

Evaluation of Critical Success Factors and their Interrelationship Using Structural Equation Model

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ABSTRACT: In the Construction Industry for a project to be successful there are many factors and their inter-relationship which play an important role. The major aim of this study is to reveal those factors and their relationships existing in the industry affecting the Project Success, known as Critical Success Factors (CSF's). In this study total 40 number of success factors are considered below 7 main categories like Mission and Goals, Managerial skills for project manager, Financial Resources, Pricing Policies, Owner Satisfaction, Owner – Contractor Relationship & Materials related Factors. To discover the interrelationship among the CSF's Structural Equation Model (SEM) is used. Questionnaire survey was done over different types of projects to identify the common CSF's. Thus, the interrelationships identified in this paper will make it easier to take better management over CSFs and contribute to a project's success.

KEYWORDS: Construction Management; Critical Success Factors; Interrelationships; Structural Equation Model.

I. INTRODUCTION

In the Construction industry there are numbers of factors affecting the project success. Some of the factors play an important role in project success. The identification of key factors for construction project success enables appropriate allocation of limited resources. The present study seeks to distinguish these common critical factors affecting all different types of project's success.

Relevant studies developed the conceptual definition of CSF's, such as-the critical factors that lead to project success and provide a forecasting tool to enable parties to rapidly assess the possibility of a successful project from their viewpoint (Zarina Alias, E.M.A. Zawawi, Khalid Yusof, Aris, NM), Success factors are those inputs to the management system that lead directly or indirectly to the success of the project or business (Arti J. Jari, Pankaj, P. Bhangale). Different studies have identified different CSFs, and their interrelationships too giving varying results, because developing technology nullifies the old CSF's and some new CSF's arises, i.e. the way CSF's differ for different projects, they also shows differences with varying time, so further and continuous study of CSF's and their interrelationships play an important role in Construction Industry.

This study is done to identify the new CSF's and their interrelationship in the Construction Industry. CSF's are identified from the previous literature review and then verified by conducting a questionnaire survey. Based on the results of the questionnaire survey a hypothesis for the Structural Equation Model (SEM) is proposed to identify the interrelationships amongst them. By using Goodness of fit index, this paper makes a thorough discussion of the interrelationships among the CSFs. Interrelationships that were identified and verified in the model disclose the impact mechanism among these CSFs.

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II. LITRATURE REVIEW

Critical success factor is a variable that can have a significant impact that delivers measurable improvements to the project success. (Zarina Alias, 2014)

Arti J. Jari, Pankaj, P. Bhangale (2013) purposed, identifying critical success factors would assist in taking proactive measures for successful project management of construction project.

Yong Qiang Chen, Yang Bing Zhang, Jun Ying Liu and Peng Mo (2012) explained, on the basis of the CSFs system, the structural equation model (SEM) method can be employed to discover the interrelationships among the CSF's, this relationship could be used to control better the adoption of new technology / technique / material.

Albert P. C. Chan, David Scott, and Ada P. L. Chan (2004), hypothesized that 'Project success is a function of project-related factors, project procedures, project management actions, human-related factors and external environment and they are interrelated and interrelated.'

Syed Zafar Shahid Tabish and Kumar Neeraj Jha (2012) finds that human factors play a decisive role in making a project successful as it has a path coefficient 0.98.

Yue Choong Kog and Ping Kit Loh (2012) defined project success by performance with respect to budget, schedule, and quality. They determined the success by variety of factors grouped under four main project aspects.

III. METHODOLOGY

By performing the questionnaire survey, 40CSF's were identified which consist of 7 categories like Mission and Goals, Managerial skills for project manager, Financial Resources, Pricing Policies, Owner Satisfaction, Owner – Contractor Relationship & Materials related Factors. To discover the interrelationship among the CSF's Structural Equation Model (SEM) is used. Questionnaire survey was conducted over different types of projects to identify the common CSF's. Based on the collected data a hypothesis for SEM was proposed and evaluated and Goodness of fit (GOF) indexes were calculated; if not satisfied hypothesis should be revised and interrelationship amongst the CSF's will be identified.

IV. CRITICAL SUCCESS FACTORS

The identification of key factors for construction project success enables appropriate allocation of limited resources. A variety of factors determine the success or failure of projects in terms of these objectives. The identification of the critical success factors (CSFs) for these objectives will enable limited resources of time, manpower, and money to be allocated appropriately.

