

# Earned Value Management



## Overview

Earned Value Management (EVM) is a project management technique that objectively tracks physical accomplishment of work.

More elaborately:

- EVM is used to track the progress and status of a project and forecasts the likely future performance of the project.
- EVM integrates the scope, schedule, and cost of a project.
- EVM answers a lot of questions to the stakeholders in a project related to its performance.
- EVM can be used to show the past and the current performance of a project and predict the future performance of the project by the use of statistical techniques.
- Good planning coupled with effective use of EVM will reduce a lot of issues arising out of schedule and cost overruns.

EVM has emerged as a financial analysis specialty in United States Government programs in the 1960s, but it has since become a significant branch of project management.

In the late 1980s and early 1990s, EVM emerged as a project management methodology to be understood and used by managers and executives, not just EVM specialists. Today, EVM has become an essential part of every project tracking.

## EVM - Basic Elements

EVM consists of the following three basic elements:

- Planned Value
- Actual Cost
- Earned Value

All the three elements are captured on a regular basis as of a reporting date.

## Planned Value

Planned value (PV) is also referred to as Budgeted Cost of Work Scheduled (BCWS). PV or BCWS is the total cost of the work scheduled/planned as of a reporting date.

It is calculated as:

$$\text{PV or BCWS} = \text{Hourly Rate} \times \text{Total Hours Planned or Scheduled}$$

**NOTE:** Hourly Rate is the rate at which effort will be valued.

## Actual Cost

Actual cost (AC) is also referred to as Actual Cost of Work Performed (ACWP). AC or ACWP is the total cost taken to complete the work as of a reporting date.

It is calculated as:

$$\text{AC or ACWP} = \text{Hourly Rate} \times \text{Total Hours Spent}$$

## Earned Value

Earned value (EV) is also referred to as Budgeted Cost of Work Performed (BCWP). EV or BCWP is the total cost of the work completed/performed as of a reporting date.

It is calculated as:

$$\text{EV or BCWP} = \text{Baselined Cost} \times \% \text{ Complete Actual}$$

All these three elements can be derived from Work Breakdown Structure by associating the costs to each of the tasks. For a big project, it will be a tedious task to calculate these elements manually. Scheduling software tools like Microsoft Project is used to calculate these three elements.

**NOTE:** % Completed Planned and % Completed Actual are defined below.

## % Completed Planned

The percentage of work which was planned to be completed by the Reporting Date. It is calculated using the following formula:

$$\% \text{ Completed Planned} = \text{PV} / \text{BAC}$$

## % Completed Actual

The percentage of work which was actually completed by the Reporting Date. It is calculated using the following formula:

$$\% \text{ Completed Actual} = AC / EAC$$

## EVM - Cost Variance

Cost Variance (CV) is a very important factor to measure project performance. CV indicates how much over - or under-budget the project is.

CV can be calculated using the following formula:

$$\text{Cost Variance (CV)} = \text{Earned Value (EV)} - \text{Actual Cost (AC)}$$

OR

$$\text{Cost Variance (CV)} = \text{BCWP} - \text{ACWP}$$

- The formula mentioned above gives the variance in terms of cost.
- Positive CV indicates the project is under-budget.
- Negative CV indicates the project is over-budget.

## Cost Variance %

Cost Variance % indicates how much over - or under-budget the project is in terms of percentage.

Cost Variance % can be calculated using the following formula:

$$\text{CV \%} = \text{Cost Variance (CV)} / \text{Earned Value (EV)}$$

OR

$$\text{CV \%} = \text{CV} / \text{BCWP}$$

- The formula mentioned above gives the variance in terms of percentage.
- Positive Variance % indicates % under budget
- Negative Variance % indicates % over budget.

