

## Project Monitoring & Controlling Of Infrastructure Using Earned Value Management

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**Abstract**— Project tracking is one of the important aspect of project management. The process of Monitoring and controlling the project is called as tracking. There are several tools used for project tracking but authors used Earned value Management for monitoring & controlling the infrastructure project. EVM is a methodology for evaluating project performance and progress by integrating project scope, schedule, and cost. Concrete road is considered for the tracking whose construction work is under progress at Mumbai region. This paper discuss the applicability of EVM to project. It consists of identifying activities at micro level till work package is achieved & followed by formation of baseline and comparison between baseline & actual work progress. It warns project manager whether the project is delayed or cost overrun. Results helps to concentrate on respective activities to enhance the progress of work, to highlight the problem area and speed up the activity.

**Keywords**-Earned Value Management (EVM); Baseline; Cost Variance; Schedule Variance; cost performance index.

### I. INTRODUCTION

Infrastructure is basic physical structure needed for the operation of society & enterprise such as road, bridge, rail, dam, water supply etc. Infrastructure is one of the important aspect for development of any country especially for developing countries it is key factor or milestone. Construction industry itself is integral part of nation's infrastructure & industrial growth. These are the massive and need considerable time and resources. Most of these projects undergoes delays and cost overrun due to poor planning and project tracking.

Hence the project tracking is important as far as completion of project on time and estimated cost. Monitoring and controlling is the process of overseeing all tasks or activities to ensure that the approved project is within scope, on time and on budget so that it proceeds with minimal risk of delay and cost overrun. This involves comparing actual performance with planned performance along with taking corrective action to yield the desired outcome. Scope verification & change control, schedule control. This process is continuously performed throughout the project life cycle. It is continuous and gradual process. There are several management tools used for project tracking but this paper represents the application of Earned value management to project for monitoring & controlling purpose and software is used for a formation of discipline of scheduling, logical sequences and for avoiding tedious calculations for each activity.

Earned value management (EVM) initially as a government contractual mandate was adopted by U.S. government in the management of its internal projects in defense agencies. It is widely used for tracking purpose in construction projects. Researchers discussed the applicability of EVM to the residential construction projects and projects which consists of repetitive activities.

This paper attempts to apply the Earned value management as tracking tool to infrastructure construction project. 1 KM stretch of Concrete Road in Mumbai Region is considered for the tracking purpose. Quantities, resources, cost and planning is done only for this 1KM stretch. Planned Project duration is from 15th Aug 2014 to 20th Jan 2015. All activities are updated by their percentage completion on 19th Feb 2015 & Status of progress worked out on same date.

## **II. APPLICATION OF EVM**

Earned Value analysis is a method of performance measurement. Earned Value is a project 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 for problem identification, trend analysis and Corrective actions such as re-planning and revising budget. Also it calculates the budget at the completion, time require to complete the project, delays & cost overrun.

There are different terminologies used in EVM such as ACWP(AC),BCWP(EV),BCWS(PV),CV,SV,CPI,SPI.

2.1 ACWP (AC):- Actual Cost of Work Performed (ACWP) or Actual Cost (AC) is the actual cost incurred in accomplishing the work performed within a given time period.

2.2 BCWP (EV):- Budgeted Cost of Work Performed (BCWP) or Earned Value (EV) is the sum of budgets for completed work packages and completed portions of open work packages.

2.3 BCWS (PV):- Budgeted Cost of Work Scheduled (BCWS) or Planned Value (PV) is the sum of budgets for all work packages scheduled to be accomplished within a given time period.

Cost variance (CV), Schedule Variance (SV), Cost performance index (CPI) & Schedule performance index (SPI) are the performance measures of construction project and these measures can be derived

2.4 Cost Variance:  $CV = EV - AC$  (difference between earned value and actual cost). A negative value points more has been spent for the activities than planned & positive value points less spent than planned cost. It can be expressed as a percentage (%CV) by dividing the cost variance (CV) by the earned value (EV).

2.5 Schedule Variance:  $SV = EV - PV$  (difference between earned value & planned value) A negative value means that the project is behind schedule & a positive value means ahead of schedule.

It can be expressed as a percentage (%SV) by dividing the schedule variance (SV) by the planned value (PV)

2.6 Cost Performance Index (CPI) – The ratio of cost of work performed (BCWP) to actual cost (ACWP) A CPI of less (more) than one means that the project is currently running over (under) budget.