In this present study 40 critical success factors were identified and then categorised under 7 categories. There are many pervious researches in construction regard to identify critical success factors (CSFs) analysis. The identified CSFs for construction projects were also broad strategic principles, which would definitely require further refinement to identify lower level factors that can be implemented as project strategies. From the literature review one thing was observed that some of the factors were common in all types of projects. The main aim of this project is to focus on such factors which play an important role in every type of construction project.

V. STRUCTURAL EQUATION MODEL

The structural equation model (SEM) is a multivariate technique used to estimate simultaneously a series of interrelated dependent relationships (Hair et al. 2006). It is superior to the multiple regression method because it takes into account measurement errors that occur when a large number of variables are involved (Molenaar et al. 2000). Furthermore, the SEM is more helpful in understanding performance algorithms because users can visually and systematically recognize complex relationships (Kim et al. 2009). Its ability to explore relationships, as several studies in construction management show, makes it the perfect choice for discovering the underlying interrelationships among CSFs.

The SEM method consists of measurement components and structural components (Byrne 1994). The former incorporates a confirmatory factor analysis that is concerned with how well latent variables (which cannot be observed directly) are represented by the observed variables (which can be evaluated directly). The latter includes multiple regression analysis and path analysis, and models the relationships among latent variables.

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Structural equation modelling (SEM) is offered as an adequate technique for this purpose. SEM is a causal modelling technique that is capable of analyzing complex interrelations among observed or latent variables. SEM is a confirmatory technique and a collection of statistical techniques such as confirmatory factor analysis (CFA), path analysis (PA), and multiple regression analysis. It can be used for the development of complex causal models and predictive purposes (Molenaar et al. 2000; Kline 2005).

The SEM is usually developed in the following steps:

1. Define the structural and measurement components (e.g., measured variables and latent variables) to set up a hypothetical model;
2. Assess the verification of hypothetical model and develop it with modifications, if necessary; and
3. Assess the verification of the final model and interpret it.

VI. ESTABLISHMENT OF HYPOTHETICAL MODEL

To set up the hypothetical model, 7 categories as the latent variables and the 40 CSF's as the measurable variables shown in the table no.1 are selected. The measurable variables used in the SEM need to be continuous variables and easily measured.

Table 1. Critical Success Factors System for Construction Projects

Categories	Critical Success Factors
A. Mission & Goals	Mission is clear for employees Mission is Success factor for Company Goals are formulated according to mission Employees are involved in Goal formulation Goals are formulated according to Environment Goals are flexible and adjustable Company has Future Vision
B. Managerial Skills for Project Manager	Manager are able to Plan Manager meet staff periodically Manager can Estimate cost accurately Manager has the ability to project scheduling and following up Owner is satisfied by his skills
C. FinancialResources	Company has financial resources before project execution Company has estimated financial budget Company has determine its financial resources periodically Banks policy affect type and qty. of financial resources Company's cash availability during construction Owner's availability of funding during construction
D. Pricing Policies	Company has some policy for all projects Pricing method is a critical success factor Company use cost plus approach Competitors affect on pricing decisions Changing rates make pricing difficult
E. Owner Satisfaction	Owner satisfaction is the most critical success factor Company concerns owner's satisfaction Contractor believes that profit is parallel to Owners satisfaction Company apply quality criteria to get owner satisfaction Contractor evaluate himself for owner satisfaction Contractor use feedback to increase owner satisfaction Owner satisfaction is competitive advantage
F. Owner – ContractorRelationship	Owner – contractor relationship affects selection criteria Poor communication between owner and contractor Effect of unclear and inadequate details by the owner

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G. Materials Related Factors
construction

Owners interference in contractors construction methods
Changes in material types and specifications during

Delay in material delivery
Damage of sorted materials when they are needed urgently
Delay in manufacturing special building materials
Late procurement of materials
Shortage of construction materials

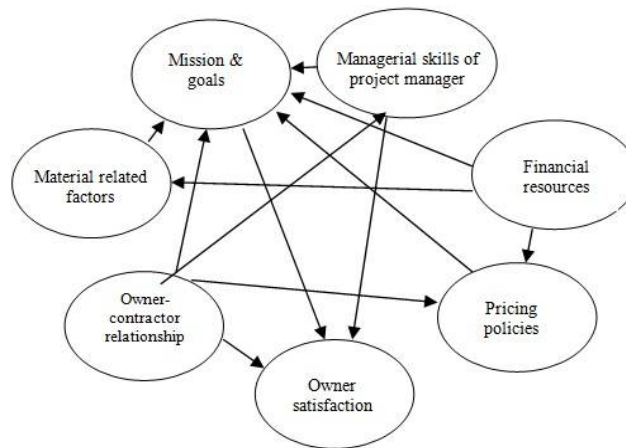


Fig.1 Hypothesized interrelationships among the CSFs subcategories.

