Control Costs: Tools and Techniques

[1]**Earned value management** is a methodology that combines scope, schedule, and resource measurements to assess project performance and progress. Using earned value management helps the team understand whether they are on target for costs or schedule per the project plan. It compares planned vs. actuals. It uses the cost, scope and schedule baselines to form the performance baseline, which helps the project management team assess and measure project performance and progress.

Let's go into more detail about each of the earned value formulas and what each one is used for and how to remember them. Consider starting to practice a "brain dump sheet," where you write down all the formulas and other information you need to remember for the exam. Make sure you practice writing down each formula name and the actual formula, until it becomes rote memory.

Here are some **definitions in earned value management:**

[1]**Budget at completion (BAC):** The total budget for the project or the sum of all budgets established for the work to be performed.

[1]**Planned value (PV):** The value of the work you plan on completing during a specific period of time in the project schedule. Or it's the authorized budget assigned to scheduled work.

[1]**Earned value (EV):** The value of work that's actually been performed or completed. Or it's a measure of work performed expressed in terms of the budget authorized for work.

[1]**Actual cost (AC):** The actual money spent on the project at a given point in time. Or it's the realized cost incurred for the work performed on an activity during a specific time period.

Tip: In order to calculate the earned value formulas, you only need to get values for each of the items above. Once you have the four values above, you can calculate any of the EV formulas. It's just a matter of plugging in the values and solving the formula.

Variances from the approved baseline are measured with the following:

[1]**Schedule variance (SV):** The difference between the work you planned to do and what you actually did (planned vs. actuals) at a specific point in time. It's a measure of schedule performance expressed as the difference between the earned value and the planned value. It is the amount by which the project is ahead or behind the planned delivery date, at a given point in time.

[1]**Cost variance (CV):** The difference between the costs you planned to spend and what you actually spent (planned vs. actuals) at a specific point in time. It's the amount of budget deficit or surplus at a given point in time, expressed as the difference between earned value and actual cost.

[1]**Schedule performance index (SPI):** Measures the efficiency of the work put into the project at a specific point in time. It's a measure of schedule efficiency expressed as a ratio of earned value to planned value. It measures how well the project team is using its time.

[1]**Cost performance index (CPI):** Measures the efficiency of the money spent on the project at a specific point in time. It's a measure of cost efficiency of budgeted resources, expressed as a ratio of earned value to actual cost. It's considered the most critical EVM metric and measures the cost efficiency of the work completed.

There are a few **values used for forecasting**:

[1]**Estimate at completion (EAC):** Based on project performance, the cost at the end of the project may be more or less than what was budgeted (BAC). EAC will tell you the cost estimate based on how the team is performing now. The expected total cost of completing all work expressed as the sum of the actual cost to date and the estimate to complete.

[1]**Estimate to completion (ETC):** Takes into consideration what you've spent to date, then evaluates team performance, and then provides a cost of how much the remaining work will cost to complete. The expected cost to finish all the remaining project work.

[1]**Variance at completion (VAC):** Calculates the difference between the BAC and what you expect to spend (EAC). A projection of the amount of budget deficit or surplus, expressed as the difference between the budget at completion and the estimate at completion.

The final **earned value forecast** looks at how the project needs to handle cost performance to meet original goals:

[1]**To-complete performance index (TCPI)** Measure of the cost performance that is required to be achieved with the remaining resources in order to meet a specified management goal, expressed as a ratio of the cost to finish the outstanding work to the remaining budget.

In this table, you'll see each earned value term, abbreviation, formula, and description.

Term	Abbrev	Formula		Description
Budgeted at Completion	BAC	The sum of all budgets established for the work to be performed		The total budget originally allocated for this project
Actual Cost	AC	The realized cost incurred for the work performed on an activity during a specific period of time		The total costs spent during a specific period of time
Earned Value	EV	EV=Actual % Complete x BAC		The planned value of all the work completed (earned) to a point in time
Planned Value	PV	PV=Planned % Complete x BAC		The value of the work planned to be completed to a point in time
Cost Variance	CV	CV=EV-AC		The difference between the value of work completed to a point in time, and the actual costs to the same point in time
Schedule Variance	SV	SV=EV-PV		The difference between the work completed to a point in time, and the work planned to be completed at the same point in time
Cost Performance Index	CPI	CPI=EV/AC	<1=bad 1=on track >1=good	Measures the cost efficiency of budgeted resources at a specific point in time
Schedule Performance Index	SPI	SPI=EV/PV	<1=bad 1=on track >1=good	Measures the schedule efficiency at a specific point in time
Estimate at Completion	EAC	EAC=BAC/CPI[c]		The expected total cost of completing all work
Estimate to Completion	ETC	ETC=EAC-AC		The expected cost to finish all the remaining project work
Variance at Completion	VAC	VAC=BAC-EAC		The estimated difference in cost at the completion of the project

Term	Abbrev	Formula	Description
To-Complete Performance Index	$TCPI_c$	$TCPI_c = (BAC-EV)/(BAC-AC)$ or $(BAC-EV)/$remaining funding <1 is good is this case because you have the space to spend more	The efficiency that must be maintained in order to complete on plan

Next, I've provided an example that you can use to practice applying these formulas. The first thing you want to do is calculate the first four values: BAC, AC, EV, and PV.

Example: You have a project to install 10 hair dryers in a salon. The cost per hair dryer is $2,750 and the project will last 10 weeks. At week 5, six hair dryers were installed and you've spent $15,500.

