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The impact of contractors' attributes on construction project success: A post construction evaluation

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Abstract

The success of construction projects is a fundamental issue for most governments, users and communities. In the literature that deals with construction project success and causes of time and cost overruns in the construction industry, there is some literature that highlights the role of the contractors in project success. While most studies rank contractors' success attribute from tendering, prequalification, and a long term historical perception perspective, this paper aims to study the impact of contractors' attributes on project success from a post construction evaluation perspective to identify what critical success factors (CSFs) that greatly impact the success of project. In an attempt to understand and investigate this impact, a questionnaire survey is used to establish construction professionals' perception of CSFs of contractors that greatly impact on the success of construction projects. Factor analysis reveals nine underlying clusters namely :(i) safety and quality; (ii) past performance; (iii) environment; (iv) management and technical aspects; (v) resource; (vi) organisation; (vii) experience; (viii) size/type of pervious projects; and (ix) finance. Logistic regression techniques were used to develop models that predict the probability of project success. Factors such as turnover history, quality policy, adequacy of labour and plant resources, waste disposal, size of past projects completed, and company image are the most significant factors affecting projects success. Assuming that project success is repeatable, these findings provide clear understanding of contractors' performance and could potentially enhance existing knowledge of construction project success.

Keywords: Construction project success; Contractor selection; Project performance

1. Introduction

The construction industry is vital for the development of any nation and the physical development of construction projects such as buildings, roads, and bridges is the measure of their economic growth. According to Ye et al. (2009), the construction industry is one of the most significant industrial contributors to the European economy in terms of gross product and employment. As a result, the success of a construction project is a fundamental issue to most governments, users and communities.

In modern construction projects there are significant challenges for both clients and contractors to deliver the project successfully due to increasing complexity in design and the involvement of a multitude of stakeholders (Doloi, 2009).

In addition to the above stated complexity of construction projects, defining project success itself is a complex issue (Lam et al., 2008; Toor and Ogunlana, 2010; Wang and Huang, 2006).

Chan and Chan (2004) reported that the concept of project success is developed to set criteria and standards to aid project participants to complete projects with the most desirable outcomes.

However, this concept remains somewhat of an enigma as there is no agreement on what should be the critical success criteria on construction projects despite several studies (Ahadzie et al., 2008).

The iron triangle (on time, under budget, according to specifications) has been the widely accepted criteria for project success during the last couple of decades. However, Toor and Ogunlana (2010) reported that the same old-fashioned performance

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criteria can no more be the sole determinant of project success due to change in demands of users, evolving environmental regulations, and shifting functions of buildings.

Pinto and Covin (1989) pointed out that many of the reasons behind project success can be found in the existence, or lack, of several CSFs. In addition, Belassi and Tukel (1996) asserted that of prime importance in determining project success or failure is the existence of groups of success factors and their interactions. Furthermore, post construction evaluation to identify what went right and what went wrong proved to be a valuable exercise in construction projects (Wite, 1988).

There are many factors that contribute to project success. Construction projects and their success are highly dependent on contractors (Banki et al., 2009; Ng et al., 2009; Palaneeswaran and Kumaraswamy, 2001; Yaweli et al., 2005). Appointment of the right contractor will not only ensure the overall quality of the project but also offer the opportunity of saving on costs (Yaweli et al., 2005).

When the main contractors start their main duties, it impacts upon a project's success when the project reaches the construction or execution stage. During this lifecycle, the actual work of the project is accomplished. Therefore, this study aims to examine the impact of contractors' attributes on construction project success from a post construction perspective incorporating clients', consultants', and contractors' viewpoints. An attempt is made to capture the perception of construction project practitioners regarding the CSFs of contractors that greatly impact upon the success of projects, as they play the main role in project success. To achieve this goal, this research comprised two components: a comprehensive literature review and survey questionnaire.

The structure of this paper is as follows. First, we review project success and its definition within the construction industry. This is followed by introducing the concept of CSFs in construction projects. Then, the contractors' success criteria in the construction project are reviewed including a set of success criteria and CSFs identified from the literature review for this study. Thereafter, we introduce the approach and methodology adapted for this paper. Subsequent sections then present data analysis and model development as well as discussion of the findings. The final section concludes the article, summarising the study objectives and the research's key results.

2. Project success

Project success has been widely discussed in the project management literature. Most studies in project success focus on dimensions such as how it is measured and other specific factors influencing project success. Project success means different thing to different people (Wang and Huang, 2006). Lam et al. (2008) reported that it is difficult to assess whether the performance of a project is a success or a failure due to the fact that the concept of success remains vague among project participants.

