Tracking of Construction Projects by Earned Value Management

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Abstract – **'How construction projects can be completed timely and cost effectively' is the burning issue in the construction industry. There have been several studies that are focused on this; it has been seen that the tracking with closed monitoring of the true progress of tasks from the beginning of the project and managing them using earned value concept will results in considerable cost saving and timely completion. This paper is focused on concept and importance of Earned Value Management (EVM). Also, it includes elements and performance indicators used for tracking and forecasting the project that benefits project manager and ultimately results in project success.**

Keywords – Earned Value Management (EVM), construction, project

I. INTRODUCTION

Construction industry is one of the most booming industry in the whole world. The construction projects creates lots of investment opportunities across various related sectors hence it is an important development indicator of developing countries like India. Construction industry in India plays a vital role in its economic growth, due to which it is necessary to track the construction project's progress.

In past, progress of project is based on only two parameters: planned expenditure and the actual expenditure, which helped them to compare how much was planned to be spent and how much has been spent to date. As it did not give any idea about the completed work, this information was not sufficient. Moreover, it was also not possible to relate the completed work with the amount of money spent on it.

This is where Earned Value Management came into the scene, which helped project managers to overcome the shortcomings of traditional project management methods.

II. LITERATURE REVIEW

[7]A work done by *Prof. Shelke, Prof. Attarde, & Mrs. Chavan (2015)* was Focused on planning, scheduling and delay analysis of construction projects under which the information was provided regarding introduction of planning, steps in project planning, Introduction of scheduling, Project Scheduling Steps, Manpower Management & manpower planning. Further the case study of residential project of residential apartment was included by using MS Project and MS Excel software. At the end of paper, discussion was done regarding Master Schedule, Activities, Unskilled labours, Shortage of workers, Shortage of materials, improper management, improper planning & Weather problems which causes the delay. Also the recommendations were given to minimise the delay.

[8] In another study done by *Shaik, Devanand, & Harsha, (2014)* Focus was on understanding the role of EVM for monitoring and control in progress and timely completion of construction project. The key point was that Earned Value Analysis enables to spot a potential problem early in the project and do something to correct the situation. The case study of a Duplex Apartment of "Windmills of Your Mind" at Whitefield, Bangalore was taken. Primavera P6 software was used for project planning and EVM calculations. It concluded with 'Earned Value Management is a remarkable method of project management because it integrates cost, schedule and scope and can be used to forecast future performances and project completion dates. It allows projects to be managed better on time and in budget.'

[9]Another classical work done by author's *Subramanil, Jabasingh, & Jaylakshmi, (2014)* aims at evaluating Earned Value Analysis function of three software namely Microsoft Project 07, Primavera 6 and Developed Software. The Case Study of Residential building Project (having 120 sq.m. Built-up Area) had been taken. This study also indicated that newly developed software EVA has significant value and presents unique features that can benefit clients, consultants and industries. The two Projects were analysed using the developed software, MS Project 2007 and Primavera P6 based on Earned Value Analysis Method. The result showed a strong relation between each software. The final result gives more than 99.5% accuracy. A new parameter SV (t) (Schedule Variances respect to time) is identified and incorporated in developed software which is not in MS Project 2007 and Primavera 6.

[10] In another research done by *Vandevoorde & Vanhoucke, (2006)* comparison of three different project duration methods using earned value metrics and evaluated them on fictive and real-life project data was done. A generic formula to forecast the duration of a project was presented and linked with different project situations. Each method was further sub-divided into three different forecasting models as a function of the project situation. Each method was applied on a fictive single-activity project with linear and non-linear increasing periodic values reflecting the absence or presence of learning curves as well as three real-life projects from Fabricom Airport Systems, Belgium. The results showed a similar forecasting accuracy for each method in the linear planned value case. However, the introduction of learning curves, results in a different

forecasting accuracy for the three methods. The three real-life projects revealed that the earned schedule method was the only method which showed satisfying and reliable results during the whole project duration.

[11]Also *Verma, Pathak, & Dixit, (2014)* proposed the scheduling and project monitoring process along and also discussed main parameters involved in the calculation of Earned Value Analysis in cost management of civil construction projects. It emphasised on Project cost (which is one of the governing factor in project success) and Project management (which is used to increase productivity in terms of human resource and materials). The focus was on planned expenditure and actual costs. The case study of foundation work of boy's hostel at Rashtriya Sanskrit Sansthan, Bhopal was taken for performance evaluation and Primavera P6 software is used for EVM calculations. It is concluded that use of primavera P6 software for earned value analysis helps to complete the project on schedule time and cost.