Budgeted at Completion		$27,500
Actual Cost		$15,500
Earned Value	Actual % Complete x BAC	$16,500
Planned Value	Planned % Complete x BAC	$13,750
Cost Variance	EV-AC	$1,000
Schedule Variance	EV-PV	$2,750
Cost Performance Index	EV/AC	1.06
Schedule Performance Index	EV/PV	1.2
Estimate at Completion	EAC=BAC/CPI	$25,943.39
Estimate to Completion	ETC=EAC-AC	$10,443.39
Variance at Completion	VAC=BAC-EAC	$1,556.61
To-Complete Performance Index	(BAC-EV)/(BAC-AC)	0.91666

BAC: To calculate BAC, just take 10 dryers times the cost per hair dryer ($2,750): 10(2,750)=$27,500.

AC: The next value to get is the AC, which is stated as "you've spent $15,500."

EV: Now let's calculate EV. You do this by taking Actual % Complete x BAC. To calculate the actual % complete, take the number of hair dryers installed (6) and divide by the total number of hair dryers to install (10): 6/10=.60. Then apply the formula: .60 x $27,500=$16,500. This is the value you've earned at this point in the project.

PV: Now let's calculate PV. You do this by taking Planned % Complete x BAC. To calculate the planned % complete, take the number of hair dryers that were supposed to be installed by week 5 (5) and divide by the total number of hair dryers to install (10): 5/10=.50. Then apply the formula: .50 x $27,500=$13,750. This is the planned value at this point in the project.

Now you have all the values needed to complete the rest of the equations! Let's move on to the rest of the formulas.

CV: Calculated by taking EV-AC: 16,500-15,500=$1,000. Notice that this is a positive number. This is good because you've spent less money than what you planned to spend at this point in the project.

SV: Calculated by taking EV-PV: 16,500-13,750=$2,750. Notice that this is a positive number. This is good because you've installed more hair dryers than what you planned at this point in the project.

Tip: For any CV or SV value:

- \>$1 is good as you're getting more value out of your money or time.

- <$1 is bad as you're getting less value out of your money or time.

- =$1 you're right on target with costs and time.

CPI: Calculated by taking EV/AC: 16,500/15,500=1.06. This is good. What this means is that for every $1.00 spent, you are getting $1.06 worth of value. You are getting more for your dollar.

SPI: Calculated by taking EV/PV: 16,500/13,750=1.2. This is good. What this means is that for every 1 hour worked, you are getting 1.2 hours worth of work done. You are getting more for your time.

Tip: For any CPI or SPI index value:

- \>1 is good as you're getting more value out of your money or time.

- <1 is bad as you're getting less value out of your money or time.

- =1 you're right on target with costs and time.

The following formulas are used for forecasting:

EAC: Calculated by BAC/CPI: 27,500/1.06=$25,943.39. This means if the project continues performing, as it is now, that the total cost of the project at completion will be $25,943.39. This is great news because the BAC was set at $27,500. The sponsor will pay less than planned for the project.

ETC: Calculated by EAC-AC: 25,943.39-15,500=$10,443.39. What this does is looks at what you've already spent (AC) and what you estimate to spend at completion (EAC) and, subtracts them so you end up with an amount you'll spend from now until the end of the project.

VAC: Calculated by BAC-EAC: 27,500-25,943.39=$1,556.61. This tells you the difference between what was budgeted (BAC) and what you'll actually spend on the project (EAC).

TCPI: Calculated by (BAC-EV)/(BAC-AC) (original budget) or (BAC-EV)/(EAC-AC) (current forecast). (27,500-16,500)/(27,500-15,500)=11,000/12,000=0.91666. This is good. The amount of effort to complete the project on plan is less than 1. The project team doesn't have to work as hard to complete the project per plan. They may even finish early if they choose to.

Tip: This calculation is the exception when it comes to the indices. You want this number to be =/-1 because this measures the amount of *effort* needed to achieve the schedule or financial goals. Let's say the value was 2. This means the project team would have to put in twice the effort to complete the project on plan.

- >1 is bad.

- <1 is good.

- =1 you're right on target.

Tip: Here's a way that might help you remember these four formulas. First, put them in alphabetical order by pairs: CV, SV, CPI, SPI.

CV=EV-AC
SV=EV-PV
CPI=EV/AC
SPI=EV/PV

- Notice that they each start with EV.

- The first two are minus, minus.

- The second two are divide, divide.

- In alphabetical order, AC (costs) comes before PV (schedule). So it's AC, PV, AC, PV. When you practice writing these, do it in order vertically:

Formula		1st step	2nd step	3rd step	4th step	5th step
CV=EV-AC		CV	=	EV	-	AC
SV=EV-PV		SV	=	EV	-	PV
CPI=EV/AC		CPI	=	EV	/	AC
SPI=EV/PV		SPI	=	EV	/	PV

Tip: Also, there's somewhat of a pattern with these three formulas that might help you remember them when you practice for your dump sheet. First, put them in alphabetical order.

EAC=BAC/CPI

ETC=**EAC**-AC

VAC=BAC-**EAC**

Next, if you look at them like it's a tic-tac-toe board, notice how EAC starts in the upper-left corner, then goes to the middle and then to the bottom-right corner.

Then BAC is on the top and the bottom. Remember to divide, then minus, minus. The last two you just need to remember, no tricks: CPI and then AC. This helped me; maybe it'll help you too!