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Contractor's Critical Factors Influencing Project Success: a Case of Indian Construction

B. Bhavani Shankar[1], K. L. Radhika[2]
[1]*Post Graduation Student,*[#2] *Associate Professor, Department of Civil Engineering, Osmania University, Hyderabad, India*

Abstract*: In India, the success is a basic issue for many construction projects. Many critical success factors (CSFs) are responsible for success/failure of the projects. Contractor is the main stakeholder who is responsible for the success or failure of the project. So, it is necessary to study about the influence of contractor on construction projects. This study deals with the contractor's CSFs influencing project success in terms of budget, schedule, and quality. In order to identify the impact of contractor a questionnaire survey with 29 CSFs were used. The responses for this survey were taken from professionals in construction industry. The data collected through the survey was analysed using factor analysis initially. From factor analysis, certain number of attributes turns out to be the components. Later, a logistic regression model was developed to identify the factors affecting project success.

Keywords*: attributes, construction management, contractor, critical success factor (CSF), factor analysis, logistic regression, project success*

I. INTRODUCTION

Construction industry is one of the largest industries in India. The revenue contribution to the nation from this industry is very huge. This industry comprises many skilled and unskilled personnel. Many infrastructure projects are being executed. A number of challenges are faced during the execution of the projects. The challenges may include on time delivery of project, cost overrun, inadequate quality, incompetency of the management, resources availability, clients, contractor, sub-contractor, etc. Many studies reveal that contractor's qualification plays a significant role in project implementation. So, there is necessity in understanding how the contractor is responsible for the project success.

projects. The project success is not just dependent on time, cost, and specifications but there are other criteria to be considered. There are many critical factors (known as critical success factors in this paper) which impact the success criteria. The factors may be related to management, stakeholder, resources etc. The critical factors vary with the perception of the viewer (professional). Since they are dependent on perception there are infinite number of factors. In past, many studies were done to identify these factors but no study could identify all the factors. So, the scope of the study in this field (project success) is very high.

The project is considered successful if it meets the criteria of time, cost and quality[1]. The iron triangle represents the most accepted criteria (on time, under budget, according to quality) for project success [2]. There was an intensive attempt in the previous studies to measure this project success but there is no universal criteria to measure project success [3].

Many stakeholders (government, contractors, management, customers etc come under stakeholders) play a key role in the construction of projects. The importance of the contractor as a main stakeholder is studied in many previous studies. This importance is seen in studies done in selection criteria of the contactor based on his/ her qualification [4] [5].

II. LITERATURE REVIEW

Cheng et al. [6]developed a framework to establish the CSFs for partnering projects. The CSFs identified and discussed in this framework are effective communication, conflict resolution, adequate resources, management support, mutual trust, long term commitment and coordination, and creativity. It is concluded that partnering project success can be determined by objective measures and subjective measures.

Cooke-Davies [7] investigated few European projects and identified 12 factors affecting project success. These factors were categorized into project management success, individual project success, and cooperate success.

respondents were asked to scale (1-5) the attributes. The attributes were classified into 3 groups based on the mean values of the attributes. The main groups were success attributes and failure attributes, the other group was neglected. Relative Importance Index (RII) was used to rank the attributes. The success attributes and the failure attributes were classified into success factors and failure factors respectively based on the factor analysis. Another questionnaire survey was conducted based on this success factors and

failure factors. The stepwise regression model was developed for these factors. Finally, it was concluded that the factor named coordination between project participants is the factor which influences the cost performance in the Indian construction industry.

Doloi et al. [9] selected set of 45 attributes. In their study using this set, they first identified the key factors impacting delay in Indian construction industry and then established the relationship between the critical attributes from developing prediction models. They identified that the critical factors of construction delay as lack of commitment, inefficient site management, poor site coordination, improper planning, lack of clarity in project scope, lack of communication, and substandard contract from factor analysis. From regression model it is identified that slow decision from owner, poor labour productivity, architects' reluctance for change, and rework due to mistakes in construction are the reasons that impact the project delay.