III.   BENEFITS OF PROJECT MANAGEMENT

Project management gives the better understanding of overall project goals. Also it provides more accurate and reliable project status information, better communication, faster response to conflicting project goals and greater awareness of project progress. It is a more organised way to manage project. It also helps in more efficient use of project resources, faster project completion, lower project costs. Due to proper project Management, the project failure rate is considerably decreased.

IV.   IMPORTANCE OF EVM IN CONSTRUCTION PROJECTS

Earned Value Management (EVM) is a technique of performance and progress measurement. EVM is a systematic approach to the integration and measurement of cost, schedule, and technical (scope) accomplishments of a project or task. It provides both the client and contractors the ability to examine detailed schedule information, critical program and technical milestones, and cost data.
EVM was originally developed for cost management and has not widely been used for forecasting project duration. However, according to recent research trends, an interest to track the performance indicators for predicting total project duration is increasing.

Earned value can provide any project manager with an 'early warning tool' that sends out a signal during 'work in progress'. This signal allows the project manager to forecast the final required funds needed to finish the job within a narrow range of values. If the final forecasted results are unacceptable to management, steps can be taken early to alter the final requirements. The end benefit is that projects can be completed that contain more final features, if the project's management monitors the true cost performance from the beginning of the project. With clearer picture, managers can create risk mitigation plans based on actual cost, schedule and technical progress of the work that enables managers to identify and control problems before they become insoluble.

V.   BASIC ELEMENTS OF EVM
EVM tracks the project's progress against a baseline. It involves the following basic elements to evaluate projects technical performance.

- Planned Value (PV) – It is that portion of the approved cost estimate planned to be spent on the given activity during a given period or in simple way, the cost of the project according to the schedule of the project. PV is also known as Budgeted Cost of Work Scheduled (BCWS). Planned Value is calculated before actually doing the work, which also serves as a baseline. Total Planned Value for the project is known as Budget at Completion (BAC).
- Earned Value (EV) – EV is the budgeted cost of the work performed till date or the planned value of actually completed work. It is also known as Budgeted Cost of Work Performed (BCWP).
- Actual Cost (AC) – AC is the total of costs incurred in accomplishing work on the activity in a given period or the amount spent on the project to date. This actual cost must correspond to whatever was budgeted for the Planned Value and Earned Value (e.g. all labour, material, equipment and indirect costs). It is also known as Actual Cost of Work Performed (ACWP).

VI.   PERFORMANCE INDICATORS IN EVM
EVM implementations for large or complex construction projects helps in indicating and forecasting the cost performance (over budget or under budget) and schedule performance (behind schedule or ahead of schedule).

Table 1: Formulae for performance indicators

Sr. No.	Performance Indicators	Abbreviation	Formula
1.	Schedule Variance	SV	$SV = EV - PV$
2.	Cost Variance	CV	$CV = EV - AC$
3.	Schedule Performed Index	SPI	$SPI = EV / PV$
4.	Cost Performed Index	CPI	$CPI = EV / AC$

If	SPI = 1, SV = 0	Project is on proper schedule	If	CPI = 1, CV = 0	Project is on budget
	SPI < 1, SV < 0	Project is behind the schedule		CPI < 1, CV < 0	Project is over budgeted
	SPI > 1, SV > 0	Project is ahead of schedule		CPI > 1, CV > 0	Project is under budgeted

e.g. if a construction project to be completed in 20 months and the cost of the project is Rs.200,000. At the end of 15 months, Rs.150,000 has been spent, but on closer review you find that only 50% of the work has been completed. For this,

Actual Cost (AC) = Rs. 150,000

Earned Value (EV) = 50% of work = 50% of BAC = 0.5 X 200,000 = Rs. 100,000

Planned value (PV) = 75% of work = 75% of BAC = 0.75 X 200,000 = Rs. 150,000

Schedule Variance = Earned Value – Planned Value = 100,000 – 150,000 = - 50000

Cost Variance = Earned Value – Actual Cost = 100,000 – 150,000 = - 50000

Since both the variances are negative, project is behind schedule and under budgeted.

Usually, cost performance has the more weightage. But in some cases, schedule performance (timely completion of project) is more important than budget. It is not that cost is unimportant but finishing the work later than competitor may cause great loss.

Implementations of EVM can be scaled to fit projects of all sizes and complexities.

VII. CONCLUSION

Tracking of construction projects using Earned Value Management is useful in recognising the risk factors of the construction projects and to forecast the potential problems in order to face the remaining project work. It also helps the project team in decision making and to be proactive in managing their projects.

It provides the practical level of knowledge to the contractor about
- Where he is in project
- Whether the project is behind the schedule, ahead of the schedule or on schedule
- Whether the project is under budgeted or over budgeted

It is also useful in the forecasting of total project's cost as well as its date of completion.

Hence, it proves most helpful to any contractor or project manager who has made a firm commitment to complete all the features within a definitive schedule and for a finite amount of funds.

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