APPLYING ANALYTICAL HIERARCHY PROCESS TECHNIQUE TO DETERMINE THE EARLY PREDICTABILITY OF PROJECT SUCCESS

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Abstract: A project can be captured on paper with a few elements, a start date and an end date, the task that has to be carried out and when they have to be finished. The common view of project success depends on whether the project is successful? "A project fails when project objectives are not achieved and therefore no business value is obtained". Thus in reality to ensure project success there must be less dependency on the tactical execution of the project and more focused on the projects ability to deliver business value. Success also depends mainly on two components which are completion and outcome satisfaction by the sponsors. If is not achieved, then failure of the project is inevitable. Through this research we found and analyzed the different factors in the chronological order of their influence on the project success by developing a model based on the Analytical Hierarchy Process to investigate the most critical success factors for different project is inevitable. In order to achieve such a task interview surveys were conducted with thirty three experts from real estate sector with a minimum ten years of experience in the construction industry, twelve owners representatives, thirteen contractors and eight from the consultants .

Results are reported for all the project participants and also for overall construction industry. After that pair wise comparison and analysis of fifty four factors were done. Overall project participants agreed on time as the most important project objective and financing group as the least factor.

Keywords: AHP method, Success factors, Critical factors, Ranking

INTRODUCTION:

A construction project is completed as a result of a combination of many events and interactions, planned or unplanned, over a life of a facility, with a change in the environment and participants. Certain factors are more critical to project success than others. These factors are called critical success factors (CFS's). The term "CFS's" in the context of projects and the management of projects, was first used by Rockart (1982) and is defined as those factors predicting success on projects1.

Our research is focused to the construction industry of India is focused to the construction industry of India, based on the results of the survey, it is anticipated that patterns will emerge regarding the key performance indicators for measuring project success in Indian construction industry. These results could then be used in effecting successful projects. The three important factors of project success are to complete the project within the given time, cost and money meeting the quality requirements.

AIM OF STUDY

The aim of study is to develop a system for measuring construction project performance and to use it in analyzing the success factors of a construction project. The scientific contribution of the study is thus the new understanding of factors that should be taken into consideration in trying to improve performance of a project.

METHODOLOGY

Steps involved in study:

- Sampling
- Data collection
- Data analysis
- Result interpretation

Sample the data to be collected should be obtained from the different professions in the construction industry such as project managers, architects, engineers, contract administrators, site supervisors, quantitative surveyors etc.

Data will be collected using a questionnaire consisting of a series of questions related to the factors responsible for the project failures. Weightages for the different factors will be assigned to arrive at the most critical factors affecting a project success or failure.

Data analysis will be done using statistical method.

Results would be concluded.

LITERATURE REVIEW

It was done to determine the various factors which are effecting in the project success. This review is done on the various research studies, magazines, journals etc. Mainly, study was focused on the research studies which were conducted in the past. Subjects focused on the review study were to determine the following questions,

1. What is meant by success?
2. What are the different project objectives?
3. Who are the different project participants?
4. What is meant by the critical success factors?
5. What are the critical success factors, as identified in the previous researches?
6. Define AHP?

Project success should be viewed from the different perspectives of the individual owner, developer, contractor, user, the general public, and so on. For those involved with a project, project success is normally thought of as the achievement of some predetermined project goals, which commonly include multiple parameters such as time, cost, performance, quality and safety. The expectation on the outcome of the project and the perception of the project success or failure will be different for everyone (*Lim and mohammed,* 1999).[1]

According to a significant and comprehensive study by *Murphyet al.* (1974), the definition of project success centers upon "perceptions" and they argue that the definition be termed more appropriately as "perceived success of a project".[2]

According to *Pinto and Slevin* (1988) "There are few topics in the field of project management that are so frequently discussed and yet so rarely agreed upon as the notion of project success."[3]

Griffith et al.(1999) concluded in their research that there does not seem to be a universally accepted definition or measurement of project success.[4]

Sanvido et al.(1992) developed a list of typical success criteria for the owner, consultant, designer, and contractor.[5]

Owner's criteria for measuring the success are:
1. On schedule
2. Within budget
3. Quality
4. Function for intended use (satisfy users and customers)
5. End results as envisioned
6. Return on investment

Consultants/Designer's criteria for measuring success are:
1. Client satisfaction
2. Quality architectural product
3. Design fee and profit goal
4. Experience gained, leaned new skills
5. Met project budget and schedule
6. Minimal construction problems(disputes, liabilities)
7. Well defined scope of work.