The conventional measures or the so-called iron triangle of time, cost, and quality has been the dominating performance indicator in construction projects (Toor and Ogunlana, 2010). Conversely, Collins and Baccarini (2004) note that there is more to project success than just meeting time, cost and quality objectives and the project management community need to be educated regarding this.

The concept of project success is developed to set criteria and standards to aid project participants to complete projects with the most desirable results (Chan and Chan, 2004). Traditionally, success is defined as the degree to which project goals and expectations are met (Chan et al., 2002). Ashley et al. (1987) referred to project success as having "results much better than expected or normally observed in terms of cost, schedule, quality, safety and participant satisfaction".

Tuman (1986) suggests a contrary definition of construction project success as "having everything turn out as hoped. Anticipating all project requirements and having sufficient resources to meet needs in a timely manner". Wite's (1988) view was that "The project is considered an overall success if the project meets the technical performance specifications and/or missions to be performed, and if there is a high level of satisfaction concerning the project outcome among: key people in the parent organization, key people in the project team, and key users or clientele of the project effort". Despite this controversy, this research follows the broad definition of project success as per Wite (1988).

One of the issues related to project success is at what point a project is considered to be successful or not (Ojiako et al., 2008). An additional issue for consideration is that performance measurement criteria vary from project to project (Toor and Ogunlana, 2010). Collins and Baccarini (2004) observed that it is important to differentiate between success criteria and CSFs.

Scholars make a distinction between project management success and project success when attempting to measure success as the two, although related, may be very different (Baccarini, 1999; Cooke-Davies, 2002; Wite, 1988). Pheng and Chuan (2006) pointed out that the successful accomplishment of cost, time, and quality objectives were regarded as project management success. Alternatively, project success deals with the final project objectives. In addition, Shenhar et al. (1997) mentioned that project management success is an internal measure of project efficiency while project success is concerned with a project's external effectiveness. Wite (1988) concludes that good project management can contribute towards project success but is unlikely to be able to prevent project failure. Contractors are often solely engaged in the process that produces the product and this study is aimed to investigate, in a post construction evaluation, the impact of objective and subjective success criteria of contractors on construction projects success, as they play the main role in project management success which can contribute towards project success.

3. Concept of CSFs

Numerous lists and models have been proposed in the literature regarding critical success factors. Belassi and Tukel (1996) reported that most of the work in project management since the 1950s has focused on project scheduling problems based on the assumption that the development of better scheduling techniques would result in better management and thus the successful completion of projects. They argue, however, that there are many factors outside the control of management that could determine the success or failure of a project and these factors are referred to as critical success/failure factors. Rockart (1982) defines the concept of CSFs as “the limited number of areas in which results, if they are satisfactory will ensure successful competitive performance for the organization”.

Pinto and Slevin (1987) reported fourteen CSFs commonly related to implementation success across a wide range of companies and project types. These success factors are project mission, top management support, project schedules, client consultation, personnel recruitment, technical tasks, client acceptance, monitoring and feedback, communication and trouble-shooting, characteristics of the project team leader, power and politics, environmental effects and urgency.

Sanvido et al. (1992) defined a set of factors that, when thoroughly and completely satisfied, ensure the successful completion of a facility. They tested seven factors (the facility team, the contract, facility experience, resources, product information, optimisation information, and performance information) that predicate success on sixteen projects.

A new scheme proposed by Belassi and Tukel (1996) describes the impact of critical success factors on project success and categorised them in to five main groups. These are factors relating to project, project manager, team members, organisation and external environment. Grouping factors in this scheme made it easier to identify whether the success or failure is related to the project, to the project manager or to external factors.

Chua et al. (1999) identified different sets of CSFs for different project objectives. Using analytical hierarchy processes, they identified sixty-seven project success factors relating to four project aspects: project characteristics, contractual agreement, project participants and interactive process. Success factors relating to contractors were addressed: capability of contractor key personnel, competency of contractor proposed team, contractor team turnover rate, contractor top management support, contractor track record and contractor level of service.

Cooke-Davies (2002) investigated data from 136 European projects that were executed between 1994 and 2000 by a total of 23 organisations and was able to identify 12 factors critical to project success. He categorised these 12 factors in to three major areas: project management success, individual project success, and corporate success.

4. Contractors’ success criteria in construction

Over the past few decades, numerous studies have highlighted success criteria and CSFs of contractors. These studies have been expanded by both the industrial and academic worlds. While these criteria and their influencing factors have been discussed from tendering, prequalification, and long term historical perception perspective, our approach in this paper is to investigate those criteria from an immediate post construction delivery perspective. The main target in doing so is to record lessons and to identify what CSFs that greatly impact the success of project before moving to the next one.