To rank different critical success factors (CSFs) for construction projects in Lithuania, Analytic Hierarchy Process (APH) was used as a tool. For construction projects in Lithuania various CSFs were ranked [10].

Sines lassie et al. [11]conducted a questionnaire survey in Ethiopian construction industry. The questionnaire survey was designed to assess the impact of the identified 35 project performance attributes on the cost of the project. Target respondents of the survey were engineers involved in public sector projects. Many statistical tests were carried out to determine the success and the failure factors. Finally, through stepwise multiple regression it is found that success factors namely scope clarity, project manager's competence were affecting cost of the project. It was also found that failure factors namely conflict among project participants and projects manager's ignorance, and lack of knowledge were affecting cost performance of the project in the Ethiopian public construction projects.

Palaneeswaran and Kumaraswamy[12] developed a scoring model to assess contractors selection for design-build projects based on a range of criteria established through a knowledge mining process. The model categorizes design/build projects into either simple or complex projects based on an assessment of project attributes. The developed model is also unsatisfactory since it did not establish a relationship between contractor selection criteria and project outcomes.In previous studies, many different methods were used to identify the factors influencing the project. The factors considered in the study were general factors, they were not related to a particular stakeholder (contractor, client, employees etc). This paper is based on the contractor related critical success factors affecting the project success. The criteria considered for project success are the cost (budget), the time (schedule), and the quality of the project. This study focuses on Indian construction industry.

III.METHODOLOGY

A. Identification of Critical Success Factors Affecting Project Success

Firstly, the CSFs related to contractor which affect the project success are to be identified. To identify the CSFs many professionals in reputed organizations were interviewed. From these interviews certain number of CSFs were concluded. These factors were classified into 10 attributes of contractor. The classification of the attributes is shown in Table I. This classification was done to have a clear idea about CSFs.

TABLE I
CLASSIFICATION OF ATTRIBUTES

S.No.	Attributes	CSFs
1.	Financial attribute	– Turnover History – Credit History – Cash flow forecast
2.	Management attribute	– Management Capability – Organisation of site
3.	Technical attribute	– Work Programming – Knowledge of particular construction method
4.	Experience attribute	– Type of projects completed – Size of projects completed – Length of time in business – Experience in region
5.	Past performance attribute	– Failure in completion of project

		– Overrun of contract time – Overrun of contract cost – Record of conflicts and disputes
6.	Firm attribute	– Company size – Image of the company – Age in business
7.	Environmental attribute	– Disposal of waste during construction – Environmental plan during construction – Materials used in the project
8.	Health and Safety attribute	– Health and safety records – Occupational Safety and Health – Experience Modification Rating
9.	Quality attribute	– Quality control – Quality policy – Quality assurance
10.	Resources attribute	– Adequacy of labour – Adequacy of plant

B. Development of Questionnaire Survey

The questionnaire was designed to assess the influence of the identified 29 CSFs on the project success. The first part of the survey consisted of personal details of the respondents. These questions were asked to ensure that the respondent had enough experience in the construction industry. Second part of the questionnaire was the principal part of the questionnaire, and was designed for rating critical success factors on a Likert scale of 5 (1-strongly disagree, 2-disagree, 3-neutral, 4-agree, and 5-strongly agree). The respondents were invited to rate the influence of each CSF on project success based on their experience. 29 critical success factors wrt to their attributes were listed in the questionnaire. The respondents were requested to add any other missing contractor's factors which affect the project success. This part also had a question which asks the respondent to rate the contractor's influence on project success on Likert scale of 5.

C. Data Analysis

The survey was targeted on the professionals who had experience in Indian construction industry. It was seen that invalid responses were excluded from the analysis. The invalid responses included repeated respondents and responses from the respondents who had no experience in Indian construction industry. The questionnaire was sent to 500 professionals. Finally, 222 responded for this survey. So, the response rate is 44.4%. It is seen that the respondents had a good experience.

