

PM WORLD TODAY – SECOND EDITIONS – JUNE 2009

Editor's note: Second Editions are papers that have been previously published that have continued relevance and deserve additional visibility. The paper below was originally published in the December 2008 issue of Crosstalk, and the Spring 2009 edition of the Measurable News, published by the PMI College of Performance Management (PMI-CPM). This paper is included here with the permission of the authors, who are copyright holders.

The Two Most Useful Earned Value Metrics: the CPI and the TCPI

By Quentin W. Fleming and Joel M. Koppelman

Primavera Systems, Inc.

The Project Management Institute (PMI) has just released the Fourth Edition to their world standard on project management: *A Guide to the Project Management Body of Knowledge, the PMBOK® Guide*. Many new features have been added to this massive document among them new coverage of an earned value metric called the “To-Complete Performance Index” or simply the TCPI. What is the TCPI and why is it important? This article describes its purpose and utility.

Whenever a project commits to the employment of earned value to help manage their effort, they are suddenly inundated with a windfall of performance metrics which are available in no other project management technique. New acronyms suddenly emerge: PV, EV, AC, SV, SPI, CV, CPI, BAC, EAC, TCPI, and on and on.¹ While all of these performance indicators can have value to any project, two EVM metrics in particular are critical to projects. They are the “CPI” and the “TCPI.”

The CPI (Cost Performance Index) tells us “*what we have accomplished for what we have already spent.*” Did we stay within the budget, or did we overrun? By contrast, the TCPI (To-Complete Performance Index) focuses on future work: “*what performance levels we must achieve on the remaining work in order to meet our financial commitment to management.*” While most practitioners of earned value understand the utility of the CPI, most have rarely ever used the TCPI. What a pity, for the TCPI when used in conjunction with the CPI provides a powerful set of tools in the management of a single project, a program, or a full portfolio of projects.

Earned Value Management (EVM)...the ten requirements.

As a general rule, whenever a project manager makes the decision to employ earned value in the management of a project, that choice ideally should be supported by management, the stakeholders at all levels. Stakeholders must want to know the full truth. The reason: EVM performance data can be available to everyone working the project: the functions, senior management, the paying customers, all parties who have a vested interest in the success of the project. As long as everyone has a rudimentary understanding of what the EVM data means, everyone connected to the project knows what everyone else is doing. Thus, it is imperative that there be a management buy-in whenever a project manager elects to employ EVM on a project.

The commitment to employing EVM requires both the compliance with certain basic requirements, and discipline on the part of everyone supporting the project. Based on our experience, we have listed below ten key requirements which must be met in order to successfully implement EVM. Some find these requirements overwhelming. See for yourself. These requirements are:

1. EVM requires that the project be fully understood, defined, and scoped to include 100% of the project effort. You need to know what constitutes 100% of the work in order to measure progress along the way.
2. EVM requires that the defined scope be decomposed, broken down into major management tasks, which are selected as points of management controlⁱⁱ, then planned and scheduled down to the detailed work package level.
3. EVM requires that an integrated and measurable project baseline be authorized, relating the scope of work directly to an achievable budget, then locked into a specific time-frame for performance measurement. It's called: bottom-up planning.
4. EVM requires that only authorized and budgeted work be accomplished. The effort being worked must be tightly controlled. Scope creep cannot be allowed. All changes must be managed, and not worked until specifically authorized by the project manager.
5. EVM requires that physical performance be measured (the earned value) using previously defined schedule metrics.
6. EVM requires that the values earned be related to the planned values to reflect performance against the project baseline. Earned value less the planned value represents a variance from the baseline plan.

7. EVM requires that the actual costs being reported be consistent with the earned value being measured, to allow for an accurate portrayal of cost performance. The relationship of values earned to actual costs reflects the true cost performance. Earned value less actual costs provides cost performance.
8. EVM requires that forecasts be made periodically (weekly, monthly) as to how much time, and how much money it will take to complete 100% of the project.
9. EVM requires that a full disclosure of actual results be made to all persons who have a vested interest in the project. All stakeholders will receive the same actual performance results. Only one set of books is allowed.
10. EVM requires that project management, in conjunction with management at all levels, and customer stakeholders, decide on the appropriate actions to be taken to stay within authorized project expectations.

