EVALUATION OF SUCCESS FACTORS IN CONSTRUCTION INDUSTRY BY USING RII

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Abstract - Success has been the ultimate goal of every business activity. It is highly important for the organizations to be successful in their businesses in order to survive in competitive business environments such as construction. Thus, construction companies have to adopt these applications and develop appropriate strategies to be more competitive in this industry and get success in their businesses. The different success parameters for projects in this industry are cost, time and quality. In this study, an attempt is made to identify the critical success factors, which attributes towards the success of the construction project. Forty crucial success factors were identified through an extensive literature survey. A two stage questionnaire-based survey was conducted to solicit the consistent judgment of 50 experts working in different sectors like real estate as well as in infrastructure having a wide experience, which they have gained during their involvement in the construction field. Twenty success factors were identified by Relative Important Index as the most crucial factors, which govern the success of the project according to analysis of the first stage responses. Some of the critical success factors obtained after analysis are Availability of material resources, Project manager's competence, Timely payment of contractor/ consultant, Technical capability of contractors/ Experience of the contractor, adequacy of design details and specification, good co-ordination among project participants, a regular progress meeting on projects, excellent technical capability of the contractor, etc. The second stage survey helped to evaluate the extent of criticality of these factors in to three categories as supercritical, critical, and subcritical with reference to the indicated performance.

Index Terms - Relative Important Index (RII), Success Attributes, Failure Attributes, etc.

I. INTRODUCTION

In any construction project, a number of scarce resources are at stake. If a project is executed well—under the stipulated time and cost, and with the desired quality - it gives immense satisfaction to the participants. The project is then termed successful. Researchers from the area of project management have tried to find the attributes or factors that make a project either a success or a failure. The inherent objectives behind these researches have been to emulate the success factors and eliminate the factors responsible for failure. A number of studies have been carried out since the 1960s to identify the performance-affecting factors of projects in different countries, and the findings are recorded in several international literatures. Besides, the professionals have also shared their experiences in these literatures.

The term 'success' itself has undergone a sea change in the complex project environment with so many stakeholders. Success for one participant may be failure for another participant. The Denver airport project in the USA reveals that what is viewed as failure today may be treated as success in future (Griffith et al. 1999). Besides, the construction projects today are no longer confined to a single discipline but are generally multidisciplinary. Modern projects involve multiple players such as designers, contractors, subcontractors, construction managers, consultants and specialists from different disciplines. In a multi-agency environment, it is natural to have a clash of objectives among different participants. The objective of project management is to ensure success of the project, which is not just managing the schedule, cost and quality, generally known as 'the iron triangle'. Apart from 'the iron triangle', a number of performance-measuring parameters/criteria are cited to call a project successful, such as satisfaction of project participants, technical performance of the project, and number of disputes at the completion of project. Thus, the measurement of performance also depends to a great extent on the criteria employed to measure it (PMBOK 2000).

II. CRITERIA FOR PROJECT PERFORMANCE EVALUATION

Criteria are the set of principles or standards by which judgment is made (Lim and Mohamed 1999) and are considered to be the rule of the game. Traditionally, project performance is evaluated using schedule, cost and quality performances, also known as the 'iron triangle' (Atkinson 1999). Subsequently, different researchers have proposed different sets of success evaluation criteria in addition to the iron triangle. You can make an analogy of these criteria with the performance measurement of a student in a particular course - marks obtained, attendance, discipline, and so on. Some of the criteria used by Baker et al. (1983), Ashley et al. (1987), Freeman and Beale (1992), Maloney (1990), Norris (1990), Parfitt and Sanvido (1993), Songer and Molenar (1997), and Lipovetsky et al. (1997) for evaluating the performance of a project are given in the following paragraphs.

A. Budget or Cost Performance

The project if completed at or under the contracted cost is characterized as a successful project. The cost-success criterion could be measured in terms of cost over/under-run as a percentage of initial budgets.

B. Schedule or Time Performance

The project if completed on or before the contractual finish time is a successful project. The time-success criterion could be measured in terms of over/under-runs as a percentage of the initial plan.

C. Quality Performance—Whether Specifications Have Been Met

If the completed project meets or exceeds the accepted standards of workmanship in all areas and conforms to user's expectations, it is regarded as a successful project. In other words, 'the project must produce what it said it would produce' (PMI 1996). Quality typically includes such measures as the amount of rework required.

D. Safety

If the project honors health and safety rights of the people involved with the project by ensuring safe working conditions, it is regarded as a successful project. According to Crane et al. (1999), safety performance can be measured by compiling safety statistics such as lost-time incidents.