In descriptive statistical analysis, there is a need to determine the central tendency or the middle of the distribution. A measure for central tendency for Likert type data is done using mode and median. In this study all the variables were Likert type. So, to measure central tendency mode and median were chosen. The median and mode for 27 factor was agree or strongly agree. Only median and mode of the two factors namely waste disposal during construction, and material used in the project showed neutral. Since the central tendency was good, it shows that many respondents agree that all the variables considered in the survey are affecting the project success. In this paper, the factor analysis (FA) was done using SPSS 20.0 (Statistical Package for the Social Sciences). Varimax method in factor analysis was used. The Kaiser-Meyer-Olkin Measure (KMO) of Sampling Adequacy and Bartlett's Test results were verified. The KMO measure of adequacy was 0.949 (> 0.5). This shows a good sampling adequacy. The Bartlett's Test of Sphericity showed a low significance which shows that the correlation matrix is not an identity matrix. The KMO and Barlett's Test results are shown in Table II. The Cronbach's Alpha was 0.974. This indicates good internal consistency of the factors.

TABLE II KMO AND BARTLETT'S TEST

KMO Measure of Sampling Adequacy		.949
Approx. Chi-Square		4932.738
Bartlett's Test of Sphericity	df	406
	Sig.	.000

The factors with coefficient of correlation (r)>0.9 in the correlation matrix were eliminated. It was seen that the factors with loadings greater than 0.5 in the rotated matrix were only selected. Few factors were also dropped in order to arrange the factors in a meaningful component (attribute). After elimination of factors based on all the above rules, 20 CSFs were left. Only these 20 CSFs were used for further analysis.

A logistic regression model was developed to determine the most significant factors influencing the project success. The model was developed in SPSS 20.0. The model was developed with 20 CSFs as the independent variables and "contractor's influence on project success" as dependent variable.

IV. DISCUSSION OF FACTOR ANALYSIS RESULTS

From the factor analysis, the factors are finally classified into four components. The components (attributes) are firm's reputation and technical aspects, past performance, finance, and environment. The variance of each attribute and factor loading of each factor is shown in Table III. These results were obtained from SPSS 20.0. The varimax method (orthogonal factor analysis) was done.

A. Firm's Reputation and Management Aspects

Component 1 was assessed through nine CSFs: size of projects completed (factor loading 0.763), length of time in business (factor loading 0.737), knowledge of particular construction method (factor loading 0.717), type of projects completed (factor loading 0.708), experience in region (factor loading 0.704), age in business (factor loading 0.649), image of the company (factor loading 0.587), work programming (factor loading 0.585), and company size (factor loading 0.526). This component accounted for 53.473% of the total variance.

The image of the firm was an interesting finding that should definitely be considered by the firms in the market [13]. Management of the project is considered in measuring project success. Project manager is responsible for management of the project. The competent project manager was one of the CSF for the success of large construction projects. [14] [15]

B. Past Performance

time (factor loading 0.842); failure in completion of project (factor loading 0.809); and record of conflicts and disputes (factor loading 0.539). Therefore 4 CSFs accounted for this component. Nasab and Ghamsarian[16] concluded that the past performance is considered in contractor prequalification.

C. Finance

This component accounted for 5.988% of variance. This component includes credit history (factor loading 0.809), turnover history (factor loading 0.752), and cash flow forecast (factor loading 0.638). Guzduz and Yahya[17] ranked company's financial strength as the most important critical factor based on Frequency Adjusted Importance Index (FAII).

TABLE III
FACTOR ANALYSIS RESULTS

Description of components	Factor loading	Variance explained
Component 1: Firm's Reputation and Management aspects		53.473
Size of projects completed	0.763	
Length of time in business	0.737	
Knowledge of particular construction method	0.717	
Type of projects completed	0.708	
Experience in region	0.704	
Age in business	0.649	
Image of the company	0.587	
Work Programming	0.585	
Company size	0.526	
Component 2: Past Performance		7.788
Overrun of contract cost	0.848	
Overrun of contract time	0.842	

