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Project Control Factors at Front End: Indian Perspective

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Abstract The role of project control is to create a system, procedures and tools to monitor and control project delivery. The performance measurement is carried out on continuous basis and action is taken to ensure that project performance objectives are achieved. Although considerable amount of planning and organizing is required at front end, actual monitoring takes place during implementation. Poor definition of control parameters in the front end leads to poor project control brief to the other project participants namely client, consultants and contractors It is required that project control planning should start from beginning to improve the project management efficiency. The research identifies the important project control factors in the project development stage. Two brainstorming sessions resulted in identification of 18 factors that are classified into five project control areas. Analytical hierarchy process as a group decision making tool was used to make a pair-wise comparison to assign weightage to each project control group and factor. The study of weight indicates that quality (32.71%) and safety (23.64%) controls are preferred over schedule (14.74%) and cost (12.48%). Weightage derived is used to create Project Control Index (PCI). Value of PCI helps to understand the level of project controls established in the project during project development on ongoing basis. Weights and PCI guides project manager in setting and achieving project objectives.

Keywords: *project control factors, quality control, project success, analytical hierarchy process*

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1. Introduction

The Project Management Institution (PMI) has identified that most international development (ID) projects suffer from time and cost overrun [1]. Iyer and Jha [2] has observed that over 40% of Indian construction projects had time overrun ranging from 1 to 252 months. The need, therefore, for sound project management practices is emphasized by researchers worldwide.

Project management is defined by experts in different manners. According to Turner [3], *Project management is art and science of converting vision into reality.* Liu and Walker [4] defined scope of construction project management as project planning, controlling and co-ordination from concept to commissioning. Munns and Bjeirmi [5] defined project management as process of controlling the achievement of project objectives. Achieving desired project results through systematic efforts of project management remains the common element among the all these definitions. Also, project control is an essential element of project management.

The project control is that function of project management that uses skills, tools, techniques and knowledge to establish project baseline, followed by performance measurement to update project team with timely and accurate project information [6]. In terms of effectiveness Takim and Akintoye [7] consider a project to be effective when it satisfies users, project is fit for the purpose, is free from defects, gives value for money to client, offers pleasant environment and fulfils all social obligations. Atkinson [8] termed three components of project performance time, cost and quality as the 'iron triangle'. Meyer [9] defines performance measurement at delivery end of project as Result Measurement. Project managers are responsible for achieving project performance goals or results through various project management tools, techniques and skills. The owner needs to create a project control mechanism right from the stage of project conceiving in order to achieve these goals.

According to the project influence curve theory, efforts put in during project conceiving and definition phase cost less and have larger impact on project results than those during subsequent phases. In front-end planning, owner needs to establish an overall plan that deals with cost, schedule, and change management during project execution phase. Project execution strategy and contract type largely govern the physical structure of project control [10].

However, clients in many government projects in India exercise project controls more during implementation stage than at project development stage. Another issue with project is that the policy and procedures are loosely

defined and documents are not standard. A considerable amount of project controls is transferred to contractor and control is limited to making and maintaining schedules and generating weekly and monthly progress report. Owner's control on project time is often restricted to imposing liquidated damages, which is hardly realized due to multiple reasons for delay. Quality control in terms of quality is often assigned to third party, in order to bring transparency in the system. However, the third party agency is hired along with or after hiring contractor, giving them no scope for front end activities.

While there are few index tools available to assist project managers to evaluate project development performance. Design quality indicator (DQI) tool for design quality measurement however focuses on building rather than process. The project development rating index (PDRI) developed by Construction Industry Institute covers various scope definition elements for buildings, but it has limited coverage to project controls. There is no specific tool available to measure the project control scope definition at front end. The research aims to bridge this gap.

2. Basic Project Controls

This research aimed at identifying important project control factors. Safety, quality, cost, schedule, and risk are the basic project control areas which have direct influence on project results.

