International Journal of Construction Management

ISSN: 1562-3599 (Print) 2331-2327 (Online) Journal homepage: https://www.tandfonline.com/loi/tjcm20

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To cite this article: E. G. Sinesilassie, S. Z. S. Tabish & K. N. Jha (2018) Critical factors affecting cost performance: a case of Ethiopian public construction projects, International Journal of Construction Management, 18:2, 108-119, DOI: 10.1080/15623599.2016.1277058

To link to this article: https://doi.org/10.1080/15623599.2016.1277058

Published online: 27 Jan 2017.

INTERNATIONAL JOURNAL OF CONSTRUCTION MANAGEMENT, 2018
VOL. 18, NO. 2, 108–119
http://dx.doi.org/10.1080/15623599.2016.1277058

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Critical factors affecting cost performance: a case of Ethiopian public construction projects

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ABSTRACT

A striking feature of public construction projects worldwide has been the occurrence of cost overrun, and the Ethiopian construction industry is no exception. The purpose of this study is to determine the factors responsible for impacting the cost performance of Ethiopian public construction projects. For this purpose, 35 attributes responsible for impacting performance of the projects were identified and presented to Ethiopian construction professionals in the form of structured questionnaire and responses were collected. The factor analysis conducted on success attributes and failure attributes separately resulted in seven success factors and six failure factors. Further analysis using stepwise multiple regression indicates that scope clarity and project manager's competence have positive impact on cost performance. On the other hand, conflict among project participant, and project manager's ignorance and lack of knowledge have negative impact on cost performance of Ethiopian public construction projects. The findings are expected to assist researchers and practitioners to gain better understanding of the critical success and failure factors and helping them to take proactive measures to improve project cost performance.

KEYWORDS

Public projects; cost performance; factor analysis; critical factors; Ethiopia

Introduction

Due to the dynamic nature of the construction industry, construction projects constantly face uncertainties that make the management of costs difficult and consequently cause poor cost performance. For this reason, poor cost performance has been considered as one of the most critical issues during the execution of public construction projects.

The construction industry entails many players at various stages. The stakeholders such as client, designer, contractor, sub-contractors, specialists, construction managers, consultants, etc. are involved from the start till completion of the project. Each stakeholder has his/her own definition of success and it may not be the same even in a given project. Successes and failures are relative terms and are highly subjective (Parfitt & Sanvido 1993). The definition of success or failure can even change from project to project. Success to one participant may be a failure to another (De Wit 1998). Therefore, it becomes a very complex process to measure the performance of any construction project in terms of success or failure.

Success or failure attributes are the variables that influence the outcome of a project in a positive/negative manner. The attributes can be people oriented (project participants and their qualities and traits), resources based, technology dependent, working environment and system, or task.

A construction project is commonly acknowledged as successful when it is completed on time, without cost overruns and in accordance with specifications. A number of researchers have used these three criteria to measure project success (Atkinson 1999; Chan 2001; Cooke-Davies 2002; White & Fortune 2002; Koelmans 2004). The three criteria collectively are also referred to as the 'iron triangle' in the project management parlance (Atkinson 1999). There are certain other criteria such as safety performance, satisfaction of stakeholders and the status of dispute, which have been used by some researchers (Crane et al. 1999; Tabish & Jha 2011) to measure the project performance. However, in the present paper, only the factors affecting the cost performance of public construction projects have been discussed.

Public procurement is an influential factor in the national economy and an important function of government. All public sector organizations operate to serve the public at large, whereas the private sector aims at profit or return on investment. Most public sector

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projects are over budget to the concern of management; hence, this study was felt necessary. Public construction means construction activity by government or its entity.

Earlier studies were either for the private sector or they have considered mixed projects. In the present study, we have taken only public sector projects and respondents are also public sector officers. As public procurements are based on rules and regulations, to some extent they are country specific.

Poor cost performance has been reported as major problems globally (Zarina et al. 2014; Chen et al. 2016; Suk et al. 2016). However, the problem is very severe in developing countries where cost overruns sometimes exceed 100% of the anticipated cost (Olatunji 2008). Like other developing countries, Ethiopia is also facing a serious problem of cost performance in the construction industry (Becker & Demissie 2006; Mustefa 2015). For instance, Dessa (2010) in his study examined the performance of 15 completed public construction projects in different regions of Ethiopia and found that the cost increases in most projects are greater than 80% of their contractual sum.

There are many attributes that affect the performance of cost either positively or negatively. Hence, identification of these attributes and their impact on project performance is the aim of this research.

Thus, the objectives set for the study are as follows:

- To identify the relative importance of success and failure attributes for cost performance in the Ethiopian construction industry.
- To understand the latent properties of these success and failure attributes by studying the critical success and failure factors for improving the cost performance.