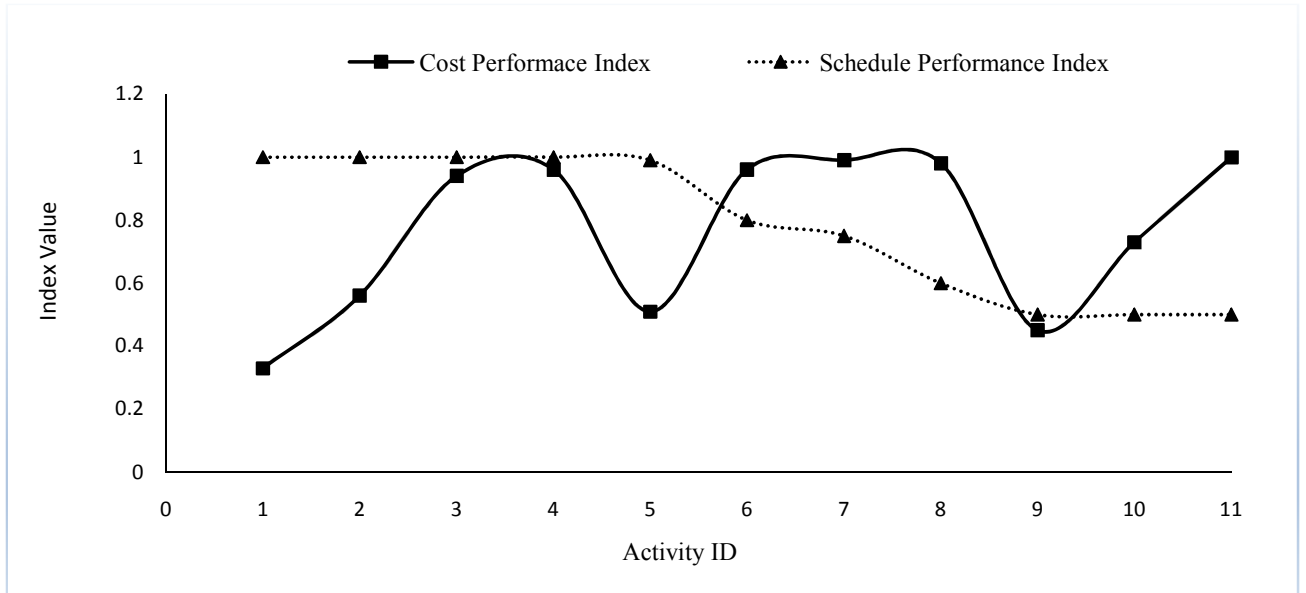
2.7 Schedule Performance Index (SPI) – The ratio of work accomplished (BCWP) to work planned (BCWS). A SPI of more (less) than one means that the project is ahead of (behind) plan. Work break down structure of concrete road is prepared such that separate packages are obtained and activities were listed out. Scheduling is done by logical sequencing of activities & Start No Earlier Than Logic is applied to the activities. According to quantities of each activity resources are allocated i.e. Human, materials, equipment. Duration of each activity is calculated by considering the Sunday as holiday & working time from 8AM to 1PM and 2PM to 5PM. Working time for execution is set as 8 hours a day & 48 hours per week thus the baseline is formed & saved as standard baseline for execution plan. All activities are monitored and updated according to the status of completion and actual consumed resources along with if any fixed cost is required for activity. Methodology consists of listing of activities by Work break down structure method, crating calendars i.e. deciding work time, appointing activity resources and durations, assigning logical sequencing, creating standard baseline, updating schedule according to their status and followed by Earned value operation. Comparison of standard baseline & updated schedule gives the values of ACWP (AC), BCWP (EV), BCWS (PV), CV, SV, CPI, SPI are obtained for each activity.

### III. RESULTS AND DISCUSSIONS

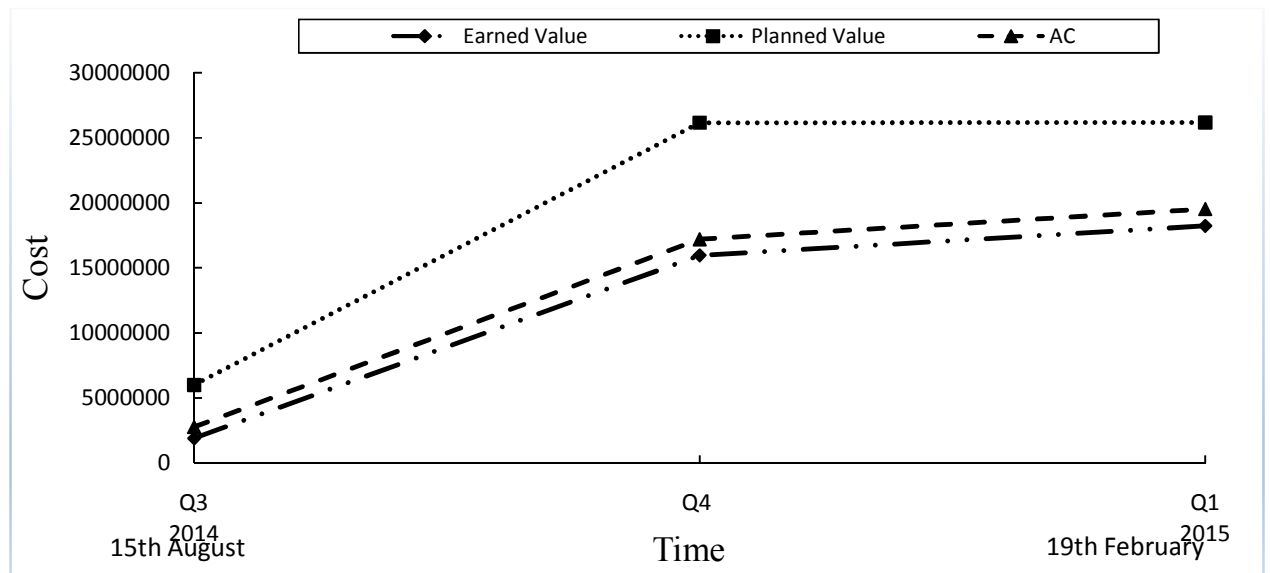
*Table 1. Cost Variance and Schedule Variance for each activity*

