

Understanding the use of TCPI in EVM

The **To Complete Performance Index** (TCPI) in Earned Value Management describes the performance efficiency required to achieve a cost objective; it is the measure of the required future cost performance that must be achieved with the remaining resources in order to meet a specified management goal¹.

The TCPI indicator is a ratio of the work remaining to be accomplished divided by the amount of unspent funding:

- The work remaining is calculated from the difference between the total project budget (Budget at Completion or BAC) and the Earned Value (EV) accrued.
- The funds remaining are the difference between the Actual Cost (AC) incurred to date and the target total cost (TC) the project is required to achieve, either the original BAC, or a different target cost agreed by management. Therefore the funds remaining can be assessed in several different ways, the two most common are:
 - The difference between the AC and the BAC, or
 - The difference between the AC and an Estimate At Completion (EAC) approved by management (this may be the current EAC² or a different approved EAC)

As with other aspects of the earned value methodology, the way the TC is determined is decided at the planning stage and only varied if the change is formally approved.

The TCPI index is defined as follows:

$$\text{TCPI} = (\text{BAC} - \text{EV}) / (\text{TC} - \text{AC})$$

When the desired final cost is the original project budget:

$$\text{TCPI} = (\text{BAC} - \text{EV}) / (\text{BAC} - \text{AC}).$$

When the desired final cost is an estimate at completion:

$$\text{TCPI} = (\text{BAC} - \text{EV}) / (\text{EAC} - \text{AC}).$$

Notes:

1. If the current EAC is calculated as BAC/CPI (and is used as the EAC) the TCPI will always resolve to 1 because the EAC has been adjusted based on the current performance.
2. If the EAC is calculated using a 'bottom up' estimate of the remaining work, the TCPI can validate this estimate (a TCPI of 1.0 would suggest the estimate is reliable).
3. Other options for calculating EAC can be similarly validated; eg, IEAC = BAC/(CPI * SPI).
4. The EAC may simply be an approved target total cost.

¹ A similar calculation for schedule performance (TSPI) is included in the Earned Schedule extension to EV:

- TSPI = (PD – ES) / (PD – AT) targeting planned duration, or
- TSPI = (PD – ES) / (ED – AT) targeting and 'expected' duration.

For more information see: <http://www.earnedschedule.com/Terminology.shtml>

² EAC can be calculated in many different ways, see:

http://www.mosaicprojects.com.au/WhitePapers/WP1081_Earned_Value.pdf



Worked Example

Your project has a BAC of \$1000, the earned value (EV) is \$400, the actual costs (AC) are \$500 and management have approved the release of \$150 of management reserves creating a target total cost (EAC) of \$1150.

The current Cost Performance Index (CPI) for this project is $\$400 / \$500 = 0.8$, its Cost Variance $CV = \$400 - \$500 = -\$100$. The project is clearly in financial trouble.

The change in performance needed to recover to achieve the BAC is

$$TCPI = (1000 - 400) / (1000 - 500) = 600 / 500 = 1.2$$

The change in performance needed to achieve the authorised EAC is

$$TCPI = (1000 - 400) / (1150 - 500) = 600 / 650 = 0.923$$

Note: The TCPI reverses the usual EV approach to values, for TCPI a number greater than 1 indicates a problem (whereas for CPI and SPI values greater than 1 are 'good news') – see next section.....

Understanding the TCPI results

The TCPI result should always be a number close to 1.0

- If the result is less than 1 the target should be relatively easy to achieve or better.
- If the result equals 1 the target will be achieved by maintaining the current level of performance.
- If the result is greater than 1 (say $TCPI = 1.1$) an improvement in performance is required.

From the example above, to achieve the original BAC the TCPI is 1.2, this means all remaining work has to be completed with a cost performance that is 20% better than the original plan. This step change in performance is unlikely to be achieved:

- You are currently performing at 80% of the planned level ($CPI = 0.8$).
- You are required to improve to 20% better than planned ($CPI = 1.2$).
- The increase in performance required to achieve target is $1.2 - 0.8 = 0.4$.
- But your current performance is only 0.8.
- The increase in cost performance required is $0.4 / 0.8 = 50\%$ increase in performance.

Considering the BAC 'total cost' target: While in the example the improvement against plan is *only* 20% you are not currently achieving the plan... the improvement has to be made from the current levels being achieved, presumably with everyone already working to capacity. For this, and a number of other reasons, most authorities consider a target total cost with a TCPI greater than 1.1 is unlikely to be achieved³ – for all practical purposes the target total cost (the BAC) is now unachievable.

Considering the EAC 'total cost' target: Achieving the target EAC of \$1150 will be much easier. A TCPI of 0.923 indicates that the final cost of the project will be less than the desired total cost if the current cost performance efficiency is maintained. In fact the efficiency can fall off a little (but not too much) and the

³ The heuristic that a TCPI of 1.1 means the project is unlikely to achieve the desired target cost has been validated as 'reasonable' but at the moment there does not appear to be any empirical data correlating the TCPI value with a statistical probability of achieving the desired total cost of the project.

target will still be met. In this circumstance routinely monitoring the TCPI and watching its trend will tell you if the project is continuing towards success, or if corrective actions are needed.