These ten requirements are what is needed to successfully implement earned value on any project. To the authors, these requirements constitute nothing more than following fundamental project management best practices.

Now let us discuss the two, in the opinion of the authors, most important earned value indicators: the Cost Performance Index (CPI) reflecting completed performance, and the To-Complete Performance Index (TCPI) with a focus on the required future performance.

What is a CPI (Cost Performance Index), and how is it used?

The EVM Cost Performance Index (CPI) is a reflection of project cost efficiency. The CPI relates the physical work accomplished expressed in its budgeted value, against the actual costs incurred to accomplish the performed work. Budgets can be set with various monetary values, hours, deliverables, anything that can be measured. The issue: are we staying on target, under-running, or perhaps overrunning our costs?

This concept is portrayed graphically in Figure 1.

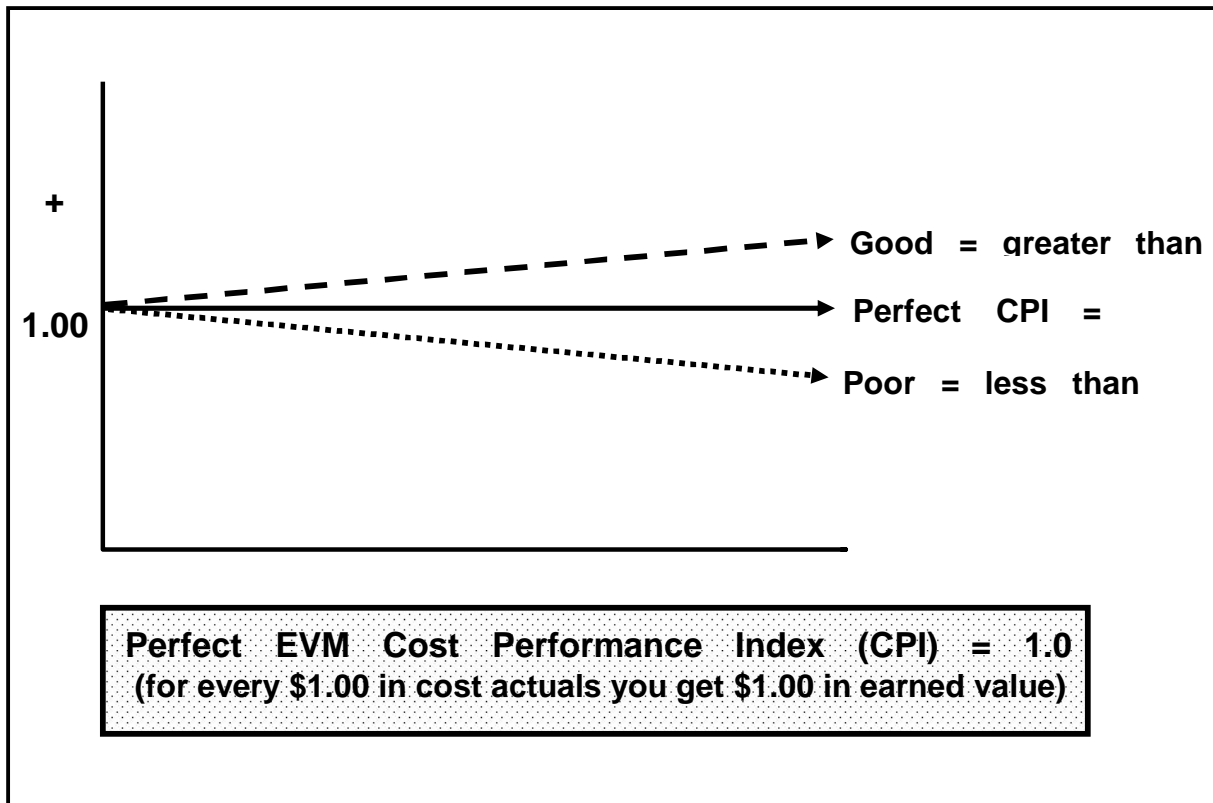


Figure 1: Monitoring Earned Value Cost Performance Index (CPI)

Perfect cost performance would be defined as achieving a CPI of 1.0. For every dollar spent we would get an earned value equal to one dollar. Sometimes we do better, sometimes worse. This is a particularly critical metric to track for performance less than 1.0 is a reflection of excessive costs spent against budget. Initial overruns are typically non-recoverable. Think about it: in order to recover an overrun you must under-run future work. Rarely does this happen. The same conditions which may have caused the overrun in the first place are likely to occur again and again.