2.1. Safety

CIDC [11] has estimated that nearly 31 million workers in India are engaged in building and other construction works. Construction process often results in fatal accidents which demotivate workers, disrupt work, delay progress, and it has adverse impact on productivity, cost, and schedule. Therefore, use of effective planning and control techniques to have safer construction has merit [12]. Safety starts from project development phase. It needs to be planned and subsequently controlled. The designer and contractors need to be given safety brief by client [13]. Role of owner with regard to safety could range from selecting better contractor to active participation in safety management during actual execution of work [14].

2.2. Quality

There is a growing concern about decreasing quality in construction in India with news of newly constructed building collapse in metros and increasing number of dissatisfied end users. The government projects are equally criticized for lower quality. There is a substantial cost attached to poor quality. Most companies do not record quality deviation during construction and just rectify the defects as and when they occur. On their study on direct cost of rework on nine industrial projects, [15] found that design deviation and construction deviation costs were 9.5% and 2.5% of the project cost respectively. The status in other sectors may not be better.

Clear policies, quality assurance plan, technical specifications, independent audit, and statistical quality control are some of the quality control factors at front end. Client's vision of project quality guides the consultant and the contractor. Technical specifications form the part of contract document. It plays important role in controlling construction projects [16]. Quality assurance plan is devised by contractors with reference to guiding principles and specifications provided by client. Quality control is effective implementation of quality assurance program [17]. Currently in India, quality control is entrusted to third party consultants. In public projects this is practiced as a means of bringing transparency in system. While testing, frequency of testing and interpretation of results are clearly mentioned in quality assurance plan, the effective implementation, monitoring and controls is something that needs to be strengthened.

2.3. Cost

Cost is measured in terms of unit costs and percentage variation over final costs [18]. Out of 951 central sector projects in India, 309 projects have cost overrun of 55.22% and 12.10 % overall cost overrun [19]. There are several reasons for the cost overrun. The incorrect baseline estimates due to inadequate time available for estimating is one of the prominent reasons. In India, due to urbanization, infrastructure development programs and industrial growth, projects are often put on fast track. This results in quantity variation as the estimates are prepared prior to design completion. Tools such as earn value management are not widely used particularly in real estate projects.

2.4. Schedule

Time is often measured in terms of construction time, speed of construction and time overrun [18]. Time overrun is popular measure for project performance. Out of 955 central sector projects in India, 466 projects have shown time overrun ranging from 1 to 192 months. Out of these 466 projects 139 have exhibited both time and cost overruns [19]. The results clearly indicate that the project monitoring in terms of schedule is ineffective.

Schedules are used as a tool for project control [20]. A comprehensive schedule covering all the phases of the project is missing from many projects in developing countries. The schedule is restricted to the construction schedule and it is often left to contractors. It is not derived from master schedule, but it only captures milestones provided by the owners. The use of software in scheduling is a must, but it is not extensively used for the monitoring purpose. Subcontractors are employed for most jobs in India. Main contractors lose control over number of laborers employed by subs and in the process. Resource schedules are rare in such situation. Overall project monitoring thus happens through milestones and gut-feeling.

2.5. Risk

Barnes [21] defines risk as *uncertain future events, which, if they happen, will cause significant extra cost or delay*. Good risk management practices can minimize losses and increase profitability in construction [22]. However formal risk management practices are not widely practiced due to lack of awareness, particularly on small and medium scale projects. The ways, in which contracts are written, owners try to transfer risk to contractors [23]. However, the ultimate sufferer is the owner and the end results of the project are affected by such risk transfer.

3. Identifying Important Project Control Factors

The selection of brainstorming, as a technique to identify the factors affecting project development, has been carefully done. There are four widely used processes for such purpose as illustrated in figure 1. The technique selection is based on the researcher-informant and informant-informant interaction [24]. Where there is low interaction between researcher and informant and that between informants is low, Delphi process is used. When there is low interaction between researcher and informant, and high interaction between informants, Focus group method is preferable. However, in this case, the interaction between researcher and the respondent has been strong. So, Group interview technique or Brainstorming technique is found to be appropriate. Out of these two, the brainstorming technique is preferred where inter-informant communication is good. Hence, brainstorming technique was adapted in this case.

