

Earned Value Analysis In Construction Industry

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Abstract

Construction industry an important industry at both the global level and national level. It is second largest sector in India. It provides huge employment to the people and plays very significant role in country economy. Project delay is most common problems in the construction industry. Project overruns due to time and cost result in delays during project execution. In developing countries project overruns is a serious where implementation of project faces many uncertainties. It result in wastage of scare financial resources, delays in providing facilities, development and also make construction costlier .With globalization and technology driven economic growth all over the world, a scientific and systematic approach to project management becomes imperative to ensure that project objectives are attained within the constraints of time and resources .EVA is the process of measuring performance of project work against a baseline plan. EVA application helps in providing performance standard for the evaluation of progress report of project and it also act as a control device to take care of time and cost schedule. It provide better performance picture of project and gives better forecast of the final completion cost. Earned Value is an enhancement over traditional process of cost accounting.

1. Introduction

Traditionally the budgeted cost is evaluated by computing the difference between planned cost and actual cost incurred in a project. The focus was on planned expenditure and actual costs. Earned Value reveals future opportunities and it also examines actual accomplishment. With the help of EVA, project managers get sufficient help to keep deep intuitive understanding into potential risk areas. So that with the help of clearer picture of the project cost performances, managers can create risk mitigation plans based on actual cost, schedule and technical progress of the work. It is like an alarm for the managers to identify and control problems by taking timely corrective actions before they become too great to overcome.

It provides better understanding of the project in terms of time and cost schedule. Earned Value Analysis System is a set of guidelines to provide satisfactory completion of project. It has been seen that to cover cost overrun, project team undergoes cost reduction either by reducing the project scope and quality or by providing additional. Similarly in case of time overrun, they plan crashing of activities or fast track programs. Therefore with the use of EVA system, project goals are achieved in better way.

1.1: What is a project?

A project is a temporary endeavour undertaken to create a unique product or service. Temporary means that every project has a definite beginning and a definite end. Unique means that the product or service is different in some distinguishing way from all similar products or services. The end is reached when the project's objectives have been achieved, or when it becomes clear that the project objectives will not or cannot be met and the project is terminated. Temporary does not necessarily mean short in duration; many projects last for several years. In every case, however, the duration of a project is finite; projects are not on-going efforts. In addition, temporary does not generally apply to the product or service created by the project. Most projects are undertaken to create a lasting result. For example, a project to erect a national monument will create a result expected to last centuries. Many undertakings are temporary in the sense that they will end at some point. Temporary means that every project has definite beginning and definite end. The end is reached when project's objectives are achieved.

1.2 Project Management

Project management is the application of knowledge, skills, tools, and techniques to project activities in order to meet or exceed stakeholder needs and expectations from a project. Meeting or exceeding stakeholder needs and expectations invariably involves balancing competing demands among:

- Scope, time, cost, and quality.
- Stakeholders with differing needs and expectations.
- Identified requirements (needs) and unidentified requirements

The term project management is sometimes used to describe an organizational approach to the management of ongoing operations. This approach, more properly called management by projects, treats many aspects of ongoing operations as projects in order to apply project management to them. Projects and project management operate in an environment broader than that of the project itself. The project management team must understand this broader context, managing the day-to-day activities of the project is necessary for success but not sufficient.

1.3 Project Mission

Each project has a specified mission or a purpose to be achieved. A construction project mission is to create a desired facility like housing complex or fertilizer plant. It is not a routine activity like the regular maintenance of building or roads. Each project mission is unique in itself, and no two

projects are ever alike. Project differ from each other in one or more influencing factors such as client and contractors, quality specifications, resource employ, responsibilities delegated and project environments. Each one of these factors has decisive effect on the development of the project.

In general construction projects are high value and employ huge resources of men, material, and machineries. Major works involve heavy investments, say from million dollars to a few billion dollars, require high level of technology and need effective management of resources. Construction projects are time bound. Each project has a predetermined duration with definable beginning and identifiable end. Its start point is the time when client decides to undertake construction and commit his financial resources. It is completed as soon as mission is accomplished. The time span between the start and the completion of the project represents the project life cycle. The completion period of the life of the project varies from few months to few years. Each project is assigned predetermined objectives; these objectives quantify the measurable results to be achieved for accomplishing the mission. Generally the construction projects objectives are stated in terms of project completion time, budgeted cost and stipulated quality specification.

1.4 Project Environment

Most construction project has one or more following characteristics associated with them

- Details of work are not precisely defined
- Scope of work gets modified during execution.
- Nature of work varies from job to job.
- Site of works are located at remote places.
- Places of works are spread out.
- Resource requirements and organization of works differ with each task.
- Investment involved large and the decisions entail risk.