E. Dispute

If the project is completed with the least number of litigations resulting from disagreements among participants, it indicates that the project is a successful one. Dispute could be measured in terms of either the number of disputes or the monetary value involved in the dispute, or through qualitative measures such as whether there are minor or major disputes, and so on.

F. Stakeholder Satisfaction

If the completed project meets or exceeds the stakeholders' goals, it is termed as a successful project. The key stakeholders include architect, client, contractor, engineer, project manager and subcontractor/vendor. The project is also considered successful by employees if it has enabled personal growth for the employees of contractor and owner organizations.

G. Other Criteria

Some other criteria used to measure the performance of a project are:

- Whether the performance of constructed facility is as per the expectation and specifications, and whether the design goals have been met
- Whether the project has met the functionality requirement as expected
- Whether any technical innovation has been achieved during the implementation of project
- Whether the efficiency of project execution was as per requirement
- Whether managerial and organizational expectations have been met during the project implementation
- Whether the financial performance/profitability is as per the expectations of the stakeholders
- Whether the project has made any substantial and positive impact on the customer
- Whether the project implementation has influenced the involved organization's business favorably and whether it has helped the organization better prepare for the future
- Whether the project has benefited the customer, and whether it has led to favorable influence on the national infrastructure

A close look at the success criteria suggests that these can be kept under two broad categories - objective and subjective. Making an analogy with the student example, marks obtained in a course can be objectively defined, while discipline and other criteria can be taken as subjective. In the case of project evaluation, the objective criteria are those that are tangible and measurable, such as schedule, cost, quality, safety and dispute, while the subjective or intangible criteria may include client satisfaction, contractor satisfaction and project management team satisfaction.

Based on the above discussion, it can be concluded that distinguishing a project along broad terms such as success or failure is always going to be contradictory. Similarly, there is hardly any coherence in the opinion on how to measure the performance of a project - i.e., what set of criteria to employ.

Construction projects are vital for the growth of a nation and so is the need to make all-out efforts in ensuring the successful outcome of a project. In the next section, we discuss some of the attributes that are considered key to ensure the success of a project.

III. PROJECT PERFORMANCE ATTRIBUTES

Project attributes are the variables that influence the outcome of a project. The attributes can be people (project participants and their traits), resources, technology, working environment and system, or tasks. '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). Also, there are certain attributes termed as failure attributes, which when present lead to failure of the project. Finding the success attributes and maximizing them is as important as finding the failure attributes and minimizing them. Accordingly, researchers have put their energy into identifying success attributes and failure attributes, with the common objective of enhancing the chances of project success. The success and failure attributes are discussed separately in the next two sections.

A. Success Attributes/ Factors

Some of the success attributes identified from literatures (Sayles and Chandler 1971, Martin 1976, Baker et al. 1983, Cleland and King 1983, Locke 1984, Morris and Hough 1987, Schultz et al. 1987, Chan et al. 2001, Ashley et al. 1987, Chan et al. 2001a, Mansfield and Odeh 1991, McNeil and Hartley 1986, Thompson 1991) are listed in Box 19.1. They are classified under some major heads purely for ease in reading. The attributes are also referred to as critical success factors (CSF). CSFs are those key areas of activity in which favorable results are absolutely necessary for a particular manager to reach his or her own goals…those limited number of areas where 'things must go right' (Rockart 1982).

B. Failure Attributes

Avots (1969) concludes that choice of wrong project manager; unplanned project termination and unsupportive top management are the main reasons for project failure. Hughes (1986) in another study identifies that projects fail because of improper basic managerial principles such as improper focus of the management system, rewarding the wrong actions and lack of communication of goals. Chitkara (1998) points out inadequate project formulation and improper management of projects as the primary reasons for project failures. According to Bonnal et al. (2002), the skill sets needed to manage the pre-project phase and the project phase are quite different. Inability to recognize this may lead to wrong selection of personnel for the pre-project and project phases, and ultimately lead to the failure of a project. Researchers have identified the factors responsible for causing schedule overrun, cost overrun and so on, in different parts of the world. These factors have been taken from the studies conducted by Mansfield et al. (1994), Chan and Kumaraswamy (1997), Dumont et al. (1997), and Jha (2004), and are summarized thus:

- Poor contract management - this may be due to lack of adequate experience and training
- Inadequate technical manpower
- Very low level of productivity
- Inadequate finances for short- and long-term purposes, and absence of specialization
- Unforeseen ground conditions and changes in site conditions
- Shortage of materials and plant items