Contractor's criteria for measuring success are:
1. Meet schedule (pre-construction, construction, design)
2. Profit
3. Under budget(savings)
4. Quality specifications met
5. No claims
6. Safety
7. Client satisfaction
8. Good communication (exceptions of a parties clearly defined).

Chua (1999) studied the effect of 67 success factors on the cost, time and quality performance of a construction project. Variables were divided into four groups: project characteristics, contractual agreements, and interactive process. The data collection method was a questionnaire, and the sample size was 20 respondents. The result was that there were different sets of success factors for different project objectives. Project success was not determined exclusively by the project managers: project characteristics and contractual arrangements too influenced project success.[6]

Chan (2001) studied success factors in the design-and-build projects. A survey using a questionnaire was completed for a sample of 53 respondents from 19 projects. Factor analysis of 31 variables revealed six project success factors. Those were project team commitment, the client's competencies, the contractor's competencies, risk and liability assessment, end user needs, and constraints imposed by end users. The first three were found to be most significant.

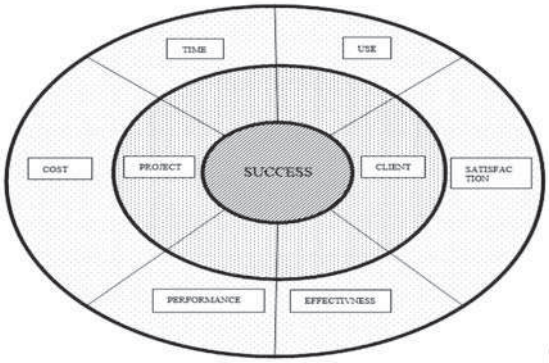

FIG1. Model for project success (Lim and Mohammed, 1990)

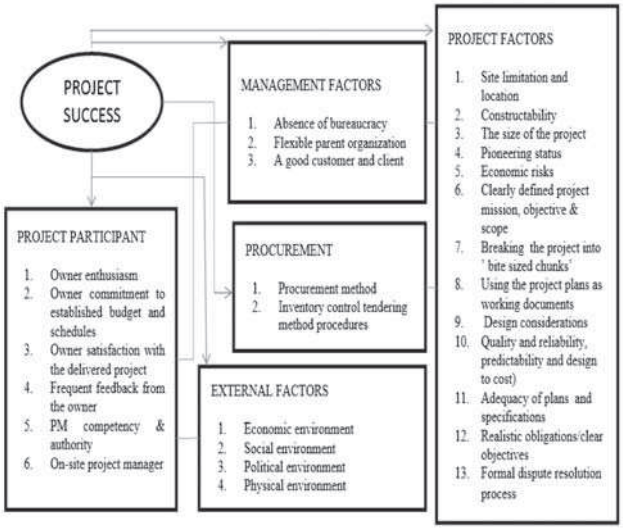

FIG2. New conceptual framework for factors affecting project success

This is the new conceptual framework for the factors which are affecting the project success which include internal and the external factors8.

RESEARCH METHODOLOGY

The research encircled project participants (experts) belonging to three major groups i.e. owner/owner representative, consultant, contractor. Experts to be interviewed must be experienced in industrial, commercial, and government sectors. First of all whole concentration of research should be on acquiring knowledge through extensive literature review about different project objectives, project participants and critical success factors from the point of view of researches and project participants throughout the world. The research methodology constitutively will be distributed into following phases of research program as shown in the chart:

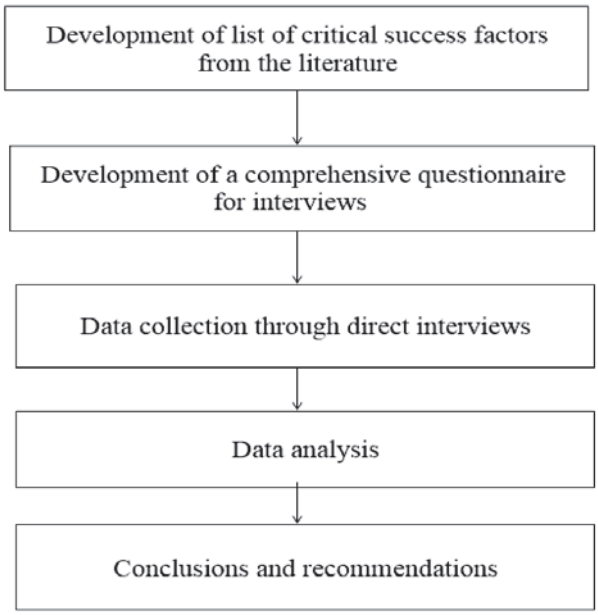

FIG3. Methodology Flowchart

Project Aspect	Success Related Factor
Materials	Shortage, changes in type and specifications during construction, slow delivery, damage in shortage while needed on site, delay in special manufacturing out of India
Manpower	Shortage, labor skill, nationality of laborers
Equipment	Failure, shortage, unskilled operators, slow delivery, poor productivity
Financing	By contractor during construction, delays in contractors progress payments by owner, cash problems during construction
Changes	Design changes by owner or agent during construction, design errors made by designers, foundation conditions encountered in the field, mistakes in soil investigation, water table conditions on site, errors committed during field construction on site.
Government relations	Obtaining permits from municipality, obtaining permits for laborers, excessive bureaucracy in project owner operation, building codes used in design of projects
Environment	Weather effect on construction activities, insufficient available utilities on site, social and cultural factors
Contractual relationships	Relationship between different subcontractors schedules in execution of project, conflict between contractor and consultant, uncooperative owner, slowness of owners decision making process, joint ownership of projects, poor organization of contractor or consultant, difficulty of coordination between various parties, insufficient communication between the owner and the designer in the design phase, unavailability of professional construction management, negotiation and obtaining of contracts, legal disputes between various parties in the construction project, project delivery systems used
Scheduling and controlling	Preparation and approval of shop drawings, waiting for sample materials approval, preparation of scheduling networks and revisions by consultant while construction is in progress, lack of training personnel and management support to model the construction operation, lack of database in estimating time and resources, inadequate early planning of the project, inspection and testing procedure used in the project, application of quality control based on foreign specification, traffic control regulation practiced in the site of the project, accidents during construction

Table1: Success factors considered in this study

Analytical Hierarchy Process (AHP) Steps

The AHP involves four steps:

1. Constructing a decision hierarchy by breaking down the decision problems into a hierarchy of inter related elements.
2. Performing pair wise comparisons of the inter-related elements.
3. Estimating the weights of the decision by using Eigen value method.
4. Aggregating the relative weights of the decision elements to provide a set of ratings for the decision alternatives.

Three major principles of analytic thought associated with AHP are construction of hierarchy, establishment of priorities and logical consistency.

Constructing Hierarchy:

- Represent the problem as thoroughly as possible, but not at the expense of loosing sensitivity to change in the elements.
- Consider the environment surrounding the problem.
- Identify the issues or attributes that contribute to the solution.
- Identify the participants associated with the problem.

The technique of hierarchy used is that from top to down. The last level of hierarchy has given more choices of alternative selection choices.

Establishing Priorities:

A hierarchy of levels is meaningless if priorities are not determined. A method designed to decide the relativity of one element over the other. Every input is rated on a 1-9 judgment scale to determine relative importance of the attributes on one level of the hierarchy to one another20. The 1 to 9 scales is tabulated in below table

10	Best Alternative
9	Extremely preferred
8	Very strongly to extremely
7	Very strongly preferred
6	Strongly to very strongly
5	Strongly preferred
4	Moderately to strongly
3	Moderately preferred
2	Equally to moderately
1	Equally preferred

Tab2. Pair Wise Comparison Scale

After scales of judgment have been identified for any levels of the hierarchy, matrices are constructed for each level from top of the hierarchy. Suppose we wish to compare a set of n attributes in pairs according to their relative weights, as shown in Figure4. The top left entry of the matrix represents the attributes that are being compared and denoted by $A_1, A_2, A_3, ...A_n$ and their weights are by

$W_1, W_2, W_3, ...W_n$. The pair wise comparisons may be

Criterion	A_1	A_2	A_3	A_n
A_1	W_1 / W_1	W_1 / W_2	W_1 / W_3	W_1 / W_n
A_2	W_2 / W_1	W_2 / W_2	W_2 / W_3	W_2 / W_n
A_3	W_3 / W_1	W_3 / W_2	W_3 / W_3	W_3 / W_n
.	.	.	.	.
.	.	.	.	.
A_n	W_n / W_1	W_n / W_2	W_n / W_3	W_n / W_n

Fig4. A simple matrix of pair wise comparison

To find overall priorities, the subjective judgments (1-9) must be synthesized to estimate the relative priorities of the objectives with respect to each other criterion. To do so, the values in each column of the comparison matrix A_1 must be added, dividing each entry in the matrix by the total of the corresponding column to obtain the normalized matrix. Finally, the entries of each row of the normalized matrix must be added, dividing the total by the number of entries of each row to obtain averages. Those averages are the estimates of the overall priorities for the lower level alternatives. These values are between 0 to 1, and their total should be unity. Next, a hierarchy composition (synthesis) is used by multiplying the vectors of priority by the weight of the criteria, and taking the sum overall weighted priority entries corresponding to those next lower levels and so on. The priorities are derived from the matrices of judgment based on the mathematical principles of Eigen vector and value.