## Cost Performance Indicator

Cost Performance Indicator (CPI) is an index showing the efficiency of the utilization of the resources on the project. CPI can be calculated using the following formula:

$$\text{CPI} = \text{Earned Value (EV)} / \text{Actual Cost (AC)}$$

OR

$$\text{CPI} = \text{BCWP} / \text{ACWP}$$

- The formula mentioned above gives the efficiency of the utilization of the resources allocated to the project.
- A CPI value above 1 indicates the efficiency of utilizing the resources allocated to the project is good.
- A CPI value below 1 indicates the efficiency of utilizing the resources allocated to the project is not good.

## To Complete Cost Performance Indicator

To Complete Cost Performance Indicator (TCPI) is an index showing the efficiency at which the resources on the project should be utilized for the remainder of the project. It can be calculated using the following formula:

$$\text{TCPI} = ( \text{Total Budget} - \text{EV} ) / ( \text{Total Budget} - \text{AC} )$$

OR

$$\text{TCPI} = ( \text{Total Budget} - \text{BCWP} ) / ( \text{Total Budget} - \text{ACWP} )$$

- The formula mentioned above gives the efficiency at which the project team should be utilized for the remainder of the project.
- A TCPI value above 1 indicates the utilization of the project team for the remainder of the project can be stringent.
- A TCPI value below 1 indicates the utilization of the project team for the remainder of the project should be lenient.

## EVM - Schedule Variance

Schedule Variance (SV) indicates how much ahead or behind the schedule a project is running.

It can be calculated using the following formula:

$$\text{Schedule Variance (SV)} = \text{Earned Value (EV)} - \text{Planned Value (PV)}$$

OR

$$\text{Schedule Variance (SV)} = \text{BCWP} - \text{BCWS}$$

- The formula mentioned above gives the variance in terms of cost which indicates how much cost of the work is yet to be completed as per schedule or how much cost of work has been completed over and above the scheduled cost.
- A positive SV indicates we are ahead of schedule.

- A negative SV indicates we are behind schedule.

## Schedule Variance %

Schedule Variance % indicates how much ahead or behind the schedule a project is running in terms of percentage.

Schedule Variance % can be calculated using the following formula:

$$SV \% = \text{Schedule Variance (SV)} / \text{Planned Value (PV)}$$

OR

$$SV \% = SV / BCWS$$

- The formula mentioned above gives the variance in terms of percentage which indicates how much percentage of work is yet to be completed as per schedule or how much percentage of work has been completed over and above the scheduled cost.
- Positive Variance % indicates % ahead of schedule.
- Negative Variance % indicates % behind of schedule.

## Schedule Performance Indicator

Schedule Performance Indicator (SPI) is an index showing the efficiency of the time utilized on the project. SPI can be calculated using the following formula:

$$SPI = \text{Earned Value (EV)} / \text{Planned Value (PV)}$$

OR

$$SPI = BCWP / BCWS$$

- The formula mentioned above gives the efficiency of the project team in utilizing the time allocated for the project.
- An SPI value above 1 indicates the project team is very efficient in utilizing the time allocated to the project.
- An SPI value below 1 indicates the project team is less efficient in utilizing the time allocated to the project.

## To Complete Schedule Performance Indicator

To Complete Schedule Performance Indicator (TSPI) is an index showing the efficiency at which the remaining time on the project should be utilized. It can be calculated using the following formula:

$$TSPI = ( \text{Total Budget} - EV ) / ( \text{Total Budget} - PV )$$

OR

$$TSPI = ( \text{Total Budget} - BCWP ) / ( \text{Total Budget} - BCWS )$$

- The formula mentioned above gives the efficiency at which the project team should utilize the remaining time allocated for the project.
- A TSPI value below 1 indicates the project team can be lenient in utilizing the remaining time allocated to the project.
- A TSPI value above 1 indicates the project team needs to work harder in utilizing the remaining time allocated to the project.

## EVM - Miscellaneous Formula

### Budget at Completion

- Budget at Completion (BAC) is the total budget allocated to the project.
- BAC is generally plotted over time. For example, periods of reporting (Monthly, Weekly, etc.)
- BAC is used to compute the Estimate at Completion (EAC), explained in the next section.
- BAC is also used to compute the TCPI and TSPI.