In order to identify the factors in the project control phase that may have influence on the project performance, two brainstorming sessions were conducted-one each with government organization responsible for implementing public projects and a private developer. One-to-one discussions were also carried out with consultants to seek suggestions. The people involved in brainstorming sessions possessed prior experience of working at the various project development phases.

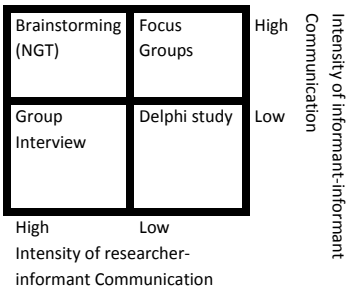

Figure 1. Selection of technique for research (Source : [23])

Table 1. Project Control Factors and their hierarchy

Sl. No.	Factors
1.10	Safety
1.101	Policy, Procedures & Standards
1.102	Housekeeping, accessibility
1.103	Use of Personal Protective Equipment
1.20	Quality
1.201	QA Policy, Procedures and Standards
1.202	Quality Audit
1.203	Specification
1.204	Control charts & analysis
1.30	Cost
1.301	Cost Estimates (baseline)
1.302	Budget and Budgetary Controls
1.303	Cost monitoring system
1.304	Change Order Management
1.40	Schedule Control
1.401	Construction Schedule (Master Schedule)
1.402	Resource Schedule
1.403	Use of Software and tools for Schedule control
1.50	Risk Management
1.501	Risk Identification
1.502	Risk Analysis- Quantitative & Qualitative
1.503	Risk Mitigation
1.504	Risk Monitoring & Control

The 18 factors identified using brainstorming techniques were grouped in to five sections as given in Table 1.

4. Analytical Hierarchy Process (AHP) for Weighting

It was developed by Saaty (1980) and hence sometimes termed as Saaty method. It allows decomposition of problem into a hierarchical structure and utilizes the qualitative and quantitative aspects of problems in the evaluation. Present day AHP has been widely used in many fields applied to different types of problems. The AHP is considered to be the fundamental approach to decision making. AHP is basically multi-criteria decision model. It allows both objective and subjective analysis. AHP is most popular decision-making method owing to its ability to reflect the way in which people think [25]. It is considered to be the comprehensive method which can handle number of criteria and sub-criteria. In this method, pair-wise comparison is carried out by decision maker to select better alternative. AHP takes care of inconsistency in the judgment and provides method to improve such inconsistency [26].

4.1. Use of AHP in Research

As said earlier, AHP is quite useful in weighting and decision making problems. Dvir et al. [27] studied the relationship between project planning and project success from various point of view which covered more than 100 defense research and development projects using factor analysis method. Dalalah et. al. [28] used AHP model by deploying the crane selection objectives into layered sub-goals, to draw conclusions on the type to be used in construction. Farkas [26] applied AHP in selection of most appropriate bridge design. He compared three bridge types with respect to six criteria. The study carried out by Ciptono [29] used AHP for the prioritizing critical success factors of TQM. Gohar et. al. [30] considered fuzzy AHP in evaluating risk of construction projects. Ariff et. al. [31] used AHP in selecting best design concept. They concluded that AHP assists designers in selecting best design concept amongst many conceptual alternatives. Okeola & Sule [32] applied AHP in evaluation of water management alternatives for urban water supply system for future operation and design alternative system improvement.