Russell et al. (1992) studied the industry evaluation of the perceived impacts of 20 decision factors and 67 sub-factors for contractor prequalification across 78 public owners, 72 private owners and 42 construction managers. Using Spearman Rank Correlation analysis, the three major criteria for making decisions across the owners in all three categories were: financial stability, experience and past performance.

In order to identify the most important and least important selection criteria from a list of the 20 most commonly used criteria, Hatush and Skitmore (1997) adopted the Delphi technique to interview six experts and two expert validators. The selection criteria were assessed against project success factors, time, cost and quality and the corresponding importance criteria were found. The criteria that were highlighted to be commonly important for all three success factors were financial status, financial stability, credit rating, experience, ability, management personnel and management knowledge.

In the Singaporean construction industry, Sing and Tiong (2006) studied 102 industry-based contractors’ selection criteria and their perceived importance among the practitioners. They analysed 128 questionnaire responses collected from quantity surveyors, developers, contractors and public and private clients. The findings of their research reported that a contractor’s experience in similar projects is one of the most important factors for ensuring a contractor’s success in projects. Qualification and experience level of project managers and other management staff and their track records of working capital were reported to be significant in assessing the capabilities of the candidate contractors.

Doloi (2009) used multiple regression analysis to study 43 influencing technical attributes in contractor selection and their links to project success objectives. The research reveals that technical expertise, past success, time in business, work methods and working capital significantly impact on contractor performance across time, cost and quality success objectives. Doloi et al. (2010) further used structural equation modelling technique to study 29 contractors’ qualification criteria and their links to contractors’ performance on a project. Based on the survey data collected across medium size construction projects in Australia, the results of the model showed that technical planning and controlling expertise of contractor is key in achieving success on projects.

Both works of Doloi were able to relate contractor success criteria to project success objectives. However, it remains unclear whether contractor success criteria where reported from an immediate post construction evaluation or from long term historical perception. The aim of this paper is to adapt logistic regression technique to investigate the impact of contractors attributes on project success from an immediate post construction perspective and links those attributes to project success objectives.

Based on the available literature and the above review, ten success attributes (criteria) and 35 influencing CSFs (shown in Table 1) were found, for this study, to be significantly and substantially related to contractors’ performance and to greatly impact on the overall success of projects. To this end, we refer to Lim and Mohamed (1999) where they agreed that criteria are a “principle or standard by which anything is or can be judged”; whereas a factor is “any circumstance, fact, or influence which contributes to a result". Hence, this paper is set to explore the success criteria and their success factors that influence those criteria to achieve project success. In light of this, the discussion in (part 7) could be viewed as identifying the success criteria, and more importantly the success factors that influence those criteria.

5. Research methodology

The approach undertaken for this research comprised two components, a literature review, discussed in the previous section, and a self-administered survey. The survey was phrased to ask the respondents to rate the impact of contractor CSFs on the success of construction projects.

The impact level is measured on a 5-point Likert scale, where 5 denotes strongly agree, 4 agree, 3 neutral, 2 disagree, and 1 strongly disagree. The respondents were required to answer the questions according to actual situations that they had experienced on projects they were working on or had recently completed.

The first part of the survey include some items for collecting background information of the respondents and their projects, such as the respondent's position, experience in the construction industry, type of firm/organisation, procurement type and main project type in the organisation. In the second part of the survey the respondent was asked to rate the impact of CSFs shown in Table 1 on the success of projects. The third part of the survey required participants to comment on the outcome of the completed project. Blank space was provided for the participant if they had their own suggested CSFs that had not been mentioned in the survey. A web based survey using the Survey Monkey website was also developed to increase the return rate.

A pilot study was undertaken to pre-test the survey and subsequently modified before a final version was produced. The survey population targeted client, consultant and contractor organisations involved mostly in infra-structure, residential and commercial projects in the UK. The survey was mailed out or hand delivered to 512 participants in January/April 2011.

One hundred and sixty four completed surveys were returned representing a 32% response rate. Online survey research became much easier and faster as a result of survey authoring, software packages and online survey services (Wright, 2005). The use of the Survey Monkey web-based survey software in this research saved on costs and time since it facilitated contact with many respondents in a short amount of time. The use of web-based survey in this study resulted in 38 responses (out of 164), representing 23%. Table 2 shows the breakdown of the three groups of survey respondents.

The valid dataset was then analysed using Statistical Package of Social Science SPSS version 19.0.

Table 1
Success attributes and critical success factors.