In the present study, the success of public construction project is measured in terms of its performance on cost. There are many attributes that affect the cost performance either positively or negatively. In the following section, the literature on project performance attributes are reviewed

Literature review

The premise that 'project success is repeatable and it is possible to find certain success attributes' has been the genesis of many research works in this area (Ashley et al. 1987). In the literature, several researchers identified, explained and discussed the factors that are critical to the success of a project. By 1982, Rockart used the word 'critical success factors (CSFs)' for the few key areas of activity in which favourable results are absolutely necessary for a particular manager to reach his or her goals (1982). Further, Boynton and Zmud (1986) defined CSFs as those few things that must go well to ensure success for a manager or an organization, and therefore, they represent those managerial or enterprise areas that must be given special and continual attention to bring about high performance.

Chua et al. (1997) applied the neural network technique on data from 75 construction projects for determining CSFs for budget performance. They found eight CSFs namely: the number of organizational levels between project manager and labourers, project manager experience on similar technical scope, detailed design complete at start of construction, constructability programme, project team turnover rate, frequency of control meetings during construction, frequency of budget updates and control system budget. In the study, field data on project performance have been used to build the budget performance model. This approach allows the model to be built even if the functional interrelationships between input factors and output performance cannot be clearly defined.

Iyer and Jha (2005) identified six CSFs: project manager's competence, top management support, project manager's coordinating and leadership skill, monitoring and feedback by the participants, coordination among project participants and owner's competence. They also identified the seven critical failure factors: conflict among project participants, ignorance and lack of knowledge, presence of poor project specific attributes and nonexistence of cooperation, hostile socio-economic and climatic condition, reluctance in timely decision-making, aggressive competition at tender stage and short bid preparation time.

Nguyen and Chileshe (2013) conducted a research study on the critical failure factors of construction projects in Vietnam. They identified 10 critical failure factors responsible for the failure of construction projects in Vietnam. They were: disregard of the significance of the project planning process and project planning, lack of experience in executing a complicated project, poor design capacity and frequent design changes, lack of knowledge and ability in managing construction projects, lack of financial capacity of owner, poor performance of contractors, lack of a systematic approach to managing the project and entire organization, corruption and bribery in construction projects, the delays in payment, and economic volatility and high inflation.

Ikediashi et al. (2014) used a quantitative questionnaire survey to analyse project failure factors for infrastructure projects in Saudi Arabia. The findings of their study revealed poor risk management, budget overruns, poor communication management, schedule delays and

poor estimation practices as the top five critical failure factors.

According to studies conducted by Memon et al. (2013) and Rahman et al. (2013), money (finance) related factors and contractors' site management related factors were found to be critical factors affecting the cost performance of the Malaysian construction industry.

According to Gudiene et al. (2014), clear and realistic project goals, project planning, the project manager's competence, relevant past experience of the project management/team, the competence of the project management/team, clear and precise goals/objectives of the client, the project's value, the project's complexity and uniqueness, the project manager's experience and the client's ability to make timely decisions are the top-ranking CSFs for construction projects in Lithuania.

From a detailed literature review, it was found that most of the studies on construction project performances have been made in the context of the developed world and only few studies were conducted pertaining to public construction projects in African countries. Hence, their findings may not be relevant to developing countries. Ethiopia is not yet a developed country and its project performance has not been encouraging. Therefore, it will be a good idea to compare and discuss the result by taking similar attributes with other countries.

Research method

The focus of this research is to identify and evaluate the success and failure attributes for the cost performance of public sector construction projects. This involves a literature review to capture the existing body of knowledge about project performance attributes. Then, a questionnaire-based survey was conducted to elicit the views of experienced public sector professionals on these attributes. Using univariate and multivariate data analyses, significant attributes were identified, and these attributes were grouped into several factors through factor analysis. Finally, regression analysis was conducted to identify the critical factors. The steps involved are briefly explained below.

Step 1: identification of attributes affecting project performance

Earlier research studies on success and failure factors include the perception of respondents from either the private sector or both private and public sector uniformly. However, the existence of differences in perceptions about the relative importance of success factors between the private and public sectors has been reported (Divakar & Subramanian 2009; Yang et al. 2010). Hence, the uniformity of respondents (employees of the public sector), which is considered in the present study, rather than a diversity of respondents involved in projects, is very important. In this context, a study of attributes responsible for the success/failure of Ethiopian public construction projects has been carried out.

As it is very difficult to obtain documented data on completed projects for study in Ethiopia, a questionnaire survey approach is considered to find out the impacts of various attributes on project cost performance. For this purpose, the project performance attributes were collected from the literature including leading journals and project management textbooks. A list of 35 project performance attributes having a strong effect on the performance of projects was identified. These attributes were discussed with key construction professionals in Ethiopia. Taking the suggestion made by these professionals, necessary modifications were made to the list of attributes and then a questionnaire was prepared.

Due to the fragmented nature of the construction industry, the above-identified attributes cannot be considered exhaustive, but the list covers many different types of construction projects.