4.2. AHP for Weighting Project Control Factors

To assign weight to the project control factors, a questionnaire was prepared to make pair-wise comparison. Identification of right sample size is important for questionnaire survey. The research focuses on front end processes and hence more people from the client and consultant side were included, as they are responsible for the project development. The AHP weighting was carried out by experienced engineers. Average experience of the engineers is 21.92 years. They were carefully selected principally from developer/client, government, consultants, PSUs, and contractor organizations. The organization

represented and work experience of the respondents is given in Table 2 and Table 3.

Table 2. Type of organization represented

Sl. No.	Type of Organization represented	Occurrence	% age
1	Builder	7	13.21
2	Contractor	3	5.66
3	Consultant	21	39.62
4	Government (Owners)	19	35.85
5	Academics	1	1.89
6	Public Sector/Board/Semi-govt.	2	3.77
		53	**100**

Table 3. Experience profile of respondents

Sl. No.	Work Experience	Occurrence	% age
1	< 5 Years	4	7.55
2	5 to 10 Years	9	16.98
3	11 to 20 Years	10	18.87
4	More than 20 Years	30	56.60
	Total Work Experience in yrs.	**1162**	**100**

All the responses collected in physical form and soft form were converted into one excel file each. Total 56 responses were received out of total 91 persons approached for the survey making a response rate of 61.54%. Three forms were discarded as they appear to be highly biased, as response were either 9 or 1/9 in almost all cases. Total 53 valid responses were summarized in one file. Geometric mean of all 53 responses was carried out by multiplying and finding out nth root. Geometric mean was entered in the AHP calculation worksheet based software. To determine the validity of the software some manual calculations were also carried out which matched with the worksheet results. Geometric mean data for each comparison was entered into matrix of the worksheet and results of weight, consistency index and consistency ratios were obtained. AHP weights for section and factors derived after calculations are given in Table 4 & Table 6 respectively.

Table 4. AHP Weightage of main sections and its validity

Id. No.	Project Control Area	AHP Weightage	Consistency Index	Consistency Ratio
1.10	Safety	23.64%	0.031	2.8%
1.20	Quality	32.71%		
1.30	Cost	12.48%		
1.40	Schedule Control	14.74%		
1.50	Risk Management	16.44%		

Consistency ratio measures consistency in judgment by the experts. Expert judgment is similar to thinking process where different people may have different thoughts about a subject [33]. Therefore in making a rule or a decision, consistency is required. A widely used tool to measure the consistency in judgment is consistency ratio (CR). CR value should be less than 10% for consistent choice making. Looking at the values of consistency ratio, the weighting results are consistent and satisfactory.

5. Result Analysis and Discussions

The AHP weighting reveals that the quality control has highest weight of 32.71% followed by safety at 23.64%. Cost control section has lowest weight of 12.48%. The top ten project control factors identified are given in Table 5.

QA policy, procedures and standards is considered to be the most important factor contributing to project success. Projects in India suffer because of lack of clear policy, absence of reference standards and ill-defined inspection procedures related to quality. The specifications play a role in defining quality requirements. A need for independent quality audit is felt by respondents due to the failure of execution team to deliver quality goals. Safety is second most prominent project control area perceived by the participants. Again emphasis is on policy, procedures and standards. Considering poor implementation of standards the use of personal protective equipment is next important factor within safety. The third safety factor in project controls at front end is housekeeping and accessibility. Certain mega projects such as Delhi Metro Rail Project on one hand demonstrate excellent safety and housekeeping practices whereas some of the local projects have extremely poor standards of housekeeping and accessibility to work.

Table 5. Top ten project control factors

Sl. No.	Section	Factors	Global Weight	Rank
1.201	Quality	QA Policy, Procedures and Standards	12.00%	1
1.101	Safety	Safety Policy, Procedures & Standards	10.52%	2
1.203	Quality	Specification	9.51%	3
1.103	Safety	Use of Personal Protective Equipment	8.44%	4
1.401	Schedule Control	Construction Schedule (Master Schedule)	7.57%	5
1.202	Quality	Quality Audit	7.06%	6
1.504	Risk Management	Risk Monitoring & Control	4.96%	7
1.102	Safety	Housekeeping, accessibility	4.68%	8
1.402	Schedule Control	Resource Schedule	4.45%	9
1.303	Cost	Cost monitoring system	4.40%	10

In schedule control, need for comprehensive master construction schedule has been considered to be utmost important by the respondents. The requirements related to risk monitoring and control have also been significant factor in achieving project performance objectives. Interestingly, the cost control factor comes at number ten. While the projects generally revolve around cost, but experienced participants do not consider cost control important enough in comparison with quality and safety.