BAC is calculated using the following formula:

$$BAC = \text{Baselined Effort} - \text{hours} \times \text{Hourly Rate}$$

### Estimate to Complete

- Estimate to Complete (ETC) is the estimated cost required to complete the remainder of the project.
- ETC is calculated and applied when the past estimating assumptions become invalid and a need for fresh estimates arises.
- ETC is used to compute the Estimation at Completion (EAC).

### Estimate at Completion

Estimate at Completion (EAC) is the estimated cost of the project at the end of the project.

There are three methods to calculate EAC:

- **Variations are typical** - This method is used when the variations at the current stage are typical and are not expected to occur in the future.
- **Past estimating assumptions are not valid** - This method is used when the past estimating assumptions are not valid and fresh estimates are applied to the project.
- **Variations will be present in the future** - This method is used when the assumption is that the current variations will continue to be present in the future.

The formulas for calculation of the three methods are as given below:

- $AC + (BAC - EV)$
- $AC + ETC$  (Estimate To Complete)
- $AC + (BAC - EV) / CPI$

## Variance at Completion

Variance at completion (VAC) is the variance on the total budget at the end of the project.

This is the difference between what the project was originally expected (baselined) to cost versus what it is now expected to cost.

VAC is calculated using the following formula:

$$VAC = BAC - EAC$$

## % Completed Planned

The percentage of work which was planned to be completed by the Reporting Date. It is calculated using the following formula:

$$\% \text{ Completed Planned} = PV / BAC$$

## % Completed Actual

The percentage of work which was actually completed by the Reporting Date. It is calculated using the following formula:

$$\% \text{ Completed Actual} = AC / EAC$$

## EVM - Examples

To illustrate the concept of EVM and all the formulas, assume a project that has exactly one task. The task was baselined at 8 hours, but 11 hours have been spent and the estimate to complete is 1 additional hour. The task would have been completed already.

Assume an Hourly Rate of \$100 per hour.

Using this information:

**PV or BCWS = Hourly Rate × Total Hours Planned or Scheduled**

$$PV = \$100 * 8 \text{ hours} = \$800$$

**AC or ACWP = Hourly Rate × Total Hours Spent**

$$AC = \$100 * 11 \text{ hours} = \$1100$$

**EV or BCWP = Baselined Cost × % Complete Actual**

$$EV = \text{baseline of } \$800 * 91.7\% \text{ complete} = \$734$$

(NOTE % Complete Actual (below) to get the 91.7%)

**BAC = Baselined Effort – hours × Hourly Rate**

$$BAC = 8 \text{ hours} * \$100 = \$800$$

**EAC = AC + ETC**

$$EAC = 1100 + 100 = \$1200$$

**VAC = BAC – EAC**

$$VAC = \$800 - \$1200 = -\$400$$

**% Completed Planned = PV / BAC**

$$\% \text{ Complete Planned} = \$800 \text{ PV} / \$800 \text{ BAC} = 100\%$$

**% Completed Actual = AC / EAC**

$$\% \text{ Complete Actual} = \$1100 \text{ AC} / \$1200 \text{ EAC} = 91.7\%$$

**SV = Earned Value (EV) – Planned Value (PV)**

$$SV = \$734 \text{ EV} - \$800 \text{ PV} = -\$66$$

**SPI = Earned Value (EV) / Planned Value (PV)**

$$SPI = \$734 \text{ EV} / \$800 \text{ PV} = 0.91$$

**CV = Earned Value (EV) – Actual Cost (AC)**



$$CV = (\$734 \text{ EV} - \$1100 \text{ AC}) = -\$366^*$$

\* indicates a cost overrun

**CPI = Earned Value (EV) / Actual Cost (AC)**

$$CPI = \$734 \text{ EV} / \$1100 \text{ AC} = 0.66^*$$

\* indicates over-budget