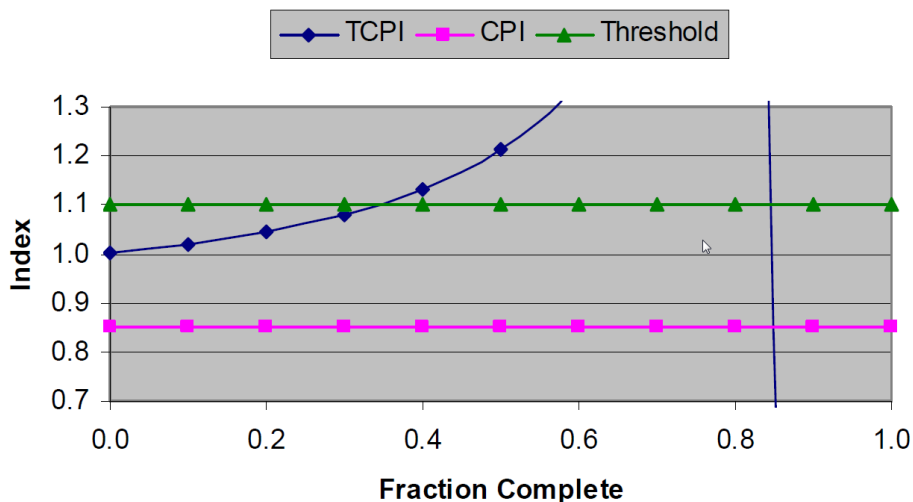
Time is critical

The cost variance identified above of -\$100 was recorded relatively early in the project; only 40% of the work had been accomplished. The same cost variance at the 80% stage has far more serious consequences. If the EV = \$800 and the AC = \$900 the CV remains at -\$100 but the TCPI calculation changes significantly.

The change in performance needed to recover to achieve the BAC is

$$TCPI = (1000 - 800) / (1000 - 900) = 200 / 100 = 2.0$$

The cost variance is the same but because there is significantly less work remaining for the improvement to occur within, consequently the amount of improvement per 'dollar' is much higher⁴.



As shown in the graph above – a consistent level of substandard performance is relatively easy to correct near the beginning of the project and becomes increasingly difficult as the work progresses. As the end of the project approaches the rate of increase in the TCPI increases rapidly; and once the threshold of 1.1 is crossed there is very little likelihood of recovery – the project is 'out of control'.

TCPI is a reliable early indicator of problems

There are three measures of cost performance CPI, CV and TCPI, of the three TCPI provides the best early indicator of emerging problems as the two cases below demonstrate.

⁴ The need for the early identification of issues and appropriate corrective actions is a key tenet of successful project management. These concepts are discussed in:

The Project Start-Up Conundrum: http://www.mosaicprojects.com.au/PDF_Papers/P003_Conundrum.pdf

Avoiding the 'Tipping Point to Failure':

http://www.mosaicprojects.com.au/PDF_Papers/P143_Avoiding%20the_Tipping_Point_PPT.pdf

Case 1 the CV remains constant at -\$50 in the project described above.

	Percent Complete			
	20%	40%	60%	80%
EV	\$200	\$400	\$600	\$800
AC	\$250	\$450	\$650	\$850
CV	-\$50	-\$50	-\$50	-\$50
CPI	0.800	0.889	0.923	0.941
TCPI	1.0667	1.0909	1.1429	1.3333

In this example the CV remains constant which allows the CPI to improve steadily (but is still below 1 which indicates a problem). The TCPI shows the project is unlikely to recover from the 60% stage onwards, and as work progresses the likelihood of recovery is continually diminishing.

Case 2 the CPI remains constant at 0.9.

	Percent Complete			
	20%	40%	60%	80%
EV	\$200	\$400	\$600	\$800
AC	\$222	\$444	\$667	\$889
CV	-\$22	-\$44	-\$67	-\$89
CPI	0.900	0.900	0.900	0.900
TCPI	1.0286	1.0800	1.2000	1.8000

In this example (numbers are rounded for clarity), the CPI is constant, this generates a steady increase in the value of the CV (the CV is getting slowly worse). Whereas the TCPI shows a clearly deteriorating trend with the rate of deterioration accelerating as work progresses (similar to the scenario plotted in the graph above). Again the 1.1 threshold is crossed well before the 60% stage and the BAC is unlikely to be achieved from that point on.

Summary

CV and CPI are based on performance to date, they tell you what's occurred, not what is likely to happen in the future. Calculating the EAC (or IEAC) provides a projected cost outcome but does not of itself show how much effort is needed to recover and achieve the target cost, this need insight and interpretation. The TCPI is a measure focused on predicting the degree of difficulty associates with achieving the target cost, either the BAC or a revised target and over time tells you if this objective is becoming easier or more difficult to achieve. Accepted orthodoxy is that once the TCPI exceeds 1.1 the current target is unachievable; studies suggest this heuristic is reasonable in most circumstances.

As with all project management, successful management of a project requires action to correct negative trends early – the two cases above clearly show this.



Note: This White Paper is a supplement to our paper on *Earned Value Formulae*, download from: http://www.mosaicprojects.com.au/WhitePapers/WP1081_Earned_Value.pdf

Acknowledgement

This summary is based on a detailed review of TCPI published by Mr. Walt Lipke, his analysis can be downloaded from: <http://www.earnedschedule.com/Docs/The%20TCPI%20Indicator%20-%20P&P.pdf>

First published 30th May 2017, augmented and updated.

This White Paper is part of Mosaic's *Project Knowledge Index* to view and download a wide range of published papers and articles see: http://www.mosaicprojects.com.au/PM-Knowledge_Index.html

This White Paper has focused on the TCPI. Additional EV resources are available from <http://www.mosaicprojects.com.au/Techniques.html#EarnedValue>

For more on project controls and scheduling see: <http://www.mosaicprojects.com.au/Planning.html>