- Design changes
- Price fluctuations
- Inaccurate estimates prepared by contractor
- Too many change orders (variations of works)
- Fraudulent practices and kickbacks
- Poor site management and supervision
- Slow speed of decision-making involving all project teams
- Poor scope definition

IV. METHODOLOGY

The Research approach is carried in following steps:

- Identified the success factors commonly considered in the construction field, through an extensive literature survey.
- After identification of success factors, a questionnaire-based survey conducted to draw the views of experienced professionals on these success factors, which includes 40 questions.
- RII (Relative importance index) is used in order to decide the ranking of the success factors.
- After the ranking of all success factors, their ranks under consultant and contractor are compared and Spearman rank correlation coefficient (Rs) between is found out to determine correlation between them.
- The output of first questionnaire survey (top 20 factors) was taken for the second round of the survey. The questions based on those top 20 factors were asked in order to obtain the last objective of the project.
- The simple analysis is done in order to get the results.
- To establish a relatively comprehensive and systematically CSFs system, with experts and practicing professionals in the construction industry.
- The hypotheses will be examined to explore the relationship between success factors for various criteria for highly successful projects.

V. DATA COLLECTION AND ANALYSIS

On the basis of questions framed for the survey the responses were collected from different technical persons who work either for consultancy services or for contractor. Generally, Project Management Consultancy (PMC) represents owner hence those who works for owner are directed in the group of consultants.

Relative Important Index is used for the ranking of the factors. ANOVA (Analysis of Variance) cannot be used on this type of survey because it is for the hypothesis testing.

Simple analysis is done on data collected in second round of survey.

A. Data collection approach and tools

Data collection includes data from two round of survey, the details are given below.

a. Data collection of the first round

Out of the 86 questionnaires that were sent out, 50 were received for the first round of the survey the details are given in the Table 5.1. The avg. experience is 8 years in case of Contractor and 9 years in case of consultant.

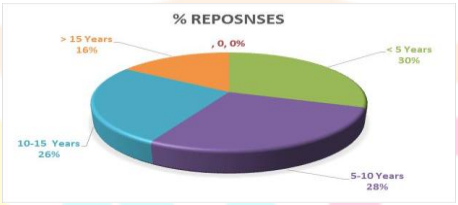

Fig 5.1 Percentage of Responses

b. Data collection of second round

In the second round of survey total 20 responses (1/3rd of the first round) were received. Out of that 12 responses were from consultant and 8 responses were from contractor. The responses collected in this round was less than what collected in the first round, this is mainly because of the scope of project in the second round.

B. Overview of the data collection and analysis

- In the first round survey analysis of collected data was done on SPSS (Statistical Package for the Social Sciences) software.
- The analysis includes the Factor analysis of the data etc.
- Relative Important Index is used for the ranking of the factors. ANOVA (Analysis of Variance) cannot be used on this type of survey because it is for the hypothesis testing.
- Simple analysis is done on data collected in second round of survey.

Ranking of the factors are done on the basis of RII

Relative importance index (RII) = $$\frac{\sum w}{A * N}$$

Where w is the weight given to each attribute by the respondents and ranges from 1 to 5, A is the highest weight (i.e., 5 in my case), and N is the total number of respondents.

For Example

In combined analysis currently there are total 50 responses, the sum of all responses for particular factor, (consider PM competency factor) is 181 then calculation for RII will be

RII = 181/ (5*50) = 0.724

So RII factor for PM competency is 0.724

The range for the RII is 0.4 to 1.0

VI. RESULTS AND INTERPRETATIONS

The analysis of the projects directs towards outcome of the project which includes the outcome of first round of survey i.e. most important factors (Top 20 factors), Least important factors and finally the sorting of the factor with respect to their importance in the project.

A. Findings of the project in first round

After the analysis of first round most and least important factors are sorted out and results are as given below in Table no. 6.1 and 6.2

a. Most important factors

If we compare top 10 factors in combined analysis with top 10 factors in contractor and consultancy, then we find the following results:

Table no. 6.1 Top 20 factors

Most important Factor			
Rank	Factor		RII
1	**F38**	Availability of material resources	0.728
2	**F5**	Project manager's competence (A trained and experienced project manager)	0.724
3	**F1**	Availability of trained and technical human resources	0.712
4	**F28**	Quality(Regular quality control and quality assurance activities)	0.708
5	**F8**	Timely payment of contractor/ consultant	0.696
5	**F36**	Technical capability of contractors/ Experience of the contractor	0.696
7	**F14**	Effective & Detailed planning of projects and plan implementation	0.692
8	**F3**	Availability of funds	0.680
8	**F39**	Safety requirements on site	0.680
10	**F20**	Adequacy of design details and specifications	0.664
11	**F2**	Good coordination among project participants	0.660
12	**F16**	A regular progress meeting on projects	0.648
12	**F32**	Effective allocation of man power	0.648
14	**F11**	Design of projects in accordance with government objectives	0.636
14	**F35**	Clear end user requirements	0.636
16	**F25**	Use of superior and appropriate technology	0.632
17	**F23**	Open and effective communication between client and contractor	0.628
18	**F10**	Preparation of Strong /detailed plan effort in design and construction	0.624
19	**F40**	Impact on public (In case of Dam, Nuclear power plant project etc.)	0.620
20	**F6**	Construction techniques used	0.612

- In consultancy's & contractor's top 10 there are 7 common factors for each. (Refer slide 21)
- (F28) Quality(Regular quality control and quality assurance activities), (F7) Influence of Political risks/ Political support, (F39) Safety requirements on site, (F11) Design of projects in accordance with government objectives and (F40) Impact on public (In case of Dam, Nuclear power plant project etc.) are not in the list of contractors top 10 but are in the list of consultants top10.
- While (F8) Timely payment of contractor / consultant, (F20) Adequacy of design details and specifications, (F2) Good coordination among project, (F3) Availability of funds and (F16) Regular progress meeting on projects are in the list of contractor but not in the list of consultant.

b. Least important factors

According to RII the list of least of least important factors are given in the table 5.2. In the analysis it is found that Political risk (F13), Minimization of conflict between stakeholders (F17), Optimization of legal and administrative services (F18), Stakeholder involvement is important for project success (F12), Cooperativeness of stakeholders on project (F21) etc. are among the top 5 least important factors.

Table no. 6.2 Least Important Factors

Least important Factor			
Rank	**Factor**		**RII**
1	**F22**	Minimization of conflict between stakeholders / No Disputes	0.476
2	**F13**	Involvement of Stakeholders	0.484

2	**F30**	Stakeholders co-cooperativeness during project execution/ solve problems	0.484
4	**F15**	Optimization of administrative services & Legal Obligations	0.500
5	**F17**	Establishment of appropriate organizational structure/ framework	0.528
6	**F33**	Realistic obligations/clear goals & objectives	0.536
6	**F18**	Performance management at each phase	0.536
6	**F12**	Troubleshooting (Certainty Clarification) / Timely assurance	0.536
9	**F9**	Favorable working conditions (site limitation and location/ accessibility)	0.548
10	**F31**	Risk identification and allocation, study of economic risks	0.552

B. Findings of the project in second round

The results of second round will help the project manager to concentrate on the factors which are categorized in three parts i.e. Supercritical, Critical and Sub critical as given in table no. 6.3.

Table no. 6.3 Results of the second survey

Super Critical Factors	**Critical Factors**	**Sub Critical Factors**
Availability of material resources (F38)	Availability of trained and technical human resources (F1)	Good coordination among project participants (F2)
Project manager's competence (F5)	Quality (F28)	Design of projects in accordance with government objectives (F11)
Timely payment of contractor/ consultant (F8)	Effective & Detailed planning of projects and plan implementation (F14)	Clear end user requirements (F35)
Technical capability of contractors/ Experience of the contractor (F36)	Adequacy of design details and specifications (F20)	Open and effective communication between client and contractor (F23)
Availability of funds (F3)	A regular progress meeting on projects (F16)	Impact on public (F40)
Safety requirements on site (F39)	Effective allocation of man power (F32)	
Use of superior and appropriate technology (F25)	Preparation of Strong /detailed plan effort in design and construction (F10)	
Construction techniques used (F6)		

VII. CONCLUSION AND FUTURE WORK

This study helps to identify the rankings of the critical success factors for the construction projects according to project management consultancy and contractor point of view. The factors can be further categorized in to following three group i.e. Supercritical, Critical and Subcritical.

From the analysis of ranking based on contractor and consultant groups, the results are mixed, so we can conclude that Consultant and Contractor do have the different approach or opinion on factors which can affect success of the project. The work can be carried on success factors according to contractor point of view in real estate project or in infrastructure project and the same with consultant point view. And after comparing that results will be more sophisticated. It is suggested that the critical factors identified in the analysis above should be followed during the execution of the project.

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