Step 2: development of questionnaire

The questionnaire was designed to assess the impact of the identified 35 project performance attributes on cost. The first part of the questionnaire deals with the personal details and professional experiences of the respondents. These questions are asked to ensure that only respondents with adequate experience and expertise respond. It was decided in advance that if any respondent had less than five years' experience, his or her response might not be considered for analysis. Details pertaining to the project were sought in the second part of the questionnaire using questions like name and location of the project, cost of the project, involvement of the respondents. Respondents were also asked to rate the cost performance of the project mentioned by the respondent on a scale of 1–5 in which 1 = over budget by >10%, 2 = over budget by ≤10%, 3 = on budget, 4 = under budget by ≤10%, 5 = under budget by >10%. The third part of the questionnaire seeks a response on the impact of the 35 project attributes on project cost performance. A 5-point scale has been used for measuring the attributes' influence on cost in which '1' refers to 'adversely affecting the cost of the project', '2' refers to 'significantly affecting the cost of the project', '3' refers to 'marginally affecting the cost of the project', '4' refers to 'no effect on the cost of the project' and '5' refers to 'helps bring savings to the cost of the project' (Iyer & Jha 2005).

Step 3: selection of respondents

Target respondents were engineers involved in public sector projects. A list of completed public construction projects was developed on the basis of information obtained from different government offices responsible for public construction works. A total of 407 questionnaires were distributed to respondents selected randomly from the list available from these offices. A total of 200 responses were received. The respondents have a wide range of experience and the average experience of the respondents is calculated to be 17 years. The response rate is approximately 49.1%. The responses were analysed using the SPSS software (version 20).

Step 4: data analysis method

The statistical tests used in this study included both univariate and multivariate analysis techniques. Mahalanobis D^2 (d-squared) was used to find the outliers from the data. Analysis of variance (ANOVA), mean, median, standard deviation and frequency were used to find out summary statistics of responses. Reliability assessment (internal consistency through Cronbach's alpha coefficient) and factor analysis (Bartlett test of sphericity, Kaiser–Meyer–Olkin (KMO) test, principal component analysis (PCA) with varimax rotation) were carried out to determine success and failure factors. Multiple regression analysis has been conducted to the factors obtained by factor analysis to determine the most important factors.

In the present study, factor analysis is performed separately on a group of 14 success attributes and 15 failure attributes. Factor analysis is a method of quantitative multivariate analysis with the main aim of representing the interrelationships between a set of continuously measured variables (usually represented by their interrelationships) by a number of underlying linearly independent reference variables called factors (Hardcastle et al. 2005).

Many researchers from other areas including politics, sociology, economics, human–machine system, accident research, taxonomy, biology, medicine and geology have also applied this technique (Child 1990). In the construction industry for instance, Enshassi and Al.Swaity (2015) used factor analysis technique to explore key stressors leading to construction professionals' stress in the Gaza Strip, K'Akumu et al. (2013) employed factor analysis technique to identify five principal components that influence the market environment for artisanal dimension stone in Nairobi and Fox and Skitmore (2007) also applied this technique to identify a set of eight key factors associated with construction industry development.

Results/findings

Identification of significant project performance attributes

The authors found nine outliers in the data samples. Analyses were performed with and without these outliers and the results obtained were compared to determine whether the results are more representative and on expected line with or without the outliers. At the end, it was decided not to include these outliers for further analysis.

The effectiveness of attributes is calculated for the projects based upon cost performance criteria for successful and failed projects. These are ranked 'on budget' and 'under budget 'for the successful projects, while for failed projects, these are ranked 'over budget'.

Mean responses of the attributes can be considered as the indicators of effectiveness of the attributes. Depending upon the mean scores of responses for various attributes, the attributes were then divided into three groups: if the mean score of responses for any attribute is significantly $\geq$4.5, that attribute contributes positively to the success of the project and it is named as 'success attribute' (Group-1), and conversely, if the mean score is significantly $\leq$3.5, then it causes negative impact and is named a 'failure attribute' (Group-3). However, an attribute with mean score falling between 3.5 and 4.5 can be considered as neutral (Group-2) as it would neither have a positive nor negative impact. It was decided to drop the project attributes of the Group-2 (with $4.5 < \mu < 3.5$).

The attributes of the first group (with $\mu \geq 4.5$) were arranged in descending order of μ (mean) values and ranked. The highest μ (mean) value indicates the most critical success attributes with rank 1 and the next indicating the next most critical success attribute with rank 2 and so on. On the other hand, attributes of the third group (with $\mu \leq 3.5$) were arranged in ascending order of μ (mean) values and ranked. The lowest μ (mean) value indicates the most critical failure attribute with rank 1, the next indicating the next most critical failure attribute rank 2 and so on.