Sometimes the CPI will reflect values over 1.0, suggesting that an under-run of costs is occurring. Care must be taken when actuals reflect an under-run of costs to budget. Oftentimes this condition is simply the result of costs which are lagging, slow to be recorded in the organizational cost ledger. For example: we measure the earned value and give full credit, but the related costs are not reflected in the cost ledger. Reason: many/most of the project work may be performed by outside "purchased labor", people who are not part of the internal labor system. Thus there can be a time mismatch between the earned value measured, and the actual payment of the purchased labor invoices. The payment of invoices generally takes more time than the recording of labor.

Under runs of costs are rare. And if artificially caused by lagging actual costs, the positive results can hide or offset problems that need management attention. It takes organizational discipline to make sure that earned value credits match the actual costs.

Why is the CPI so important? Answer: because past performance can be used to accurately determine requirements for final performance, in order to meet financial goals. The cumulative (from the beginning) CPI has been shown to stabilize from about the 20% completion point of project performance. Empirical scientific studies by the United States Department of Defense on 155 actual contracts has shown that at the 20% point of project completion, the final projected results will only change by plus or minus 10%.ⁱⁱⁱ What a finding! What useful data.

In practical terms, one can immediately take the total authorized budget (BAC), divide it by the cumulative CPI and project the total costs of a project with an accuracy of plus or minus 10%. If management doesn't like the final cost projection, then corrective action can be taken to change the forecasted results. Few project management techniques give a comparable "early-warning" signal. This formula the $BAC/Cumulative\ CPI = EAC$ can be used on the total project, or any sub-project, or integrated project teams to predict final results on their work.

The CPI metric can be used to track periodic results (monthly, weekly, daily), or the cumulative position to see the long-term performance trends.

What is a TCPI (To-Complete Performance Index), and how is it used?

Whereas the CPI is an indicator of past cost performance, the TCPI has its focus on future performance. At issue: what will it take to meet the goals set by management? The TCPI works in conjunction with the CPI, and is conceptually illustrated in Figure 2.

The CPI can be thought of as "sunk-costs", whatever the results they cannot be altered. In the illustration shown, the cumulative CPI is at .75, for every dollar spent we only earned 75 cents of project work. If the project is exactly 50% complete, in order to stay within management's budget, we must accomplish \$1.25 for every dollar in the future. Will this likely happen? Questionable at best, but highly unlikely. Opportunities for improvements are illustrated by use of the TCPI.