Number	Success attributes	Critical success factors (CSFs)
1	Financial attributes	Turn over history
		Credit history
		Bonding capacity
		Cash flow forecast
2	Management attributes	Staff qualification
		Management capability
		Site organisation
		Documentation
3	Technical attributes	Contractor's IT knowledge
		Knowledge of particular construction method
		Work programming
		Experience of technical personnel
4	Past experience attribute	Type of past project completed
		Size of past project completed
		Length of time in business
		Experience in the region
5	Past performance attributes	Failure to have completed a contract
		Contract time overruns
		Contract cost overruns
		Past record of conflict and disputes
6	Organization attributes	Size of the company
		Company image
		Age in business
		Litigation tendency
7	Environmental attributes	Waste disposal during construction
		Environmental plan during construction
		Materials and substances used in the project
8	Health and safety attributes	Health and safety records
		Occupational safety and health administration rate (OSHAIR)
		Experience modification rating (EMR)
9	Quality attributes	Quality control
		Quality policy
		Quality assurance
10	Resources attributes	Adequacy of labour resources
		Adequacy of plant resources

6. Data analysis and results

The main purpose of the factor analysis is to establish which of the variables could be measuring aspects of the same underlying dimensions (Field, 2005). Using SPSS 19.0, the survey opinions of the 35 CSFs were subjected to principal component analysis. Tables 3–4 and Fig. 1 present the results. The results of the analysis show that the Bartlett test of sphericity is 2283.362 and the associated significance level is 0.000 suggesting that the population correlation matrix is not an identity matrix (Table 3). The Kaiser–Meyer–Olkin measure of sampling adequacy is 0.708 (Table 3), which is considered good (Kaiser, 1974). The average communality of the variables after extraction was above 0.6. Cronbach's alpha of 0.865 suggested the reliability of the research instrument used was also acceptable (Table 3).

The principal component analysis generated nine components with eigenvalues greater than 1 explaining 64.6% of the variance (it should be noted that factor (component) 10 was dropped from the analysis as there is no common theme between variables). The

Table 2
Survey return rate.

	Client	Contractor	Consultant	Total
Sent	11	209	292	512
Response	3	84	77	164

Table 3
KMO and Bartlett's test.

Kaiser–Meyer–Olkin measure of sampling adequacy		0.708
Bartlett's test of sphericity	Approx. Chi-square	2283.362
	df	595
	Sig.	0.000
Cronbach's alpha		0.865

factor clustering based on varimax rotation is shown in Table 4. Only factors with loading exceeding 0.50 were selected to evaluate the factor patterns. It should be noted that the name of the factor (success attributes) shown in Table 1 will change according to the common themes resulted from varimax rotation. For full details of factor analysis and varimax rotation, the reader is referred to Field (2005). The meanings of the nine components are interpreted in the following section.

Table 4
Result of factor analysis.

Description of clusters	Factor loading	Variance explained
Cluster 1: Health, safety and quality		19.4
Quality policy	0.755	
Quality assurance	0.733	
Occupational safety and health administration rate (OSHAIR)	0.680	
Health and safety records	0.627	
Quality control	0.625	
Experience Modification Rating (EMR)	0.589	
Cluster 2: Past performance		9.2
Contract cost overruns	0.896	
Contract time overruns	0.916	
Past record of conflict and disputes	0.848	
Failure to have completed a contract	0.793	
Cluster 3: Environment		8.6
Waste disposal during construction	0.870	
Environmental plan during construction	0.879	
Materials and substances used in the project	0.828	
Cluster 4: Management and technical aspects		6.9
Management capability	0.605	
Site organisation	0.586	
Knowledge of particular construction method	0.755	
Work programming	0.727	
Cluster 5: Resources		4.8
Adequacy of labour resources	0.908	
Adequacy of plant resources	0.811	
Cluster 6: Organization		4.6
Size of the company	0.743	
Company image	0.645	
Age in business	0.659	
Cluster 7: Experience		3.9
Experience in the region	0.677	
Length of time in business	0.774	
Cluster 8: Size/type of pervious project		3.7
Type of past project completed	0.853	
Size of past project completed	0.897	
Cluster 9: Finance		3.5
Turnover history	0.650	
Credit history	0.857	
Cash flow forecast	0.694	

Cumulative variance explained=64.6%.