Failure in completion of project	0.809	
Record of conflicts and disputes	0.539	
Component 3: Finance		5.988
Credit History	0.809	
Turnover History	0.752	
Cash flow forecast	0.638	
Component 4: Environment		5.721
Environmental plan during construction	0.851	
Disposal of waste during construction	0.779	
Materials used in the project	0.734	

D. Environment

Component 4 accounted for 5.721% of the total variance. The respective CSFs are environmental plan during construction (factor loading 0.851); disposal of waste during construction (factor loading 0.779); and materials used in the project (factor loading 0.734). Subsequently this component was labelled as 'environment'. Chan et al. [18] supports that environmental attributes can be measured using economic environment, social environment, political environment, physical environment, industrial relation environment, and level of technology advanced to measure project success. So, it is concluded by them that the environmental attributes affect the project success.

V. DISCUSSION OF LOGISTIC REGRESSION RESULTS

The -2 Log Likelihood is 350.345 with chi-square 92.562. Model fit test is significant as level of significance (ρ) <0.05. It is an indication that the model fits well. In goodness of fit test, the Deviance chi-square is 350.345 with ρ>0.05 which shows that the model fits. The variance of the independent variable is explained between 41.4% and 44.9% as Cox and Snell R-square, and Nagelkerke R-square are 0.414 and 0.449 respectively. Among all the 20 CSFs only one CSF named age in business is significant at 0.05 (as ρ<0.05). Therefore, age in business is the CSF which influences the project success. In this study, project success is related to time, cost and quality.

TABLE IV
LOGISTIC REGRESSION ANALYSIS RESULTS

	Estimate	Std. Error	Wald	df	Sig.[a]	95% Confidence Interval	
Predictor						Lower Bound	Upper Bound
Age in business	.526	.222	5.600	1	.018	.090	.961
Model fit information							
-2 Log Likelihood	350.345						
Chi-Square	92.562						
Sig.	.000						
Goodness-of-Fit							
Deviance Chi-Square	350.345						
Sig.	1.000						
Pseudo R-Square							
Cox and Snell	.414						
Nagelkerke	.449						

[a.] Significant at 0.05

VI. VALIDATION OF MODEL

For model validation, a validation survey was conducted to take the expert's opinion about the CSFs. The construction industry pioneers with average experience of 32.6 years were respondents in this validation survey. There were 15 people who participated in this survey. Kendall's W Test was used to understand to what extend the model developed agrees with the expert's opinion. The mean scores of all the factors in the model developed and the expert's opinion were considered in this test. Kendall's W Test results are shown in the Table V. In this test Kendall's W is 0.926. This indicates that the expert's opinion and the model's results are

highly agreeable. Since significance is less than 0.05 the test is significant and the null hypothesis that the judgment that the experts opinion is disagreeable can be rejected.

TABLE V
KENDALL'S W TEST RESULTS

Kendall's W[b]	.926
Chi-Square	33.338
df	18
Asymp. Sig.	.015

[b.] Kendall's Coefficient of Concordance

VII. CONCLUSION

In this study, through factor analysis CSFs are classified into four attributes: (1) firm's reputation and management aspects; (2) performance; (3) finance; and (4) environment. This indicates that the respondents agree that the above attributes influence the project success in terms of the cost, the time and the quality of the project delivered.

From the regression model results, the age in business of the contractor is the most significant CSF of the contractor which influences the project success in terms of budget, schedule, and quality of the project in Indian construction industry. So, finally it is the experience of the company with plays a crucial role. In order to have a successful project a contractor's company should have reputation in the market. Selection of the companies with good fame leads to successful delivery of the project.

A. Recommendations for Further Study

Recommendations for the further studies are as follows

1) The respondents in this study are clients, contractors, and consultants. No individual perception is studied. A study can be done in individual perception.

2) The model used in this study is logistic regression model. Research can be carried out using more predictive models and this research can be carried out in different countries.

3) In this study data was collected from India. The research can be carried out in the different countries.

4) This study focused on the contractor. The further study can be focused on the other stakeholders.

5) The project success criteria considered in this study are cost, time and quality. There are many criteria to be considered. A study can be done considering the other aspects in the project success.