ID	Activity	Planned Value - PV (BCWS)	Earned Value - EV (BCWP)	AC (ACWP)	CV	SV
1	Site clearance-	₹ 12,705.00	₹ 12,705.00	₹ 38,205.00	(₹ 25,500.00)	₹ 0.00
2	Dismantling of old pavement	₹ 1,050,000.00	₹ 1,050,000.00	₹ 1,866,000.00	(₹ 816,000.00)	₹ 0.00
3	Removal of material of old pavement	₹ 227,000.00	₹ 227,000.00	₹ 242,600.00	(₹ 15,600.00)	₹ 0.00
4	Excavation in earthwork	₹ 597,000.00	₹ 597,000.00	₹ 621,000.00	(₹ 24,000.00)	₹ 0.00
5	Compacting Subgrade	₹ 97,000.00	₹ 95,650.00	₹ 188,520.00	(₹ 92,870.00)	(₹ 1,350.00)
6	Granular Sub Base with close graded material	₹ 3,485,357.00	₹ 2,788,285.60	₹ 2,903,645.60	(₹ 115,360.00)	(₹ 697,071.40)
7	Laying in situ Dry lean concrete	₹ 6,693,889.70	₹ 5,020,417.28	₹ 5,059,792.28	(₹ 39,375.00)	(₹ 1,673,472.43)
8	Laying PQC of 40mm grade along with steel	₹ 13,912,291.80	₹ 8,347,375.08	₹ 8,532,325.08	(₹ 184,950.00)	(₹ 5,564,916.72)
9	Filling in plinth and floors with murum	₹ 26,250.00	₹ 13,125.00	₹ 29,400.00	(₹ 16,275.00)	(₹ 13,125.00)

10	Water Curing	₹ 44,500.00	₹ 22,250.00	₹ 30,500.00	(₹ 8,250.00)	(₹ 22,250.00)
11	Road Furniture- zebra painting, warning sign, boards	₹ 17,310.00	₹ 8,655.00	₹ 8,655.00	₹ 0.00	(₹ 8,655.00)



*Figure 1. CPI and SPI values of Respective activities*



*Figure 2. Behaviour of Earned Value, Planned Value and Actual Cost (AC) over the time*

Above graph is cost vs. time which shows Behaviour of Earned Value, Planned Value and actual cost of construction work at different time.

Earned value (BCWP) of project is Rs.1, 81, 20642.96, Planned Value (BCWS) is Rs.2, 61, 63303.50, and Actual Cost is (ACWP) Rs. 1, 95, 20642.96.(**Figure 2**)

Hence, the Cost variance is Rs. (-13, 38,180.00), %CV is 7.36 and Schedule variance is Rs. (-79, 8084054.00), %SV is 30.50. Cost performance Index (CPI) is 0.93144 and Schedule performance index (SPI) is 0.6949.

### **III. CONCLUSIONS**

Infrastructure construction project can be monitored & controlled by Earned value management technique. Status of project worked out on 19<sup>th</sup> Feb 2015 by comparing planned baseline & actual progress. The values of performance measures for each activity is also calculated. This helps to control each activity according to their work progress.

Project has negative value of Cost variance means more amount of Rs.1338180.00 has been spent than planned baseline. Value of % CV is 7.36 which results that project is over budget for work completed till 19<sup>th</sup> Feb 2015.

Schedule Variance is also negative which means that project is behind schedule of planned baseline. % SV is -30.50 which means the project progress is 30.50% the initially planned schedule.

Cost Performance Index (CPI) is 0.93144 and Schedule Performance Index (SPI) is 0.6949 which signals that project is Cost overrun and delayed respectively. A SPI of 0.6949 shows that the project is only progressing at 69 % of the rate originally planned.

These values of performance measures helps for problem identification, trend analysis and Corrective actions such as re-planning and revising budget which can increase the progress rate of project work.

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