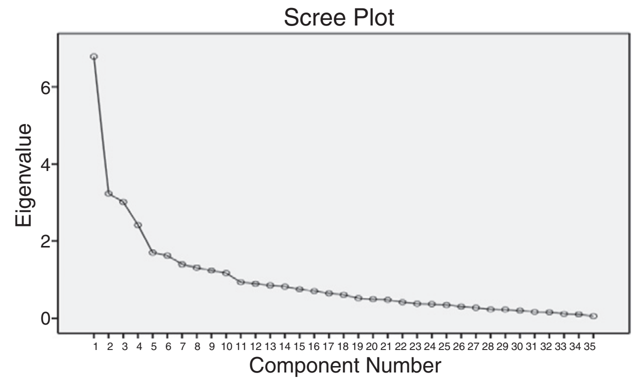

Fig. 1. Scree plot for factor analysis.

7. Discussion of factor analysis results

7.1. Health, safety and quality

This cluster explained 19.4% of the total variance as shown in Table 5. This component was represented by six variables namely: *health and safety records* (factor loading 0.627); *occupational safety and health administration incidence rate (OSHAIR)* (factor loading 0.680); *experience modification rate (EMR)* (factor loading 0.589); *quality control* (factor loading 0.625); *quality policy* (factor loading 0.755); and *quality assurance* (factor loading 0.733). Subsequently this component was named safety and quality.

Bubshait and Almohawis (1994) define health and safety as the degree to which the general conditions promote the completion of a project without major accidents or injuries. The measurement of safety is mainly focused on the construction period as most accidents occur during this stage. The safety issue has been raised and discussed for a long time (Kometa et al. 1995; Parfitt and Sanvido, 1993; Sanvido et al., 1992). Attalla et al. (2003) reported that quality and safety are two crucial aspects in the successful delivery of any project.

In terms of health and safety, the construction industry has long been known to lag behind other industries. It has the highest rate of accidents among all industries (Choudhry et al. 2008; Sawacha et al. 1999) and the risk of a fatality is five times more likely than in a manufacturing based industry (Ngowi, 1996). Ahmed et al. (1998) reported that variable hazards, a transient work force, harsh operative environments, and strenuous physical tasks contribute to poor safety performance in the construction industry. Accidents in construction may stop work in one area of the job, lower work morale, and thus productivity will decline (Alfeld, 1988). In addition to human cost, contractor profitability can be reduced due to machinery damage or material waste as a consequence of accidents in the construction industry.

The importance of all these three CSFs for successful project outcomes have been supported by the findings reported in Toor and Ogunlana (2010), Ahadzie et al. (2008), Collins and Baccarini (2004) where new emerging criteria other than cost and time have become an accepted part of project success frameworks.

Table 5
Logistic regression results.

Model	Predictor	B	S.E.	Wald	Sig	Model fit information			Goodness-of-fit:		Pseudo R-square	
						−2 Log likelihood	Chi-square	Sig.	Deviance chi-square	Sig.	Cox and Snell	Nagelkerke
Scheduling	*Adequacy of labour resources*	−1.284	0.494	6.756	0.009 [a]	267.451	50.885	0.007 [a]	267.451	1.000 [b]	0.312	0.345
	Adequacy of plant resources	1.016	0.429	5.615	.018 [a]							
	Company images	0.612	0.279	4.804	0.028 [a]							
	Turnover history	1.081	0.318	11.533	0.001 [a]							
Budget	*Adequacy of labour resources*	−1.224	0.491	6.203	0.013 [a]	267.131	44.398	0.034 [a]	267.131	1.000 [b]	0.279	0.310
Quality	*Size of past project completed*	−0.893	0.413	4.687	0.030 [a]	203.269	22.868	0.421	203.269	1.000 [b]	0.198	0.241
Contractors' impact	*Quality policy*	1.103	0.451	5.978	0.014 [a]	220.469	54.587	0.003 [a]	220.469	1.000 [b]	0.333	0.382
	Waste disposal	1.208	0.519	5.414	0.020 [a]							
	Adequacy of labour resources	1.229	0.531	5.345	0.021 [a]							

S.E.: *Standard Error*
[a] Significant at $p<0.05$.
[b] Sig>0.05, so the model fits well.

Hatush and Skitmore (1997) define quality as "the totality of features required by a product or service to satisfy a given need". Attalla et al. (2003) argue that quality and safety are the two specific issues that need to be prioritised in a 21st century construction site. Construction quality cannot be so easily quantified and measured compared to cost and time. Its assessment is rather subjective (Chan and Chan, 2004). The largest impact on quality occurs during the design and construction stage and the current quality assurance schemes emphasise these two phases (CIRIA, 1988).