6) The CSFs can be classified into success and failure attributes using different methods of classifications. Level of impact of these attributes on the project success can be analysed.

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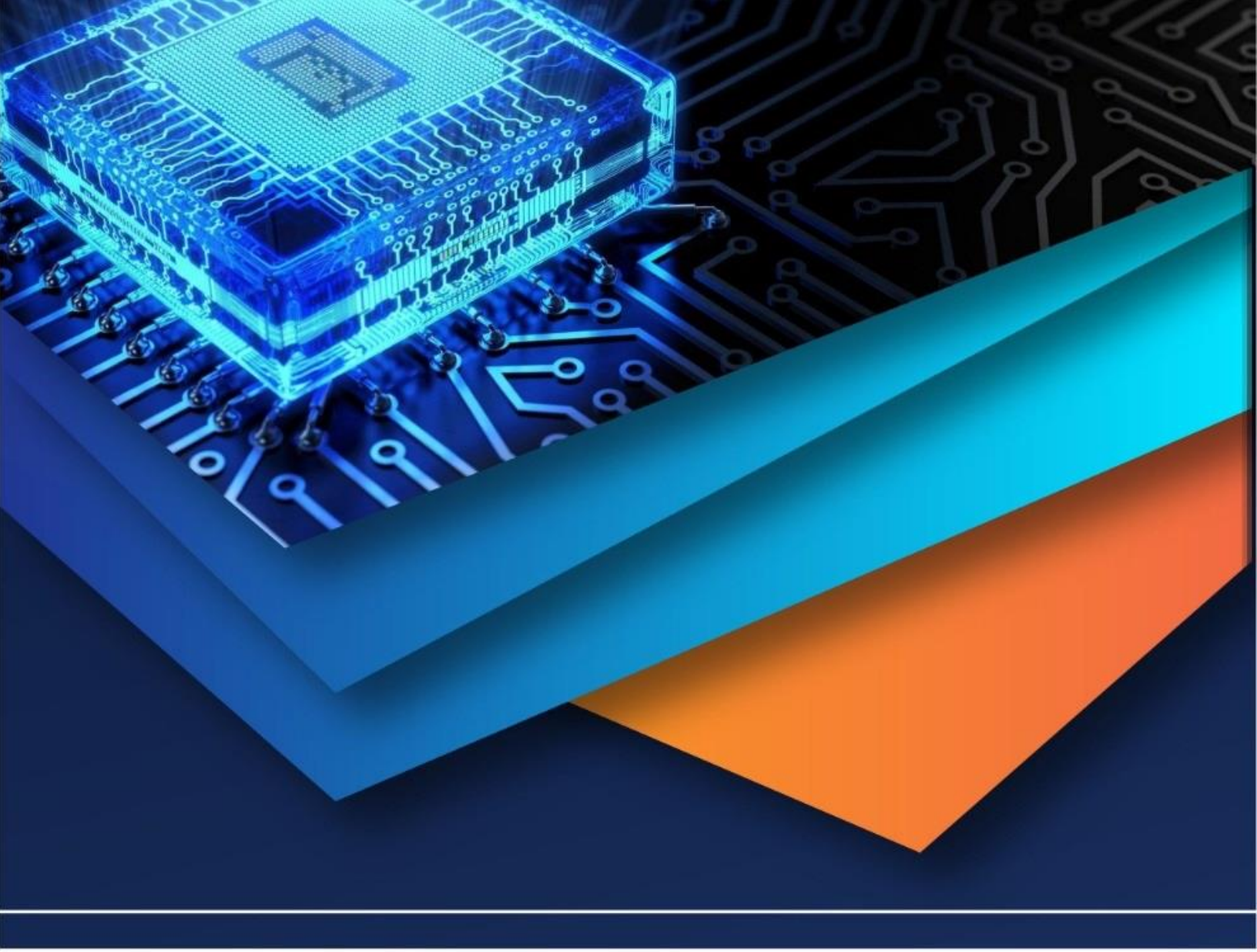

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