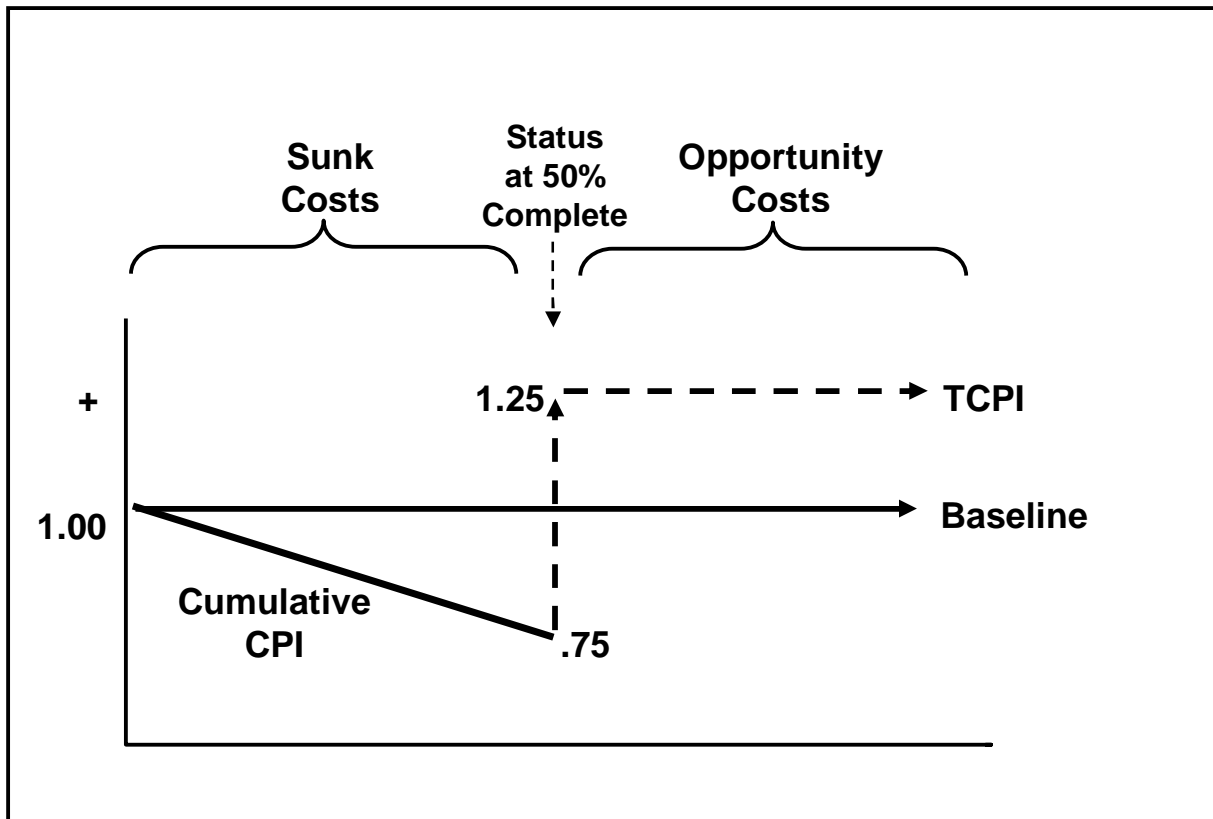


Figure 2: The Relationship of Cumulative CPI versus TCPI

The formula for the TCPI is: the [Work Remaining] (defined as total Budget less the earned value) divided by the [Funds Remaining]. Note in Figure 3 there are two scenarios for Funds Remaining.^{iv} Funds remaining will focus initially on the authorized budget. Management will track performance against what it has authorized in the form of an official budget. However, once it becomes obvious that the budget is no longer achievable, the next question from management is: how much money will it cost to complete this job, called the estimate at completion (EAC). The project then stops work and makes a new forecast of what is needed to finish the job.

Preparing a new EAC forecast can get emotional. Unrealistic optimism sometimes takes over, at the expense of realism. It is not uncommon for projects, when making a new EAC forecast to assume that everything will suddenly go right, and that all project risks are behind them. Thus an initial EAC may be unrealistic, unachievable. “Piecemeal EACs” are often the norm, where the EAC projection goes up each month as actual performance is known.

Using Figure 2 as an example, would an EAC requiring a future TCPI of 1.25, or 1.10 be achievable? Probably not. More likely, a TCPI of 1.0 or .90 would be reasonable. But it is painful to admit the full value of an EAC, having just acknowledged that the BAC is no longer valid.