Toakley and Marosszeky (2003) stressed that for the construction industry, the focus on quality management should not only be at the construction stage but for total quality to exist throughout the project life cycle. Rosenfeld's (2009) research shows that investing in quality is a worthy strategy and leads to several benefits. He concludes that the ratio of direct benefits to the investment in terms of saving on internal and external failures that might occur in the absence of quality procedures is 2:1 or more. Clients should ensure that the work performed conforms to the specifications established for the project. Indeed, low cost and speedy construction should not be achieved at the expense of the quality of the project.

Contractors play an important role in the formation of the quality of a project. The standard of workmanship and conformance to specifications determine a contractor's main contribution to the quality of a project.

7.2. Past performance (Component 2)

Component 2 accounted for 9.2% of the total variance and comprised *contract time overruns* (factor loading 0.916); *contract cost overruns* (factor loading 0.896); *past record of conflict and disputes* (factor loading 0.848); and *failure to have completed contract* (factor loading 0.793).

Contractors who completed projects successfully are more likely to achieve project targets in the future (Holt et al., 1994). Predictive performance of contractors can be determined by investigating contractors' past performance. High priority should be given to contractors' past time performance since delays in construction projects have significant cost and quality implications (Khosrowshahi, 1999).

Contractors of high repute and better past performance will improve client confidence and raise the possibility of future business (Xiao and Proverbs, 2003).

7.3. Environment (Component 3)

Component 3 accounted for 8.6% of the variance. The respective loading factors are *environmental plan during construction* (facto loading 0.879); *waste disposal during construction* (factor loading 0.870); and *materials and substances used in the project* (factor loading 0.828). Subsequently this component was labelled as 'environment'. Environmental issues during construction receive more attention from governments, non-governmental institutions and the general public (Harris and Holt, 1999). Shen and Tam (2002) reported that construction projects affect the environment in numerous ways across their life cycle and were regarded as a major contributor to environmental impacts.

A construction project has a notoriously negative impact on the environment. Songer and Molenaar (1997) reported that 14 million tons of waste has been put into landfill in Australia each year. Forty four per cent of this waste came from the construction/demolition industry. In developing countries, the construction industry consumes 62–86% of non-metallic minerals, such as glass, cement, clay, and lime Chan and Chan (2004). BRE (1998) reported that 30% of the annual waste in the UK comes from the construction industry. This damage to the environment could hold back economic growth and lower the quality of life.

Environmental-safety protection is no longer a concept but has now become a worldwide challenge facing the construction industry. Failure to meet environmental obligations at any point during construction could be very costly in terms of cost and delays to the project. Respondents to the survey reported that environmental attributes of contractors were found to have a great impact on achieving success in their project. This finding shares a common link with environmental issues and shows that evolving criteria other than time and cost are becoming an accepted part of project success frameworks.

7.4. Management and technical aspects (Component 4)

Component 4 accounted for 6.9% of the variance and comprised *management capability* (factor loading 0.605); *site organisation* (factor loading 0.586); *knowledge of particular construction methods* (factor loading 0.755); and *work programming* (factor loading 0.727). In order for contractors to successfully deliver their project, they need to provide qualified and skilled staff that has project management responsibilities and execution capabilities during construction. According to Hartman et al. (2009), understanding technical knowledge enables use of correct working methods to competently handle machinery and equipment.

7.5. Resources (Component 5)

Component 5 was assessed through two CSFs: *adequacy of labour resources* (factor loading 0.908); and *adequacy of plant resources* (factor loading 0.811) and accounted for 4.8% of the total variance as shown in Table 5. Little attention has been paid to the human resources factor in the past and projects have been managed as technical systems instead of behavioural systems. However, human resource management was included in the official definition of the Project Management Body of Knowledge by the Project Management Institute (Belout and Gauvreau, 2004). Many researchers agree that one of the most crucial elements for an organisation's success is the human resource function (Belout and Gauvreau, 2004). Nguyen et al. (2004) concluded that people are responsible for creating, managing, operating and utilising projects and play a decisive role regarding the success or failure of a project.

Hubbard (1990) reported that most project failures are due to social issues and a significant impact on the success of a project would result from managing people effectively. In addition, Todry (1990) concluded that a key factor linked with project success is a well-trained project manager capable of creating an effective team.

On-site productivity can be affected by the availability and suitability of the plant needed for construction activities (Wong et al., 2003). The vast majority of plants are available for hire as an alternative to ownership in the construction industry, hence many researchers have not emphasised the ownership of plant and construction equipment (Harris and McCaffer, 1995).

7.6. Organisation (Component 6)

Component 6 was assessed through three criteria: size of the company (factor loading 0.743); *company image* (factor loading 0.645); and *age in business* (factor loading 0.659) and accounted for 4.6% of the total variance. Although few studies have been conducted to explore the effect of company size on the performance of a project, respondents reported that the contractor's size had an impact on the success of their project.