As is shown in Table 1, a total of 14 attributes emerged as success attributes ($\mu \geq 4.5$) and 15 attributes as failure attributes ($\mu \leq 3.5$) while six attributes remained neutral ($3.5 < \mu < 4.5$). Neutral attributes falling in the group $3.5 < \mu < 4.5$ were discarded as mentioned earlier.

Success attributes

The rank order of the success attributes in cost performance criteria (Table 1) suggests that no major changes in the scope of work during construction ($\mu = 4.78$),

Table 1. Rank of success attributes ($\mu \geq 4.5$) and failure attributes ($\mu \leq 3.5$) based on performance criteria.

Sl. no.	Project success attributes	Mean	SD	Rank	Sl. no.	Project failure attributes	Mean	SD	Rank
1	No major changes in the scope of work during construction.	4.78	0.56	1	1	Inadequate project formulation in the beginning.	1.66	0.85	1
2	Project manager with similar project experience.	4.69	0.54	2	2	Conflicts between Project manager and top management.	1.80	0.99	2
3	Thorough understanding of scope of work by project manager.	4.65	0.61	3	3	Reluctance in timely decision by top management.	1.93	0.82	3
4	Adequate communication among all project participants.	4.62	0.55	4	4	Poor human resource management.	2.14	0.70	4
5	Regular design and construction control meetings.	4.62	0.58	5	5	Uniqueness of the project activities requiring high technical know-how.	2.20	1.05	5
6	Utilization of up- to-date technology by contractor.	4.62	0.60	6	6	Reluctance in timely decision by project manager.	2.26	1.02	6
7	Owners need thoroughly understood and defined.	4.61	0.61	7	7	Tendency to pass on the blame to others.	2.33	0.97	7
8	Availability of resources (fund, machinery, materials, etc.) as planned throughout the project.	4.59	0.57	8	8	Conflict among team members.	2.35	0.76	8
9	Top management support.	4.55	0.54	9	9	Hostile social and economic environment.	2.47	0.93	9
10	Coordinating ability and rapport of project manager with his team members and sub-contractors.	4.53	0.62	10	10	Size and value of the project being large.	2.49	1.08	10
11	Regular monitoring and feedback by owner.	4.49	0.57	11	11	Conflict between project manager and sub-contractor.	2.51	0.80	11
12	Regular monitoring and feedback by top management.	4.49	0.60	12	12	Lack of understanding of operating procedure by the project manager.	2.53	0.91	12
13	Thorough pre-qualification for potential bidders.	4.45	0.58	13	13	Ignorance of appropriate planning tools and techniques by project manager.	2.53	1.11	13
14	Regular quality control and quality assurance activities.	4.45	0.68	14	14	Unfavourable climatic condition at the site.	2.57	1.00	14
					15	Holding key decisions in abeyance.	2.70	0.93	15

project manager with similar project experience ($\mu = 4.69$), thorough understanding of scope of work by project manager ($\mu = 4.65$), adequate communication among all project participants ($\mu = 4.62$) and regular design and construction control meetings ($\mu = 4.62$) have emerged to be the top five success attributes when cost criterion is of prime importance in gauging project performance.

If there is no change in the scope then the project may stay within the approved budget. De Furia (2008) has found that any scope change produces unwanted cost variance on the project. This indicates that if the scope is changed, it will affect the budget. The initial budget has to be modified to the requirement of the current project scope.

Previous experience of similar projects and thorough understanding of scope of work by the project manager have a positive impact on cost performance. Besides, communication difficulties or disruptions during the course of the project can directly lead to a sharp increase in the volume of unnecessary expenditure, which results in cost overrun and also affects the progress of the project (Anumba & Evbuowan 1999). Therefore, adequate communication among all project participants is essential to the success of construction projects (Tam 1999). Otim et al. (2012) in their study were able to identify that regular design and construction control meetings are one of the cost control techniques used on building construction sites in Uganda that will enable projects to be completed as budgeted.

Failure attributes

The rank order of the failure attributes in cost performance criteria (Table 1) suggests that inadequate project formulation in the beginning ($\mu = 1.66$), conflicts between project manager and top management ($\mu = 1.80$), reluctance in timely decision-making by top management ($\mu = 1.93$), poor human resource management ($\mu = 2.14$) and uniqueness of the project activities requiring high technical know-how ($\mu = 2.20$) have emerged to be the top five failure attributes when cost criteria are of prime importance in gauging project performance.

Reviewing public sector construction projects in Nigeria, Dlakwa and Culpin (1990) found that inadequate project formulation in the beginning is one of the three main reasons for cost overruns. Chitkara (2011) also identified inadequate project formulation in the beginning as the main cause of cost overruns in projects.

Conflict seems to be synonymous with construction projects and it is found to be one of the causes of increasing project cost. According to Cheung and Suen (2002), if conflicts are not properly managed, they may cause project delays and increase project costs. Therefore, the top management must devise a means to avoid conflict by creating a suitable environment to build up a team spirit among project participants. This is because, the achievement of success in cost performance is a team effort, and if the team members are not working in unison this leads to adverse effects on the performance of a construction project.