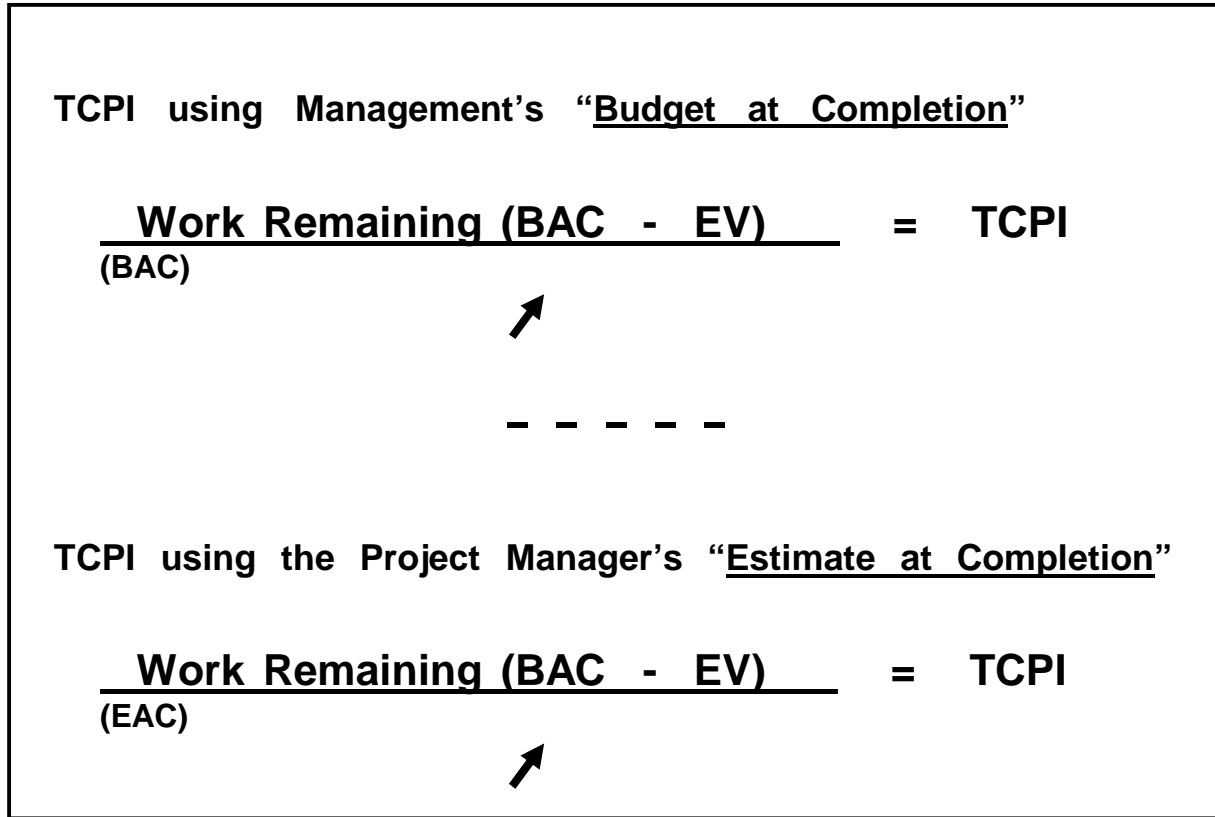


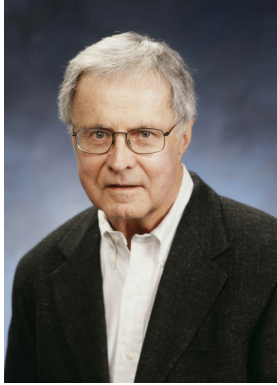
Figure 3: Two To-Complete Performance Index (TCPI) formulas

In Summary

Employing the EVM technique can present a project with data not available with any other management tool. And while each metric can be useful, the authors are of the opinion that the two metrics described above are particularly useful in the management of any project, or program, or a portfolio of projects.

End Notes

1. This article first appeared in the December 2008 issue of Crosstalk Magazine.
2. All terms used in this article are consistent with the *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, Fourth Edition, published in December 2008 by the Project Management Institute, Newtown Square, PA, USA. The terms are: Planned Value, Earned Value, Actual Costs, Schedule Variance, Schedule Performance Index, Cost Variance, Cost Performance Index, Budget at Completion, Estimate at Completion, and To-Complete Performance Index.
3. The points of management control are sometimes called project teams, subprojects, or Control Account Plans (CAPs) depending on the organization.
4. Dr. David S. Christensen, “Using Performance Indices to Evaluate the Estimate at Completion,” *The Journal of Cost Analysis of Cost Estimating and Analysis*, Spring 1994, page 19.
5. Figures used in this article are inspired from the book *Earned Value Project Management*, third edition, Quentin W. Fleming and Joel M. Koppelman, published by the Project Management Institute, Newtown Square, Pennsylvania, 2005.

About the Authors:***Quentin Fleming****Author*

Quentin W. Fleming is a management consultant specializing in earned value. He has been a consultant to the staff at Primavera Systems, Inc. since 1993. Quentin was on the core team which updated the Project Management Institute's (PMI) PMBOK® Guide Fourth Edition, released in December 2008. His personal website is <http://www.QuentinF.com>

***Joel Koppelman****Author*

Joel M. Koppelman is the cofounder and Chief Executive Officer (CEO) of Primavera Systems, Inc. His corporate website is <http://www.Primavera.com>

Fleming and Koppelman are the co-authors of "***Earned Value Project Management***", published in 1996 by the Project Management Institute (PMI). The Third Edition of this book was released in the fall of 2005. Over 80,000 copies have been sold by PMI worldwide.