Age is an indication of a mature business and normally shows stability, reliability and accrued experience (Holt et al., 1994). However, insolvency is more likely to occur in this industry than in others and confidence from an established trading history needs to be relied upon as a measure for the future. Although image is an implicit assessment and a subjective area to evaluate, a contractor's membership of trade or specialist associations is normally a recognised aspect of the image factor.

7.7. Experience (Component 7)

Component 7 accounted for 3.9% of the total variance and comprised *length of time in business* (factor loading 0.774) and *experience in the region* (factor loading 0.677). This component shows that proper emphasis on past experience and how a contractor is capable of increasing his volume of work from the time of establishment are proposed as factors that impact the success of a project. Also, geographic areas of operation and how well the contractor is experienced in the region are perceived as having an impact on project success.

7.8. Size/type of pervious projects (Component 8)

This cluster explained 3.7% of the total variance. In component 8, there were two CSFs: *type of past projects completed* (factor loading 0.853), and *size of past project completed* (factor loading 0.897). Respondents perceived the type of past project completed as having an impact on project success. This is due to the fact that it is better to select a contractor who has the requisite experience from a similar project type (Holt et al., 1994). Also, respondents reported that ensuring the proposed project does not represent more than the maximum workload capacity for contractors, had a great impact on project success.

7.9. Finance (Component 9)

Component 9 was assessed through three CSFs: *turn over history* (factor loading 0.650); *credit history* (factor loading 0.857); and *cash flow forecast* (factor loading 0.694) and accounted for 3.5% of the total variance as shown in Table 5. Financial resources show a company's credibility and reputation among clients and suppliers. It also indicates the strength of a company in the market in terms of its capacity to carry out projects (Isik et al., 2009). Profitability and turn over are the two most important indicators of the financial strength of a company.

Poor cash estimation and poor risk assessment are two of the major factors responsible for the failure of construction contractors (Varun et al., 2011). Ibukun (2010) reported that inadequate attention to cash flow forecasting causes the construction industry to be the largest sector of the economy facing bankruptcies. Hence, cash flow forecasting and control are essential for the survival of any contractor during all stages of the work.

8. Regression analysis of underlying success factors

Ordinal logistic regression was selected for this research because the dependent variables were ordinal on a scale from strongly disagree to strongly agree. Ordinal logistic regression results in more accurate and valid results as it is designed to fit the inherent order or ranking of the dependent variable (Norusis, 2008). The application of logistic regression requires no assumptions about the predictor variables. Hence, the independent variables do not have to be normally distributed, linearly related or of equal variance (Field, 2005).

The objective of using logistic regression is to predict the probability that an event will occur. In this study the event is the agreement that the contractors' attributes have an impact on the success of projects. The construction professionals respond to the survey by agreeing or disagreeing with the survey statements. The model then estimates the probability that a contractor with a given set of attributes will impact on a certain project and turn it in to a successful project. The relationship can be expressed in the form of

$$\mathrm{logit}(p) = a + b_1x_1 + b_2x_2 + \ldots + b_ix_i$$

where p is the probability of project success and $x_1, x_2 \ldots x_i$ are the explanatory variables.

The twenty nine variables that resulted from varimax rotation were entered into the model as independent (covariate) variables to determine which might have predictive ability in relation to project success. The general method of estimating the model parameters is called maximum likelihood (Field, 2005). Log likelihood (LL) represents the probability that the observed values of dependents may be predicted from the observed values of the independents. The likelihood ratio (-2LL) is a function of log likelihood (LL) and because it has an approximate a chi-square distribution, it can be used for assessing the significance of logistic regression. A small value of (-2LL) indicates a good model.

Similar in intent to R-Square in a linear regression model, the Pseudo R-Square attempts to quantify the proportion of explained variation in the logistic regression model. In logistic regression analysis, there are two types of R-Square. The first one is Cox and Snell R-Square which cannot reach the maximum value of 1 and the second one is Nagelkerke R-Square which can reach the maximum value of 1. Nagelkerke R-Square is the most widely reported when interpreting logistic regression model (Field, 2005). A deviance statistics test is preferred for assessing model goodness of fit over classification tables.

9. Models development

Factor analysis reveals nine underlying clusters described and discussed in the previous section. However, there is no direct relationship that can be shown by simply applying factor analysis. Hence, logistic regression analysis was conducted to estimate the probability of project success and assess the impact of contractors' attributes on project success.

