requirements</i>	0.265			

procurement process, procurement method, contractual terms and conditions, and works specifications as the components of procurement-related factors. The procurement method addresses the issue of contractor and consultant capacities if rightly followed. The Public Procurement Act (PPA) of Ghana stipulates thresholds for shopping, national and international bidding based on the complexity of the assignment. This is to ensure that competent contractors and consultants based on the qualification requirements for respective thresholds are engaged. Works specifications and terms of reference when adhered to ensure that contractors and consultants respectively follow best practices leading to the delivery of high-quality projects. Also, strict adherence to contractual terms and conditions, transparent procurement processes, and minimized bureaucracy reduce conflicts, boost confidence, increase competition, and facilitate the delivery of projects on time and within budget. However, the practice in Ghana is contrary when it comes to the procurement of public projects. For instance, the “standstill” period after the evaluation of tenders and public posting of contracts after award to ensure transparency and boost public confidence are not followed in the procurement of works and consultancy. Also, there is the prevalence of tempering with the contents of tender documents (Adindu et al., 2020; Osei-tutu et al., 2010; Owusu et al., 2019) due to the use of the paper-based procurement system in Ghana and most developing nations. In addition, Amoako and Lyon (2014) and Damoah and Kumi (2018) profess that bureaucracy adversely impacts the success of public projects in Ghana and the situation has not changed. Bureaucracy in these studies was discussed in relation to general administration. However, this study has added the perspective of procurement bureaucracy to the existing literature on public construction projects in Ghana. Again, Damoah and Kumi (2018) and Damoah et al. (2019) reported of the prevalence of wrong specifications in public construction project management in Ghana. Osei-tutu et al. (2010) and Damoah et al. (2019) mentioned that manipulation of procurement methods and contract terms and conditions for the personal gain of politicians, technocrats, and contractors is prevalent in Ghana. For example, abuse of the restricted tendering method and including client prepayment as clauses in public contracts lead to financial losses. The finding of this study that procurement-related factors influence the success of public construction projects is not surprising since this outcome is confirmed by studies (Chan et al., 2004; Das & Ngacho, 2017; Hai et al., 2022; Mwelu et al., 2019) in other economies. Even though it also confirms the finding of Amoah et al. (2021) in Ghana, the scope of this study was not specific to public road construction projects. Additionally, it is worth mentioning that only the procurement method and transparent procurement process comprised the procurement-related factors for that study. With regards to public road construction literature in Ghana, it extends the finding of Dagba and Dagba (2019) by discovering four (4) factors in addition to the procurement method which was the only factor studied. Therefore, the study finding extends the literature on public road construction project management in Ghana.

6. Study implications

The following recommendations can be made to enhance the application of the success factors identified.

6.1. Procurement-related factors

The amendment of the current procurement act to make e-procurement, “stand still” period, and posting of contract awards mandatory for national and international competitive tenders will minimize procurement bureaucracy and enhance competition among bidders leading to value for money. The amendment will enhance real-time auditing, thus, deepening transparency in the management of public construction projects.

6.2. Project management factors

The strict compliance with the Public Financial Management Regulation by the government (PFMR) will address the severe irregular cash flows associated with public construction projects in Ghana. This is rightly so as the PFMR does not permit the government to sign a contract without an available budget. In addition, legislators of developing nations should urgently consider enacting laws to empower public construction project managers and to also establish ethical standards for the construction industry. This will further ensure professionalism, value for money and minimize shoddy work in the construction industry.

6.3. External environmental factors

Similarly, the stipulation of e-procurement, the “standstill” period, and the posting of contract awards as mandatory in the public act and their subsequent enforcement will significantly curb politicization and corruption in the management of public construction projects. Politicians and their cronies will have no choice but to adhere to the best construction project management practices. Furthermore, parliament enacting laws to make it unlawful for a project that has commenced to be abandoned by a new government will mitigate against the current high rate of abandoned projects. These measures will contribute to an improved enabling environment for public road construction project management.

7. Conclusion

The study revealed that:

- (i) External environmental factors have the highest influence (46.23%) on public road construction project success, followed by project management factors (12.25%) while procurement-related factors have the least impact (6.97%).
- (ii) Minimized bureaucratic procurement process, transparent procurement process, procurement method, contractual terms and conditions, and works specifications comprise procurement-related factors of Ghanaian public road construction projects.
- (iii) The findings on external environmental factors and project management factors are consistent with existing literature on public construction projects in Ghana and other developing nations. Therefore, the study, to that extent, affirms past studies as well.
- (iv) Proper application of success factors by stakeholders in the construction industry will further enhance the success of public road construction projects in Ghana.

8. Limitations and future research direction

The study is limited to public road construction projects in African countries with working environments and socio-economic conditions similar to that of Ghana. Hence, further research on CSFs influencing the success of private projects in emerging economies is recommended.

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Data availability statement

This research is based on manually collected data which will be made available upon reasonable request from the corresponding author, (C.B)..

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