According to Chitkara (2011), reluctance in timely decision-making by top management causes management failure in construction project. This may be the cause for the poor cost performance of projects.

Human resources are a fundamental requirement for any projects as construction projects are labour intensive. This still accounts for the majority of costs in most construction projects (Loosemore et al. 2003). In recent years, there has been a widespread realization that improvement of human resources management performance is a critical element to achieving cost effectiveness in the construction industry (Du et al. 2007). Hence, poor human resource management may lead to poor cost performance. Furthermore, the uniqueness of the project activities may require participants to consume some initial time to become familiar with the project. This may result in loss of efficiency in the beginning that may have a negative impact on cost performance.

Success and failure factors

To ensure the suitability and reliability of the data for factor analysis, an adequate sample size was needed. According to Arrindell and van der Ende (1985), sample size should not be less than 100 even though the number of variables is less than 20 and the subjects-to-variables ratio should be no lower than 5 (Gorsuch 1983).

In this research, the ratio of respondents to variables for success and failure attributes is found to be 10.1 and 11.6, respectively, which is greater than 5 and exceeds the threshold for the minimum number of respondents (100). Cronbach's alpha (α) tests were performed to evaluate sample reliability (internal consistencies). The Cronbach's alpha of 0.755 for success attributes and 0.764 for failure attributes suggest that the overall sample reliability (internal consistency) was acceptable for factor analysis (Pallant 2001; Fellows & Liu 2008).

The data were also assessed for suitability for factor analysis using the KMO measure of sampling adequacy and also Bartlett's test of sphericity. The KMO measure of sampling adequacy, a popular diagnostic measure, tests whether the partial correlations among variables are small. It is a measure of homogeneity of variables (Sharma 1996). A higher value of KMO is desired. Bartlett's test of sphericity tests whether the correlation matrix is an identity matrix, which would indicate that the factor model is inappropriate.

It is generally recommended that the KMO value should be greater than 0.5 if the sample size is adequate (Gorsuch 1983; Field 2005). As shown in Table 2, the KMO values for success and failure attributes were 0.680 and 0.775, respectively, and were considered appropriate for use in factor analysis. The Bartlett's test for success and failure attributes were 310.390 and 882.206, respectively, and the associated significance level (sig. value) were <0.001, indicating that the population correlation matrix was not an identity matrix.

Table 2. KMO and Bartlett's test of success and failure attributes.

Parameter description	For success attributes	For failure attributes
KMO measure of sampling adequacy	0.680	0.775
Bartlett's test of sphericity		
Approx. chi-square	310.390	882.206
degrees of freedom (df)	91	105
Sig.	0.000	0.000

In order to facilitate interpretation of factor loadings, an oblique rotation of the reference axes, called varimax rotation, was performed and the derived factors and their corresponding loadings were obtained (Hair et al. 1998).

In this study, a total of seven success and six failure factors with Eigen values greater than 1 were extracted. Names were assigned to these factors. The factors with their names representing their common and latent properties, the variance explained by each of them and the factor loadings of various attributes appearing in each factor are summarized in Tables 3 and 4. Factor loadings <0.5 are suppressed in the analysis and those having loading values ≥ 0.5 are only taken for interpretations.

Table 3. Factor profile of project success attributes for cost as performance criteria.

Factor structure	Loading	Variance explained
Project manager's competence		16.53%
Regular design and construction control meetings	0.825	
Project manager with similar project experience	0.769	
Utilization of up-to-date technology by contractor	0.657	
Availability of resources (fund, machinery, materials, etc.) as planned throughout the project	0.540	
Scope clarity		10.91%
No major changes in the scope of work during construction	0.826	
Thorough understanding of scope of work by project manager	0.805	
Owner's competency		10.12%
Thorough pre-qualification for potential bidders	0.866	
Owners need thoroughly understood and defined	0.630	
Monitoring and feedback		9.85%
Regular monitoring and feedback by top management	0.847	
Regular monitoring and feedback by owner	0.729	
Coordination and communication among project participants		9.56%
Coordinating ability and rapport of project manager with his team members and sub-contractors	0.790	
Adequate communication among all project participants	0.586	
Top management support		7.89%
Top management support	0.940	
Quality control and assurance		7.80%
Regular quality control and quality assurance activities	0.883	
Cumulative variance explained		72.66%

Table 4. Factor profile of project failure attributes for cost as performance criteria.