Using the entire dataset, four logistic regression models were built in SPSS 19.0 to estimate the probability of project success based on the 29 independent variables listed in Table 4. Four dependent variables were used to develop logistic models namely: (1) The probability that a project has been completed on schedule, (2) The probability that a project has been completed within budget, (3) The probability that a project achieved the necessary quality, (4) The probability that the contractors' attributes has affected the success of a project. These four measures have been rated by respondents in the third part of the survey that asks respondents to comment on the outcome of a completed project. The analysis was based on the 'enter' method which is the default method of conducting logistic regression in SPSS 19.0 for Windows. The models' summary statistics in Tables 5 show that all models, except quality (where the level of significance for the model fit >0.05), perform adequately and permit the rejection of the null hypotheses that the independent variables are not related to the dependent variable.

10. Discussion of regression results

From the results of logistic regression, it was found that the success of a project is significantly associated with seven of the advocated variables. The findings indicate that contractors with adequate labour resources have a great impact on project success. *The* a*dequacy of labour resources* variable was a statistically significant predictor of project success in the scheduling, budget, and contractors' impact models. This is consistent with Belout and Gauvreau (2004), Hubbard (1990), Nguyen et al. (2004), and Todry (1990) who asserted that people are responsible for creating, managing, operating and utilising projects and play a decisive role regarding the success or failure of a project.

The results also show that contractors with adequate plant resources are an important and statistically significant factor affecting project success. The scheduling model reveals that the *adequacy of plant resources* factor is a statistically significant predictor of project success. This result is in accordance with Wong et al. (2003) as they found that on-site productivity can be affected by the availability and suitability of a plant needed for construction activities.

Logistic regression tests also revealed that examining *company image* and *turnover history* of a contractor appears to impact on the success of a project. These two variables turned out to be statistically significant in the scheduling model. The model shows a positive relationship between those two predictors and timely project delivery. The result of this finding is similar to findings reported in previous literature such as Holt et al. (1994) who pointed out that insolvency is more likely to occur in the construction industry than in others and confidence from an established trading history needs to be relied upon as a measure of for the future. Isik et al. (2009) and Holt et al.

(1994) also reported that financial resources show a company's credibility and reputation and turnover history mirrors company trading with an increase in turnover representing growth.

Although the findings indicate that the overall test of quality model is not statistically valid, the *size of past project completed* predictor appears to be statistically significant. This finding is consistent with Holt et al. (1994) who asserted that contractors who have the requisite experience from a similar project tend to have a greater impact on project success.

The results show that *quality policy* and *waste disposal* are significant predictors of project success in the contractors' impact model. These findings are in line with previous studies by Attalla et al. (2003) and Chan and Chan (2004) which conclude that quality is a specific issue that needs to be prioritised for a 21st century construction site. The results also indicate that contractors who meet environmental obligations and implement waste disposal programmes during construction tend to have a greater impact on project success.

11. Conclusions

There is considerable debate in project management research practice about what determines project success. While the topic has been discussed for a long period of time, an agreement has not been reached. In addition, when it comes to a definition of project success, there is no single list that is totally comprehensive. However, the concept of CSFs presents a smarter way to identify certain factors which when present or absent in a project are likely to make the project successful.

Construction projects and their success are closely related to contractors. They start their main duties when the project reaches the construction or execution stage where the actual work of the project is accomplished. In addition, identifying what went right and what went wrong in a post construction evaluation before moving to the next project, proved to be a valuable exercise in construction projects.

This research reports the statistical results of a survey aimed at collecting perceptions of construction practitioners, in post construction evaluation, about the CSFs of contractors that greatly impact on the success of a project. Based on the available literature, 35 CSFs were selected for this study. By employing a factor analysis approach, the 35 critical factors identified in this study are further categorised into nine underlying clusters namely: *(i) safety and quality; (ii) past performance; (iii) environment; (iv) management and technical aspects; (v) resource; (vi) organisation ; (vii) experience; (viii) size/type of pervious projects;* and *(ix) finance*.

Four logistic regression models were built to examine the impact of contractor attributes on project success and identify the significant association between the success criteria and the nine underlying clusters. From the results of logistic regression, it was found that the success of a project is significantly associated with seven of the advocated variables. They were: *turnover history, quality policy, adequacy of labour resources, adequacy of plant resources, waste disposal, size of past project completed,* and *company image*. The goodness of fit of the models was confirmed by the −2LL, pseudo R-squared, deviance and parallel lines tests, suggesting that the models are statically robust.

The findings showed that new and emerging criteria such as safety and environment are becoming measures of success in addition to the classic iron triangle's view of time, cost and quality.

Assuming that project success is repeatable, these findings provide a clear understanding of contractors' performance and could potentially enhance existing knowledge of construction project success.

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