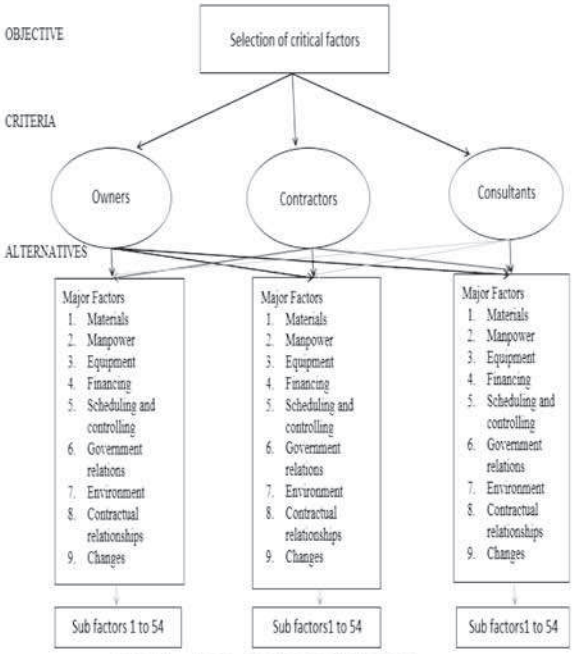

FIG5. AHP FRAME WORK

8. Results:

	Material	Manpower	Equipment	Financing	Changes	Govt. Relations	Scheduling & controlling	Environment	Contractual Relationship	PV	Rank
Material	1.00	0.85	1.15	0.77	0.95	0.99	1.20	1.51	0.99	0.11	6
Manpower	1.18	1.00	1.36	0.91	1.21	1.16	1.42	1.77	1.16	0.13	2
Equipment	0.87	0.74	1.00	0.67	0.82	0.85	1.04	1.30	0.86	0.10	7
Financing	1.29	1.10	1.49	1.00	1.22	1.27	1.55	1.95	1.28	0.14	1
Changes	1.06	0.90	1.22	0.82	1.00	1.04	1.27	1.59	1.04	0.12	3
Govt. Relations	1.01	0.86	1.17	0.79	0.96	1.00	1.22	1.53	1.00	0.11	4
Scheduling & controlling	0.83	0.71	0.96	0.64	0.79	0.82	1.00	1.25	0.82	0.09	8
Environment	0.66	0.56	0.77	0.51	0.63	0.65	0.80	1.00	0.66	0.07	9
Contractual Relationship	1.01	0.86	1.17	0.78	0.96	1.00	1.22	1.52	1.00	0.11	5
Sum EV	8.91	7.57	10.29	6.90	8.44	8.79	10.72	13.42	8.81	1	-

Tab3. Matrix for Owners

	Material	Manpower	Equipment	Financing	Changes	Govt Relations	Scheduling & controlling	Environment	Contractual Relationship	PV	Rank
Material	1.00	1.67	1.52	0.96	1.24	1.25	1.34	1.69	1.22	0.14	2
Manpower	0.60	1.00	0.91	0.58	0.74	0.75	0.80	1.01	0.73	0.08	8
Equipment	0.66	1.10	1.00	0.63	0.81	0.82	0.88	1.11	0.80	0.09	7
Financing	1.04	1.74	1.58	1.00	1.28	1.30	1.39	1.75	1.27	0.15	1
Changes	0.81	1.35	1.23	0.78	1.00	1.01	1.08	1.36	0.99	0.11	4
Govt Relations	0.80	1.34	1.22	0.77	0.99	1.00	1.07	1.35	0.98	0.11	5
Scheduling & controlling	0.75	1.25	1.14	0.72	0.92	0.93	1.00	1.26	0.91	0.11	6
Environment	0.59	0.99	0.90	0.57	0.73	0.74	0.80	1.00	0.72	0.08	9
Contractual Relationship	0.82	1.37	1.25	0.79	1.01	1.02	1.10	1.38	1.00	0.12	3
Sum EV	7.06	11.80	10.76	6.80	8.73	8.81	9.47	11.91	8.62	1	-

