



Performance Measurement Using Earned Value Management (EVM)

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Experienced project managers, especially those who have earned the Project Management Professional (PMP)®, may be wondering about the next steps in their project management journey. Project managers need to dedicate themselves to constant learning. In this article, we continue a series of techniques that project managers can apply to take their skills to the next level. Earned Value Management (EVM) including variances, performance indices, and forecasting metrics, will be discussed. Mastering these skills will help project managers take the next step in their careers.

Earned Value Management (EVM) is an advanced project management technique that can make project managers highly powerful. EVM empowers project managers by providing them one simple way to track scope, cost, and schedule performance on their projects. There is a lot of setup required to implement EVM, but the benefits are well worth the effort.

Project managers can use EVM to become powerful at predicting outcomes of projects. They can use EVM to integrate scope, cost, and schedule management, objectively measure project performance, and forecast future outcomes¹. Setting up EVM requires building the project plan with scope baseline, valuing the planned work to establish planned value (PV) and setting up rules for accruing earned value (EV) for the work to be accomplished. With these items in place, the following metrics can be used to control cost and schedule.

¹ Project Management Institute (2011). *Practice Standard for Earned Value Management*. Second Edition. Newtown Square, PA: Project Management Institute.

Variances and Performance Indices in EVM

Once EVM has been set up, data can be collected on a regular basis and variances and indices can be calculated. The following variances can be used to track cost and schedule performance:

- Cost Variance (CV) tracks the difference between planned and actual cost. To find it, use the formula **CV = EV – AC** where EV is Earned Value and AC is Actual Cost.
- Schedule Variance (SV) tracks the difference between planned and actual time spent. To find the SV, use the formula **SV = EV – PV** where EV is Earned Value and PV is Planned Value.

Variances are useful metrics that aid in determining whether a project is off-track, and if so, by how much. Acceptable control limits should be determined in project planning. It may be okay for projects to be behind some of the time, but if a project is consistently behind or falls significantly far behind, swift response may be needed.

Another useful EVM metric that requires only EV, AC, and PV is the performance index. The performance index is a measure of how much value is being derived for a single unit spent. The Cost Performance Index (CPI) and the Schedule Performance Index (SPI) can be tracked as follows:

- Cost Performance Index (CPI) measures how much value the project is earning per dollar spent. To find CPI, use the formula **CPI = EV / AC**.
- Schedule Performance Index (SPI) measures how much value the project is earning for every day spent. To find the SPI, use the formula **SPI = EV / PV**.

Note that the same variables are at play in both CV and CPI as well as SV and SPI. In CV/SV, something is subtracted from Earned Value, whereas with CPI/SPI Earned Value is divided by something.

The variance is useful at the team level for showing the level of deviation from plan. At a higher-level, executives may see more value in a performance index. Telling an executive that a project is \$500 over-budget may not have much impact, but showing how the cost performance is 80 cents per dollar may help spur action.

Figure 1 shows CV/SV and CPI/SPI performance over several months of a project:

Project A	Mar-16	Apr-16	May-16	Jun-16	Jul-16	Aug-16
EV	\$3,250	\$3,500	\$3,750	\$4,500	\$5,500	\$6,000
PV	\$3,000	\$3,500	\$4,000	\$4,500	\$5,000	\$5,500
AC	\$2,500	\$2,750	\$3,000	\$3,500	\$4,000	\$4,500
CV	\$750	\$750	\$750	\$1,000	\$1,500	\$1,500
CPI	1.30	1.27	1.25	1.29	1.38	1.33
SV	\$250	\$0	-\$250	\$0	\$500	\$500
SPI	1.08	1.00	0.94	1.00	1.10	1.09

Figure 1. CV/SV and CPI/SPI Performance over 6 months of Project A.

Forecasting

One advantage of using Earned Value Management is the ability to find lagging and leading indicators using the same set of data. While variances and performance indices look at performance to date, another set of EVM metrics helps project managers forecast future performance. With a few obtainable points of measurement, an entire array of project forecasts can be determined.

The first metric that is needed for forecasting is the Budget at Completion (BAC), which is the value planned for the sum of work². Since the BAC is a planned figure, it should be available through project plans. Once BAC is known, the following metrics can be used to forecast future performance:

- Estimate to Completion (ETC) projects the cost to finish the remaining project work. It is found by the formula **ETC = EAC – AC**.
- Variance at Completion (VAC) projects the level of variance at the completion of work. It is found by the formula **VAC = BAC – EAC**. It tells how far over or under budget the project will be at the end.
- To-Complete Performance Index (TCPI) projects the efficiency required to finish the remaining project work. If the TCPI is greater than 1, then the project is harder to complete at the current efficiency level. If the TCPI is less than 1, then the project is easier to complete. TCPI can be calculated for EAC and BAC as follows:
 - **TCPI for EAC = (BAC-EV)/(EAC-AC)**. TCPI for EAC measures what efficiency level is needed to maintain the current EAC.
 - **TCPI for BAC = (BAC-EV)/(BAC-AC)**. TCPI for BAC measures what efficiency level is needed to maintain the current plan.
- Estimate at Completion (EAC) projects the cost of the project work once it's complete. At project start, it will be the same as BAC, but as the project deviates from plan, the two figures will deviate from each other. There are four possible formulas to find EAC depending on different factors. See Figure 2 for a table explaining the ways to calculate EAC.