Factor structure	Loading	Variance explained
Conflict among project participants		18.06%
Conflicts between project manager and top management	0.769	
Conflict between project manager and sub-contractor	0.762	
Tendency to pass on the blame to others	0.715	
Conflict among team members	0.688	
Project specific factors		13.83%
Size and value of the project being large	0.973	
Uniqueness of the project activities requiring high technical know-how	0.957	
Indecisiveness of project participant		10.83%
Reluctance in timely decision by top management	0.862	
Holding key decisions in abeyance	0.797	
Project manager's ignorance and lack of knowledge		10.40%
Ignorance of appropriate planning tools and techniques by project manager	0.832	
Lack of understanding of operating procedure by the project manager	0.752	
Socio-economic and climatic condition		8.85%
Unfavourable climatic condition at the site	0.819	
Hostile social and economic environment	0.599	
Owner's incompetence		8.10%
Inadequate project formulation in the beginning	0.895	
Cumulative variance explained		70.10%

Success factors

The description of success factors is given in the following sections:

(1) Project manager's competence

All attributes of the first factor indicate project manager's competence as their common property. The factor explains a variance of 16.53%. The attributes are regular design and construction control meetings, project manager with similar project experience, utilization of up-to-date technology by contractor and availability of resources (funds, machinery, materials, etc.) as planned throughout the project. According to Iyer and Jha (2005), project manager's competence has a significant effect on project cost performance.

(2) Scope clarity

Two attributes have emerged under this factor accounting for a variance of 10.91%. This comprises: no major changes in the scope of work during construction, and thorough understanding of scope of work by project manager. Completion of any project within the estimated cost of the project is the basic criterion for the success of any project. Moreover, controlling and managing scope change are critical to the success of any project, as scope changes can significantly impact the cost of the project. According to Nguyen (2010), controlling project scope includes understanding the root-cause of changes to the project scope, identifying a tendency of changes and the risks associated with them and preventing unnecessary changes to the project scope.

A thorough understanding of the scope of the work by the project manager is a critical factor for the success of public projects. In the case where the project manager starts the project without understanding the scope of work (i.e. knowing what he/she is supposed to be delivering at the end to the client and what the boundaries of the project are), he/she actually does not have any chance of succeeding with this disorganized approach.

(3) Owner's competency

Two attributes have emerged under this factor accounting for a variance of 10.12%. This comprises thorough pre-qualification for potential bidders and owners need thoroughly understood and defined. The purpose of pre-qualification is to include only those bidders that appear to be capable of carrying out the project in an adequate manner. Thorough pre-qualification for potential bidders and thoroughly understanding and defining the needs are some of the characteristics of a competent owner. It justifies grouping these attributes in this factor.

(4) Monitoring and feedback

Two attributes have emerged under this factor accounting for a variance of 9.85%. This factor has attributes mainly focusing on monitoring and feedback. Most of the literature on the success of construction projects have identified these attributes as a key factor responsible for the success of many projects (Wang 2000; Iyer & Jha 2005).

(5) Coordination and communication among project participants

This factor has two attributes accounting for 9.56% of variance. Communication involves effective working relationships among all project participants and it allows them to understand the requirements of the owner and enables all the workers to participate in their expertise which is essential for successful cost performance. The coordinating ability of the project manager with his or her team members and sub-contractors is a great asset in such conditions. Short and informal lines of communication among project team members support achievement of desired cost performance.

(6) Top management support

Only one attribute has emerged under this factor accounting for a variance of 7.89%. This attribute is 'top management support'. Willingness of top management to provide the necessary resources and authority/power for project success has a positive impact on cost performance.

(7) Quality control and assurance

This factor with one attribute alone explains a variance of 8.49%. The attribute is 'regular quality control and quality assurance activities'. Poor quality means more product failure. Therefore, developing and applying proper quality control and quality assurance programmes in the project will reduce the cost incurred due to product failure.

Failure factors

The description of failure factors is given in the following sections:

(1) Conflict among project participants

Four attributes have emerged under this factor accounting for a variance of 18.06%, the highest of all factors. This comprises conflicts between project manager and top management, conflict between project manager and sub-contractor, conflict among team members and tendency to pass on the blame to others. The top management must devise suitable means to avoid conflict among participants.

(2) Project specific factor

The attributes having high loading in this factor are size and value of the project being large, and uniqueness of the project activities requiring high technical know-how. The research conducted by Shrestha et al. (2013) revealed that as the size and value of the project increase, the cost overrun also increases. The uniqueness of the project activities may require participants to consume some initial time becoming familiar with the project. This may result in loss of efficiency in the beginning that may have a negative impact on the cost of the project (Iyer & Jha 2006). This factor explains a variance of 13.83%.

(3) Indecisiveness of project participant

Two attributes have emerged under this factor accounting for a variance of 10.83%. This comprises: reluctance in timely decision by top management, and holding key decisions in abeyance. Indecisiveness in taking day-to-day decisions as well as holding back key decisions has a negative impact on cost performance. Therefore, top management and the project manager need to make effective and timely decisions regarding any issue that might arise during the course of the project.

(4) Project manager's ignorance and lack of knowledge

This factor accounts for 10.40% of variance explained. The attributes having high loading in this factor are: ignorance of appropriate planning tools and techniques by the project manager and lack of understanding of operating procedures by the project manager. According to Omran and Mamat (2011), ignorance and lack of knowledge in managing a project by the project manager is identified as one of the most important failure factors that affect cost performance.