Performance is sensitive to the unexplored site geology, uncertain weather and unforeseen natural calamities. Engineering failures such as ill-define scope of work, inadequate field investigations, faulty designs, absence of quality consciousness and lack of construction experience can delay completion and increase the cost

2. Project Planning And Scheduling Techniques

A schedule is a work program, set date-wise in a logical sequence; it is a time table for action. Time scheduling is the process of developing the work program. It implies the programming of the chosen work plan on a calendar basis and provides the base against which time progress is measured. A work schedule is an action plan with calendar date targets, whereas networking is the planning technique. A network needs to be scheduled in order to determine commencement and termination dates of the each activity, using the optimum resource or working within the resource constraints.

The project employs resources of men, materials, machines and money to execute the activities. Time and resource to be employed in an activity are inter-related. In most of the construction activities, increase in vital activity from a certain level decrease duration of the activity. But this uneven employment of vital resources can reduce productivity, increase the cost and create management problems.

2.1 Project Scheduling Techniques

The basic approach of all scheduling techniques is to form a network of activity and event relationship that graphically portrays the sequential relations between the tasks in a project. Such a network is a powerful tool for planning and controlling a project and has the following benefits:

- It is a consistent framework for planning, Scheduling, monitoring, and controlling the project.
- It illustrates the interdependence of all tasks, work packages, and work elements
- It denotes the times when specific individuals and resources must be available for work on a given task.
- It aids in ensuring that the proper communications take place between departments and functions.
- It determines an expected project completion date.
- It identifies so-called critical activities that, if delayed, will delay the project completion time.
- It also identifies activities with slack that can be delayed for specified periods without penalty, or from which resources may be temporarily borrowed without harm.
- It determines the dates on which tasks may be started or must be started if the project is to stay on schedule.
- It illustrates which tasks must be coordinated to avoid resource or timing conflicts.
- It also illustrates which tasks may be run, in parallel to achieve the predetermined project completion date.

2.2 CPM (Critical Path Method)

Critical path is the sequential activities from start to the end of a project. Although many projects have only one critical path, some projects may have more than one critical path depending on the flow logic used in the project. If there is a delay in any of the activities under the critical path, there will be a delay of the project deliverables. Most of the times, if such delay is occurred, project acceleration or re-sequencing is done in order to achieve the deadlines.

Critical path method is based on mathematical calculations and it is used for scheduling project activities. This method was first introduced in 1950s as a joint venture between Remington Rand Corporation and DuPont Corporation. The initial critical path method was used for managing plant maintenance projects. Although the original method was developed for construction work, this method can be used for any project where there are interdependent activities. In the critical path method, the critical activities of a program or a project are identified. These are the activities that have a direct impact on the completion date of the project.

2.3 PERT (Program Evaluation and Review Technique).

PERT (Program Evaluation and Review Technique) is one of the successful and proven methods among the many other techniques, such as, CPM, Function Point Counting, Top-Down Estimating, WAVE, etc. PERT was initially created by the US Navy in the late 1950s. The pilot project was for developing Ballistic Missiles and there have been thousands of contractors involved. PERT is employed for planning and controlling the project involving uncertainties. PERT is an event oriented technique. Its basis is a network of events in which the activities are derived by connecting the events. It lays stress on measuring the uncertainty in activity times by using three times duration estimation method. For computation of critical path the PERT three times probabilistic network is covered into single time deterministic CPM model. PERT studies the implications of uncertainties on project time scheduling and slack of events by employing statistical tools. After PERT methodology was employed for this project, it actually ended two years ahead of its initial schedule.

2.4 WBS (Work Break-Down Structure)

Dividing complex projects to simpler and manageable tasks is the process identified as Work Breakdown Structure (WBS). Usually, the project managers use this method for simplifying the project execution. In WBS, much larger tasks are broken-down to manageable chunks of work. These chunks can be easily supervised and estimated. WBS is not restricted to a specific field when it comes to application. This methodology can be used for any type of project management.

Following are a few reasons for creating a WBS in a project.

- Accurate and readable project organization.
- Accurate assignment of responsibilities to the project team.
- Indicates the project milestones and control points.
- Helps to estimate the cost, time, and risk.
- Illustrate the project scope, so the stakeholders can have a better understanding of the same.