If	Use
Initial plan no longer valid	EAC = AC + Bottom-Up ETC
CPI expected to remain constant	EAC = BAC/CPI
There is a planned rate for future work	EAC = AC + BAC – EV
Both CPI and SPI are involved	EAC = AC + [(BAC-EV) / (CPI x SPI)]

Figure 2. Four Ways to Calculate EAC.

² Project Management Institute (2013). *Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, Fifth Edition. Newtown Square, PA: Project Management Institute.

By setting up the project and combining these metrics, project managers can track performance achieved to-date and provide forecasts of where the project is going. These reports can be used to make important decisions about scope, schedule, and resources. For example, if the TCPI of EAC is greater than 1, then the project work at its current efficiency level will become more difficult. This realization can drive decisions to either improve the efficiency level or rethink project work, making project delivery more attainable. With forecasting data, critical decisions can be made with more confidence on projects.

Setting Up Earned Value

PMI's *Practice Standard for Earned Value Management* defines an eight-step process for setting up Earned Value Management (EVM) on a project³. While each step may not be necessary on every project, especially smaller projects, knowing the steps can help project managers get the most out of EVM. The eight steps of the Earned Value framework are as follows:

1. *Organize Project*. In the first step, Organize Project, the project charter and requirements documentation are used to generate the scope management plan and scope baseline so that work packages can be created.
2. *Assign Responsibility*. In the Assign Responsibility step, roles and responsibilities for EVM data gathering and reporting are determined.
3. *Develop Schedule*. In the Develop Schedule step, activities are created and sequenced from work packages to form the schedule baseline.
4. *Establish Budget*. In the Establish Budget step, the project charter and schedule baseline are used to form the cost baseline.
5. *Determine Measurement Method*. In this step, methods for measuring Earned Value (EV) are selected. Methods include:
 - a. *Discrete*: Defined start and end of measure with a tangible output. For example, setting EV based on one side of a building being constructed is a discrete measure.
 - b. *Apportioned*: Apportioned earning methods accrue EV based on support for discrete tasks, such as inspection of the completed side of the building.
 - c. *Level-of-effort (LOE)* earning methods accrue EV based on ongoing work, such as project management for a project.
6. *Establish Performance Measurement Baseline (PMB)*. The Performance Measurement Baseline (PMB) becomes the basis for project monitoring and control. It consists of:
 - a. Scope Baseline
 - b. Cost Baseline
 - c. Schedule Baseline
 - d. Undistributed and Distributed Budget
 - e. Contingency Reserve (for risks and other situations)
7. *Analyze Performance*. As the project progresses, data is gathered and reported on.
8. *Maintain PMB*. The PMB updates based on inevitable changes as the project progresses.

³ Project Management Institute (2011). *Practice Standard for Earned Value Management, Second Edition*. Newtown Square, PA: Project Management Institute.

Conclusion

In this article, we have examined how to use Earned Value Management (EVM) to find both lagging and leading metrics including variances, performance indices, and forecasting metrics. The wide array of tools offered by EVM can seem staggering at first. One way to get started with EVM is to track the basics first. Using a simple measure such as percent complete to accrue earned value, project managers can quickly set up a tracking system for cost and schedule variances and performance. For example, if the PV for an activity is \$1,000 and 50% of the work is complete, under the simple percent complete measure, the EV is 50% of \$1,000, or \$500. Over time, more metrics can be incorporated based on needs.

Whether project managers start small with EVM or go through the complete setup to establish an earned value framework, the fact remains that there is some effort required to set up and use earned value management. With EVM, however, project managers gain valuable insights into where a project is at the moment, where it has been, and where it is going. Due to its ability to make project managers powerful, EVM belongs to the category of advanced project management metric.

For more about the advanced techniques discussed in this article, visit [RefineM's blog](#). We also offer [consulting](#) and [training](#) on Earned Value Management and other project management topics.

References

1. Project Management Institute (2013). *Guide to the Project Management Body of Knowledge (PMBOK® Guide)*. Newtown Square, PA: Project Management Institute.
2. Project Management Institute (2011). *Practice Standard for Earned Value Management, Second Edition*. Newtown Square, PA: Project Management Institute.