(5) Socio-economic and climatic condition

Attributes of this factor include: unfavourable climatic condition at the site and hostile social and economic environment. Iyer and Jha (2005) identified socio-economic and climatic condition as one of those factors having significant influence on cost performance. Both attributes under this factor have a negative impact on the efficiency and productivity of the work force and thus impact the cost performance. This factor explains 8.85% of variance.

(6) Owner's incompetence

This factor with one attribute alone explains a variance of 8.10%. The attribute is inadequate project formulation in the beginning. An incompetent owner will go ahead with the project even with an inadequately formulated project which may result in an unsuccessful outcome as far as cost is concerned.

Critical success and failure factors

As mentioned earlier, factor analysis has been used to transform 30 success and failure attributes into a few success and failure factors. To explore the relative importance of these factors in impacting cost performance, multiple regression analysis has been applied.

The general purpose of a multiple regression is to learn about the relationship among several factors (known as independent variables or explanatory

Table 5. Stepwise multiple regression results for success factors.

Independent variables	*B*	σ	*b*	*t* Value	*p* Value
Dependent variable: Cost; $R^2 = 0.11$, adjusted $R^2 = 0.10$					
Constant	4.44	0.05	NA	89.50	0.00
Factor 2. Scope clarity	0.16	0.05	0.26	3.28	0.00
Factor 1. Project manager's competence	0.12	0.05	0.20	2.49	0.01

Table 6. Stepwise multiple regression results for failure factors.

Independent variables	*B*	σ	*b*	*t* Value	*p* Value
Dependent variable: Cost; $R^2 = 0.22$, adjusted $R^2 = 0.21$					
Constant	1.66	0.03	NA	51.65	0.00
Factor 1. Conflict among project participants	−0.20	0.03	−0.41	−6.07	0.00
Factor 4. Project manager's ignorance and lack of knowledge	−0.11	0.03	−0.24	−3.49	0.00

variables) and another factor (known as the dependent variable or response variable). The regression model takes the form of the following equation:

$$Y = a_0 + a_1X_1 + a_2X_2 + a_3X_3 + \ldots + a_nX_n + e \quad (1)$$

where Y is the dependent variable, X_i $(i = 1, 2 \ldots n)$ are the independent variables, a_i $(i = 0, 1 \ldots n)$ are the parameters to be estimated and e is the error term.

This study uses the responses on cost performance of the project as dependent variable and factors found from factor analysis as independent variables.

Critical success factor

Table 5 shows the stepwise multiple regression results, when 'cost performance' is treated as dependent variable and the seven success factors discussed above as independent variables.

In this case, 'scope clarity' (Factor 2) and 'project manager's competence' (Factor 1) were found to be significant at $p < 0.05$ for cost performance for public projects. These factors are the most important when the objective is cost performance.

For the success of public projects, the project manager must have a thorough understanding of scope, which is only possible when the scope itself is clearly articulated. Major changes during construction should also be avoided as it disturbs project planning resulting in extensive delays and cost overruns like the Sydney Opera House that was delivered 10 years later than originally planned at a cost overrun of 1400% (Flyvbjerg 2014). According to Nguyen et al. (2004), a competent project manager is found to be one of the CSFs for project success in large construction projects in Vietnam.

Critical failure factor

Table 6 shows the stepwise multiple regression results, when 'cost performance' is treated as dependent variable and the six failure factors as independent variables. 'Conflict among project participants' (Factor 1), and 'project manager's ignorance and lack of knowledge' (Factor 4) were found to be significant at $p < 0.05$ for cost performance of public construction projects.

The cause of conflict in team projects can be related to differences in values, attitudes, needs, expectations, perceptions, etc. Project managers must identify, analyse and evaluate negative values of conflict and their effect on cost performance. According to a study of 50 Indian construction firms, Iyer and Jha (2005) found that respondents ranked conflict among project participants as the highest factor affecting project cost. Besides, ignorance and lack of knowledge of the required effort to achieve cost performance by the project manager results in an unnecessary wastage of money that causes cost overrun for the project.

Discussion

Cost overrun is a pertinent issue in the construction industry, which needs serious attention to improve a project's cost performance as the overrun is an additional burden to all parties involved in the project.

The findings of studies on the performances of public construction projects suggest that most of the public funded projects across the globe suffered from the phenomenon of cost overrun. The study of Flyvbjerg et al. (2002, 2004) covered 23 countries across five continents and found that infrastructure projects often suffer from cost overruns. Therefore, for the successful delivery of the project without any cost overrun, it is necessary to investigate the various causes of cost overrun, and for the various causes, preventive measures are to be implemented to avoid cost overrun.