Twelve assumptions were used to construct the hypothetical structural model in Fig. 1. The arrows represent the direction of the hypothesized influence.

For example, “managerial skills of project manager” is believed to have a direct influence on “owner’s satisfaction.” Hence, the arrow originates from “managerial skills of project manager” to “owner’s satisfaction.” This study hypothesized the following 12 relationships for the structural model:

- H1: Mission & Goals have a direct influence on an owner satisfaction.
- H2: Managerial skills of project manager have a direct influence on mission & goals.
- H3: Managerial skills of project manager have a direct influence on owner’s satisfaction.
- H4: Financial resources have direct influence on mission & goals.
- H5: Financial resources have direct influence on pricing policies.
- H6: Financial resources have direct influence on material related factors.
- H7: Pricing policies have direct influence on mission & goals.
- H8: Owner-contractor relationship have direct influence on pricing policies.
- H9: Owner-contractor relationship have direct influence on owner’s satisfaction.
- H10: Owner’s satisfaction have direct influence on mission & goals.
- H11: Material related factors have direct influence on mission & goals.
- H12: Material related factors have direct influence on Managerial Skills.

VII. DATA COLLECTION

A questionnaire was designed to collect data for the model. Each CSF was to be assessed on a five pointer scale. Table 2 shows an example of how the factors were scored in the questionnaire. The questionnaire survey firstly was performed face to face for the sake of good response rate & quality.

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Questionnaires were also distributed by mails but the response was not good as expected. Then, telephonic survey was taken place and that gave us the most of the quality responses. Just to find out what difference does it makes; the experience and the level of education are taken into consideration.

Table 2. Example of Scoring Instruction in the Questionnaire-

Categories	Critical Success Factors	Level (1-5)
Mission & Goals goal	Mission is clear for employees	1- unclear; 5- clear picture of
	Mission is Success factor for Company	1- Strongly disagree; 5- Strongly Agree
Managerial Skills for Planned Project Manager Important	Manager are able to Plan	1- Unable to plan; 5- Well
	Manager meet staff periodically	1- No Need; 5- Meeting Staff is
Pricing Policies Agree	Manager can Estimate cost accurately	1-No; 5- Accurate Estimation
	Company has some policy for all projects	1- Strongly disagree; 5- Strongly Agree
	Changing rates make pricing difficult	1- It is Easy; 5- It is Difficult

VIII. MODEL DEVELOPMENT AND VERIFICATION

The SEM will be verified by evaluating its appropriateness. If its appropriateness is not good, it will be developed and revised. The appropriateness will be assessed from the results of the covariance structural analysis, which is indicated by the goodness-of-fit (GOF) indexes. Various GOF indexes can measure the appropriateness of a model from different aspects. Four indexes will be therefore used in this study to measure comprehensively the model's goodness of fit: (1) the X^2/df (degrees of freedom) index, which can compare the observed covariance matrix with the covariance matrix estimated by assuming that the tested model is true; (2) the non-normal fit index (NNFI) or the Tucker-Lewis index (TLI), which considers a correlation for model complexity; (3) the comparative fit index (CFI), which represents the relative improvement in the fit of the hypothesized model; and (4) the root-mean-squared error of approximation (RMSEA), which estimates the discrepancy between the observed and the estimated covariance matrices in the population.

Amos in SPSS (SPSS 19) was employed to test the Structural Equation Modelling of the proposed hypotheses. From the results obtained, required development has been done and correlation between the categories of the CSF's has been verified.

IX. DISCUSSION

RELIABILITY TEST: Cronbach's alpha reliability test was employed to analyse the appropriateness of the grouping of the CSFs and the reliability of the data. The alpha value ranges from 0 to 1. In reliability testing, values ranging from 0.6 to 0.7 are regarded as sufficient; a value more than 0.7 is regarded as good (Sharma 1996). As Table 3 demonstrates, all groupings in the hypothetical model have Cronbach's alpha values greater than 0.6. This indicates that the internal consistency reliability of the hypothetical model is sufficient.

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Table no.3: Reliability Test

Reliability Statistics	
Cronbach's Alpha	N of Items
0.755	42

Results of reliability test in table 3 gives us the result i.e. > 0.7 indicating the data collected is good for the further calculations.

EVALUATION OF CSF'S: Table no.4 Means, Weighted means and P-values of all the Critical Success Factors using one sample T-test.