2.5 PNA (Precedence Network Analysis)

Procedure for drawing PNA is similar to CPM; its model presents different look. For beginners, the step by step network modeling procedure involves defining the scope of network, listing activities, developing logic diagrams, structuring networks, incorporating activity duration, super imposing construction job constraints and, finally, numbering the various activities. Here,

Latest finishing date (LFD) = Latest finishing time (LFT)

Total Float = Latest finishing time - Early finishing time (EFT), or

Latest start time - Early start time

2.6 LOB (Line of Balance Method)

The LOB activity schedule chart show the graphics plan of work execution in linear or 'S' curve shape. The graph representing the cycle of work are referred to as 'cyclographs' or 'cyclograms'. The time units in a cyclograms are represented along the horizontal axis, while the vertical axis shows the number of similar work units of the projects. The time units reflected on the horizontal axis can be further being divided into calendar months after assessing the working days available in each month. Development of the limited LOB scheduling chart depends upon four main factors in a single unit construction, i.e. the activity start time, the activity duration, the activity rate of buildup, and the buffer available prior to starting the subsequent activity. The scheduling chart showing number of work units (cumulative) planned for completion having linear or 'S' curve shape.

3. Cost And Time Overrun In Construction Industry

Table 3.1: Factors of cost overrun

Sr. No.	Factors of cost overruns	Group
1.	High transportation cost	Labour and equipment
2.	Change in material specification	Material
3.	Escalation of material price	Material
4.	Frequent breakdown of the const.plant and equipment	Labour and equipment
5.	Rework	Construction items
6.	Lack of coordination at design stage	Construction items

7.	Fluctuation in money exchange rate	Financial
8.	Material fluctuation	Environmental
9.	Additional work at owners request	Owner's responsibility
10.	High maintenance cost of machinery	Labour and equipment
11	Shortage of materials	Material
12	Wastage on site	Construction items
13	High quality of work required	Owner's responsibility
14	Lack of financial management and planning	Financial
15	Incomplete design	Construction items
16	Difficulties on importing equipment's and materials	Political
17	High cost of machinery	Labour and equipment
18	Mistakes during construction	Construction items
19	Wastage on site	Construction items

Table 3.2. Factors Of Time Overruns

Sr. No.	Factors of time overruns	Group
1	Material market rate	Economic condition
2	Contract modification	Owner's responsibility
3	High level of quality requirement	Project condition
4	Project location	Project condition
5	Depend on the fresher's to bear the whole responsibility	Contractor's responsibility
6	Rework of bad quality performance	Management condition
7	Often changing sub –contractor's company	Contractor's responsibility
8	Lack of technical skill	Contractor's responsibility
9	Lack of experience in similar projects	Project condition
10	Shortage of experienced staff and labour	Contractor's responsibility
11	High quality of work required	Owner's responsibility
12	Labour strike	Environmental condition
13	Lack of sub-contractors skill	Sub-Contractor's responsibility
14	Unclear specification	Design and documentation
15	financial payment	Owner responsibility
16	Incomplete drawing	Design and documentation
17	Equipment shortage	Project condition
18	Poor productivity of material and labour	Contractor's responsibility

19.	Poor Documentation	Design and Documentation
20	Poor Scheduling	Labour and material

4. Concept Of EVM

Earned Value analysis is a method of performance measurement. Earned Value is a program management technique that uses “work in progress” to indicate what will happen to work in the future. Earned value management is system for planning and controlling the project cost performances. EVM establish work packages earned value baseline by integrating project scope, time schedule and cost objectives This baseline is called as cost control and is used for performance evaluation of project on a given date. Analysis of variance from the baseline provides the cost related information’s for problem identification, trend analysis and corrective actions such as re-planning and revising budget. Earned value analysis serves two main purposes

It analyses cost changes which is resulting in time and cost over-run or under-run so that timely corrective actions are taken such as modification of cash flow, updating financial forecast and project profitability expectations. Analysis of variance from the baseline using earned value management systems gives variety of variances which are analyzed to provide current status of project, to initiate corrective actions and to forecast future trends

4.1 Scheduling Analysis

Earned value is a technique for measuring project performance according to project cost and schedule. The comparison in between budgeted and actual performance is performed. There are three earned value parameters as shown below,

Planned Value (PV) It is the cost of the project according to the schedule of the project. it is also called as Budgeted cost of work scheduled (BCWS)

Earned Value (EV) It is the budgeted cost of the work performed till date. It is cumulative budgeted cost incurred in activities that have been completed on the due date.

Actual Cost (AC) It’s the actual costs that have spent on the project till date. It is also called as actual cost of work performed (ACWP).

5. Conclusion

Here Project management system is directly responsible on efficient planning, monitoring and controlling of construction project with use of project management software Primavera P6. This study shows importance, implementation and unique features of earned value management that benefits project manager and ultimately results in project success. The companies which do not use PM software tools efficiently have to increase their investments in training and educating their employed project teams, as well as in establishing information technology systems that will support and help PM teams. The use of such software’s helps to complete the project on schedule time and cost.

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