This study identified the critical factors affecting the cost performance of public construction projects in Ethiopia. The stepwise multiple regression analysis results indicated that Factor 2 (scope clarity) and Factor 1 (project manager's competence) can significantly contribute to the cost performance of Ethiopian public construction project while the remaining two factors – conflict among project participants, and project manager's ignorance and lack of knowledge – are found to be detrimental to the cost performance of Ethiopian public construction projects.

Previous studies show scope changes have a significant impact on the cost of projects (Bolin 2015; Rathi & Khandve 2016). Chick (1999) showed that the later a change occurs in a project the more effect it will have on the project's cost. Chester and Hendrickson (2005) conducted a study on quantifying the costs and time

overruns of a project due to changes in the scope of work during construction and they have found a 4% increase in cost to the total cost of a project. Clear articulation of work during pre-project planning helps in developing a thorough understanding of the scope of work by the project manager and also results in no major changes during construction. Andersen et al. (2006) observed that a well-understood project improves the managerial ability to deliver results in cost which is possible if the project manager understands the scope clearly.

A competent project manager possesses the capability to ensure that the project is completed within budget and on schedule. One of the methods to ensure this is to conduct regular design and construction control meetings which is the primary method of controlling and reviewing progress and also provides the opportunity for all parties involved to sit down, together, and discuss every design and construction related issue. The previous experience of a project manager on similar projects also makes him or her competent.

It is not enough to possess the skills mentioned earlier unless the project manager is able to ensure the availability of various resources necessary for the project. This is because the success of any project is highly dependent on adequate availability of various resources (Babu 2015). Hence, prior and adequate arrangement for resources (funds, machinery, materials, etc.) as planned throughout the project is required at each stage of construction. Project resources provide the means for accomplishing the work objectives (Padilla & Carr 1991).

Various problems such as delay in the completion date of critical activities may crop up due to the unavailability of resources and this may give rise to project time overrun and cost overrun. Therefore, availability of adequate resources at each stage of construction, which is ensured by using proper construction resources management, has a significant impact on project cost performance (Meeampol & Ogunlana 2006). Further, the project manager should ask the contractor to use up-to-date technology whenever necessary. Another factor that affects the performance of the project is conflict among project participants. Conflict is a serious disagreement between parties due to various reasons, for example: payment, communication, public interruption, etc. It can give rise to problems including project cost overrun and project delay. The study conducted by Jaffar et al. (2012) revealed that conflict among project participants is one of the top five causes that increase project cost.

It is obvious that ignoring the conflicts at the initial stages leads to major disputes at a later date and it further adds to the cost overrun, sometimes even leading to court proceedings. A project manager's ignorance and lack of knowledge also affects the performance of the project. The study by Omran and Mamat (2011) identified the project manager's ignorance and lack of knowledge as one of the failure factors that affect cost performance in construction projects.

As with any other opinion-based study, the present study also has some limitations. The majority of respondents have evaluated the projects in their execution stage only and very few have evaluated the performance of projects in the planning and operation stages. Moreover, the study was carried out only in the Ethiopian context. Hence, the study has a limitation in these regards.

In this study, the importance of understanding the impact of various factors on project performance has been emphasized.

Conclusion

Using factor analysis, the study identified seven success and six failure factors. Furthermore, multiple regression analysis revealed that scope clarity, project manager's competence, conflict among project participants and project manager's ignorance and lack of knowledge are critical factors affecting cost performance of Ethiopian public construction projects.

Our research indicates that people's competence at all levels plays a significant role in overall public construction project cost performance. Developing countries should target their investments in education and training at the best programmes aimed at producing professionals, technicians and skilled people suited to deliver the best possible public construction projects in the context of the country. Further, foreign consultancy firms in Ethiopia should also offer effective training programmes at appropriate intervals to project participants in order to produce competent people in the sector and thereby help to enhance the domestic capability.

The results of this study are expected to help researchers and industry practitioners to focus on a few factors in order to take proactive measures and achieve the optimum results in the cost performance of public construction projects.

The present study has identified and evaluated the determinants affecting the cost of public construction projects in Ethiopia. The determinants will play a vital role in the construction industry especially in new projects and may help in eliminating/reducing failure factors and bringing in success factors with regard to the cost of a project. This may ultimately lead to projects being completed within the stipulated budget.

The implications of this study are not limited to researchers and construction industry practitioners alone. The Ethiopian government could adopt the results of this study to reduce/avoid additional costs incurred

due to the poor cost performance of public construction projects that result in poor utilization and increased social and economic costs. Furthermore, the study may also help government efforts to enhance efficiency and effectiveness in the use of public funds on construction projects which is an on-going concern of government and of the international development community.

A series of in-depth case studies on various public construction projects should be launched in the future to verify the applicability and reliability of the critical factors (success/failure) identified in this study. While the data on which these findings are based are specific to Ethiopia, the results generally agree with earlier studies in developed countries.

Disclosure statement

No potential conflict of interest was reported by the authors.

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