Sr. No	Critical Success Factors	Mean	Weighted Mean %	Rank	P-Value
A	Mission & Goals	4.187	83.73	4	0.000
B	Managerial skills of Project Manager	4.211	84.21	2	0.000
C	Financial Resources	4.094	81.87	5	0.000
D	Pricing Policies	4.274	85.51	1	0.000
E	Owner Satisfaction	4.206	84.11	3	0.000
F	Owner-Contractor relationship	3.814	76.27	7	0.000
G	Materials related factors	3.947	78.95	6	0.000

Table no. 4 shows that Pricing Policies as a CSF is the first with mean 4.274 and weighted mean 85.51%; this reflects the vitality and importance of pricing policies in the tender or any construction project. While, the second was the question related to managerial skills of project manager referring it as a CSF's among most of the contractors. In addition, owner satisfaction CSF was the third with a mean of 4.206 and weighted mean 83.11%, this denotes the importance of ownersatisfaction in construction industry. Also the fourth CSF was mission and goals with mean 4.187 and wt. mean of 83.73%.

INTERRELATIONSHIP AMONG CSF'S: After the verification of the proposed hypotheses and the obtained results, required modifications were done in the proposed hypothesis. Following results shown in the table no. 5 were obtained for the model fit indices. And the revised model shown in Fig. 2 was developed showing the interrelationships among the categories of the CSF's.

Table no.5 Results of GOF (Goodness Of Fit) Measures:

GOF Measures	Recommended level of GOF	Hypothetical Model	Revised Model
X ² /df	Recommended level from 1 to 2	1.168	1.403
NNFI or TLI	0 (no fit) to 1 (perfect fit)	0.555	0.88
CFI	1 (no fit) to 1 (perfect fit)	0.587	0.937
RMSEA	<0.05 Very Good Fit; 0.05-0.08 Fairly Good Fit; 0.08-0.1 Acceptable Fit; >0.1 Unacceptable Fit	0.039	0.06

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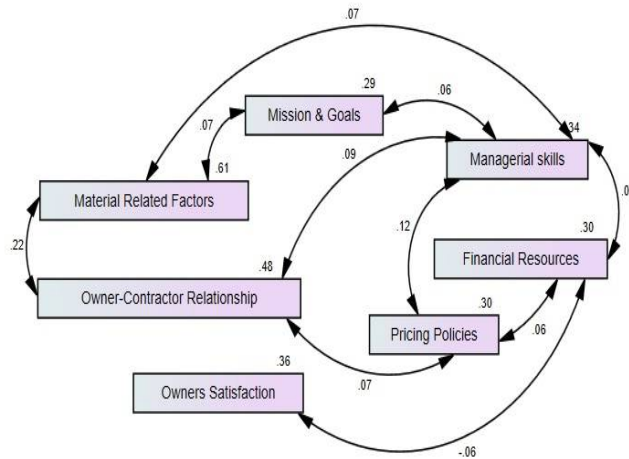


Fig.2 Revised Interrelationship Among CSF's

From the results obtained, it is observed that maximum categories of the CFS's have interrelationship with the Managerial Skills, which means success of the project mainly depends on the Managerial Skills of the Project manager. Categories such as Mission & Goals, Material Related Factors, Financial Resources, Pricing Policies and Owner-contractor relationship gets affected by the Managerial Skills of the project manager. Mission and Goals of the project are affected by the material related factors and managerial skills and vice-versa. Owner-Contractor relationship gets affected by the Material Related Factors, Pricing Policies and managerial skills and vice-versa. Owners satisfaction gets affected by just financial resources. Whereas, financial resources gets affected by managerial skills, owners satisfaction and pricing policies.

X. CONCLUSION

Identification of key factors has been done and a questionnaire to identify the critical success factors is also designed and distributed to the stakeholders. 85% of the respondents have responded till today's date. The aim for the number of stakeholders is kept 120-135. Data collected will be analysed by SPSS.

Based on these 85% (i.e. 114 no.) responses a hypothesis is proposed (Fig.2) for interrelationship of the critical success factors, will be needed to revise and developed by deleting some of the hypothesis and developing new interrelationships.

By analysing the key factors we got the most influential Critical Success Factor which is pricing policies affecting construction industry. This identification works as preventive measures for the construction industry. Results can be used to improve inter-organizational performance and therefore improve project performance.

By studying hypothesis leads to interrelationship of CSF's. Showing that maximum number of categories of the CSF's have interrelationship with the managerial skills of the project manager affecting the project success.

Study of critical success factors is important to achieve new heights in the construction industry and to overcome the failures of the project. Results can be used to improve inter-organizational performance and therefore improve project performance. The cycle shown above will be used to improve the results.

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