The weights of project control factors can be used to prioritize the activities of project development that has maximum impact. Also, for a given project, a scale of 1 to 5 can be used to rate the each of the project control factors. The value of 1 to 5 against each factor can be multiplied with weightage of that factor to arrive at Project Control Index (PCI) that has maximum value of 500. Projects can be compared internally using PCI value.

$$PCI = \sum_{i=1}^{18} pcfw_i \cdot c_n$$

Where pcfw is weight of i^{th} project control factor and c_n is performance of project control factor for a given project which is

1 for Poor performance
2 for Fair performance
3 for Good performance
4 for Very good performance
5 for Excellent performance

The weights $pcfw_i$ are as given in Table 5 The PCI obtained in this manner can have maximum value of 500.

Table 6. factor weights and validity

Id. No.	Factors	Local Weight	Global Weight	Consistency Index	Consistency Ratio
1.10	**Safety**	**100.00%**	**23.64%**		
1.101	Policy, Procedures & Standards	44.52%	10.52%	0.08	3.1%
1.102	Housekeeping, accessibility	19.80%	4.68%		
1.103	Use of Personal Protective Equipment	35.68%	8.44%		
1.20	**Quality**	**100.00%**	**32.71%**		
1.201	QA Policy, Procedures and Standards	36.69%	12.00%	0.061	6.8%
1.202	Quality Audit	21.58%	7.06%		
1.203	Specification	29.07%	9.51%		
1.204	Control charts & analysis	12.65%	4.14%		
1.30	**Cost**	**100.00%**	**12.48%**		
1.301	Cost Estimates (baseline)	19.09%	2.38%	0.006	0.6%
1.302	Budget and Budgetary Controls	25.87%	3.23%		
1.303	Cost monitoring system	35.28%	4.40%		
1.304	Change Order Management	19.76%	2.47%		
1.40	**Schedule Control**	**100.00%**	**14.74%**		
1.401	Construction Schedule (Master Schedule)	51.34%	7.57%	0.015	2.6%
1.402	Resource Schedule	30.21%	4.45%		
1.403	Use of Software and tools for Schedule control	18.45%	2.72%		
1.50	**Risk Management**	**100.00%**	**16.44%**		
1.501	Risk Identification	26.48%	4.35%	0.017	1.9%
1.502	Risk Analysis- Quantitative & Qualitative	24.12%	3.96%		
1.503	Risk Mitigation	19.25%	3.16%		
1.504	Risk Monitoring & Control	30.16%	4.96%		
	PROJECT CONTROLS		**100.00%**		

6. Conclusions

To achieve project objectives is the key task for project managers. Project objectives are achieved by developing and implementing effective project management practices. Project controls is an important task within project management discipline. This paper has presented an approach to identify the project control factors and assigned weight to these factors. Analytical hierarchy process was selected amongst other methods as AHP considers both qualitative and quantitative aspects in the group decision making. Its applicability is established to wide range of problems. Project control factors identified and assigned weight by AHP can be used to develop PCI which reflects the level of project controls exercised at front end of the project. Controls related to quality and safety has been considered more important than cost and schedule control by the respondents. Validity of PCI can be further checked by applying PCI on completed projects for which both controls at project development and project results are available. The expert participants in the research considered Indian project scenario while responding the AHP questionnaire that has led to identification of factors and weightage which are more applicable to developing countries.

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