Tab4. Matrix for Contractors

	Material	Manpower	Equipment	Financing	Changes	Govt Relations	Scheduling & controlling	Environment	Contractual Relationship	PV	Rank
Material	1.00	1.27	1.44	0.74	1.13	1.07	1.22	2.08	1.06	0.13	2
Manpower	0.79	1.00	1.13	0.58	0.88	0.84	0.96	1.64	0.83	0.10	7
Equipment	0.69	0.88	1.00	0.51	0.78	0.74	0.85	1.45	0.73	0.09	8
Financing	1.35	1.72	1.94	1.00	1.52	1.44	1.65	2.81	1.43	0.17	1
Changes	0.89	1.13	1.28	0.66	1.00	0.95	1.08	1.85	0.94	0.11	5
Govt Relations	0.94	1.19	1.35	0.69	1.05	1.00	1.14	1.95	0.99	0.12	4
Scheduling & controlling	0.82	1.04	1.18	0.61	0.92	0.88	1.00	1.71	0.87	0.10	6
Environment	0.48	0.61	0.69	0.36	0.54	0.51	0.59	1.00	0.51	0.06	9
Contractual Relationship	0.95	1.20	1.36	0.70	1.06	1.01	1.15	1.97	1.00	0.12	3
Sum EV	7.90	10.06	11.37	5.85	8.89	8.44	9.64	16.45	8.36	1	-

Tab5. Matrix for Consultants

8.1 Priority Matrix For Factor Ranking

Factors	Owners	Contractor	Consultant	Overall PV	Result of AHP
Material	0.112	0.142	0.127	0.127	2
Manpower	0.132	0.085	0.099	0.105	6
Equipment	0.097	0.093	0.088	0.093	8
Financing	0.145	0.147	0.171	0.154	1
Changes	0.118	0.115	0.121	0.115	5
Government Relations	0.114	0.113	0.119	0.115	4
Scheduling & Controlling	0.093	0.106	0.104	0.101	7
Environment	0.075	0.084	0.061	0.073	9
Contractual Relationship	0.114	0.116	0.120	0.116	3

Tab6. Matrix Ranking

from both the literature review done.

CONCLUSION

Project success has been defined as well as the interview survey from different project participants. The definition given by each participant reflect the objectives whose

Factors	Owners	Contractors	Consultants	Over all
Material	6	2	2	2
Manpower	8	8	7	6
Equipment	7	7	8	8
Financing	1	1	1	1
Changes	3	4	5	5
Government Relations	4	5	4	4
Scheduling &controlling	8	6	6	7
Environment	9	9	9	9
Contractual Relationships	5	3	3	3

Tab7. Priority Table

Percentage agreement between the participants

Owners and contractors : 30%

Owners and consultants : 30%

Consultants and contractors : 40%

Percentage agreement between participants and overall ranking

Owners with overall ranking : 30%

Contractors with overall ranking : 30%

Consultants with overall ranking : 70%

Factor Wise Interpretation

Material:

The material group of delay factors was ranked high by consultants and contractors and relatively low by the owners. This result is mostly due to the delay factor of material shortage. This is probably because owners are unaware of material within the premises.

Financing

All parties agree that the financing group of delay factors is the most important rank of group of delay. It is noticeable that the consultants and owners ranked the factor "financing by contractor" as very important where as the contractors who are getting the financing only ranked it important.

Changes

All parties agree on the ranking of the changes group of delay factors as somewhat high. Within this group the contractors ranked design changes by owner as the most important. The consultants agreed with the contractor, although they did not give it as high an overall ranking. The owner rated design errors made by the designer as the most important delay factor of this group.

Government Relations

The government relations group of delay factors is ranked relatively important by both owners and contractors, whereas the consultant ranked it very low. It is interesting to note that owners who themselves are government agencies ranked excessive bureaucracy as a very important cause of delay.

Scheduling And Controlling

Contractors and consultants seem to agree that this group of delay factors is somewhat important, but the owner gives it a low ranking. However, contractors ranked preparation and approval of drawings as the number one delay factor. Waiting for approval of sample material was also ranked high by contractors. The consultants on the other hand ranked highly the estimating of time and resources required. Accidents during construction were a factor ranked very low by all three parties.

Environment

Environment as a delay group was given the lowest ranking of all groups by all three parties. This is probably because the factors involved are taken into consideration in estimating the time and resources of project activities.

Contractual Relationship

All three parties agree that this group is delay factors are important. This relationship between the sub contractors scheduling in the execution of the project was rated very high by the consultants, but only somewhat high by the owners and contractors. The low competence in owner's organization was ranked high by both contractors and consultants, and rated high by owners. The consultants also ranked highly the factor of controlling subcontractors by general contractors in the execution of work. Owners ranked highly the unavailability of professional construction management.

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