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Earned Value Project Management

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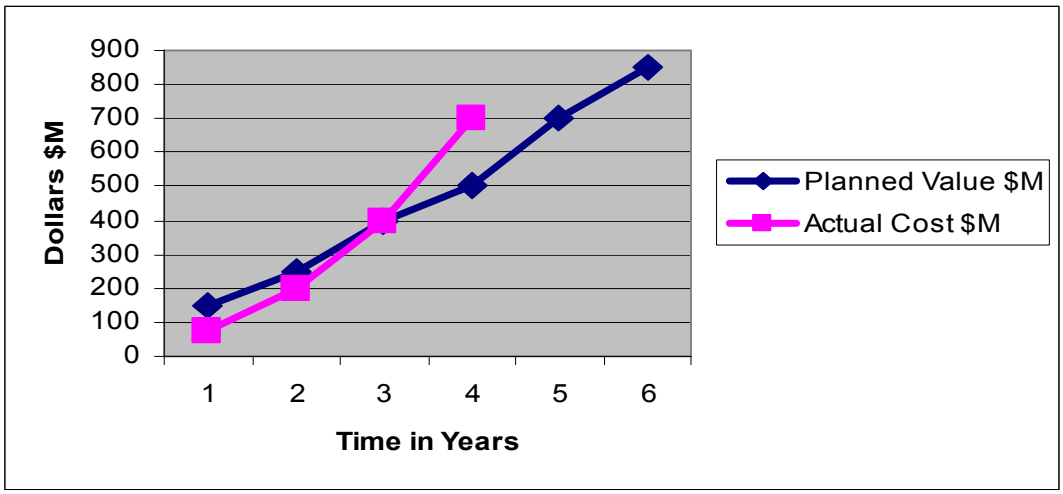
Abstract. Do you try to smile "knowingly", but are secretly baffled when your customers talk about Earned Value? This session will focus on the formulas and application of Earned Value Management (EVM), which is surprisingly easy, so that anyone can have a firm grasp of what it means and how it is used in Project Management.

Objective. Are you Smarter Than a 5th Grader? The goal is to put Supply Chain professionals at ease with the concepts involved in performing Earned Value, because the math involved really is NO MORE than a 5th grade level! The mathematical concepts are "elementary", so there is no reason to stay in the dark with respect to Earned Value. The next time customers bring up the subject of Earned Value, you will be able to understand and maybe even provide meaningful contributions to the discussion.

Definition and Purpose of EVM. The EVM process forces project managers to define their schedules in such a way as to set the framework for a completely objective analysis of the status of a project. We didn't previously have a good way to integrate the three elements of scope, schedule and cost into a single thought, and one that can be captured mathematically. Also, because EVM can start benefitting a project almost immediately at its onset, it will show the red flags earlier than other stand-alone statistics.

Combining scope, schedule, and cost in a single integrated method of measurement.

This chart represents a project BEFORE EVM.



X-axis is "Time in Years", and Y-axis is "Dollars"; as expected, the total expenditures rise as time progresses on the project.

The blue line is Planned Value, or how much the project was planned to cumulatively cost over its duration of 6 years, the project baseline.

As shown by the pink line, we are now at the 4 year mark, and we have spent more than we had planned to spend by this time. Notice that we actually started out under budget--we spent less than we thought we would during years 1 and 2, then we caught up to the plan in year 3, and now we are over the plan.

Is this good or bad?

The answer to this question is "It depends". On the surface, it looks like it might be bad, since we've spent more than we intended to have spent by this time. But what if the project is ahead of schedule? In fact, what if we have already almost finished all the work of the project? What if we thought the project would cost between $800M and $900M, but instead, it is almost complete, and we've only spent $700M. Then we're in great shape, right? So, we conclude that this graph is incomplete because it doesn't really tell us how we are doing.

Variables. There are three basic variables.

PLANNED VALUE (PV): This has also been called "Budgeted Cost of Work Scheduled (BCWS)". This was the dark blue line on the graph, the BASELINE values that we had planned to spend from the beginning of the project. These are the original estimated values of the work planned to be done.

ACTUAL COSTS (AC): In the early days of EVM this had the longer title of "Actual Costs of Work Performed (ACWP)". Obviously, it is the actual amount of money spent.

But these two numbers cannot operate in a vacuum, as we just saw on the graph.

EARNED VALUE (EV): You may have heard the term "Budgeted Cost of Work Performed (BCWP)". This is the original estimated value of the work actually done. These estimates are the same estimates that were used for the "Planned Value" numbers; it's just a matter of timing. As work is accomplished, those "planned value" dollars also become part of the EARNED VALUE dollars. Also, as opposed to the Actual Cost of the work that has been done, this is the amount that was budgeted or estimated for that same work. As you can imagine, this is the number that will bridge the gap that was observed on the graph.

Formulas-- How it works.

Year 1 complete.

PV=$150M
AC=$ 75M

Here are the relevant data points at the conclusion of year 1 for the project. At this point in time we had planned to have spent $150M already, which is the Planned Value number. The Actual Costs for the work completed to date are $75M. As we

know from the graphical example, these two numbers alone don't tell whether the project is in good shape or not. The key is an Earned Value number:

EV=$35M

$35M is the cumulative budgeted amount for the items that have been completed. This is truly depressing. For the work we have accomplished, $35M was budgeted, yet we have spent $75M! Now to apply the first simple formula; Cost Variance (CV).

CV = EV-AC

COST VARIANCE is negative $40M, therefore the project is OVER BUDGET.
(Negative is over budget, positive is under budget)
Now to apply the second simple formula, SCHEDULE VARIANCE (SV).

SV = EV-PV

We had planned to complete $150M worth of work, yet we have completed only $35M worth of work! This is really awful! SCHEDULE VARIANCE comes to negative 115, so we are BEHIND SCHEDULE. (Negative is behind schedule, positive is ahead of schedule)

Year 2 complete.

PV = $250M
AC = $200M
EV = $130M

The baseline plan was to have spent $250M by now, and we have spent only $200M. EARNED VALUE is $130M, which means that the items in our baseline budget that we have completed, when added all together, total $130M.

Applying the same subtractions discussed above yield a Cost Variance of negative $70M and a Schedule Variance of negative 120. So the project is still over budget and behind schedule. Now we might apply another formula to give our cost information some new perspective. It's called Cost Performance Index (CPI).

CPI = EV/AC

It is simply EV/AC, which results in 0.65. This means that we are getting 65 cents out of every dollar spent! This is a valuable indicator! Not only can we confidently say "We're over budget", we can quantify that in a way that communicates the rate at which the work has cost more than anticipated.

Year 3 complete.

PV = $400M
AC = $400M
EV = $350M

We are starting to close the gap. Planned Value was $400M and, miraculously, Actual Costs are also $400M. But this doesn't mean all is well, because Earned Value

is only $350M. However, the Cost Performance Index has improved; it is now at 0.875, so we are getting 88 cents out of every dollar.

Another performance index is Schedule Performance Index (SPI).

SPI = EV/PV

The SPI is 350 / 400, which is coincidentally also 0.875, and so this indicates that we are progressing at 88% of the rate that we had intended.

Year 4 complete.

PV = $500M
AC = $700M
EV = $600M

The exciting news is that the project's Earned Value has now surpassed the Planned Value! So immediately we understand that schedule variance is in the positive (100 to be exact), so we are ahead of schedule! The SPI (EV/PV) is 1.2, so we are now progressing at 120% of the rate we had anticipated for schedule. The Cost Performance Index has dropped just slightly; it is 0.857, which means we are getting 86 cents out of every dollar.

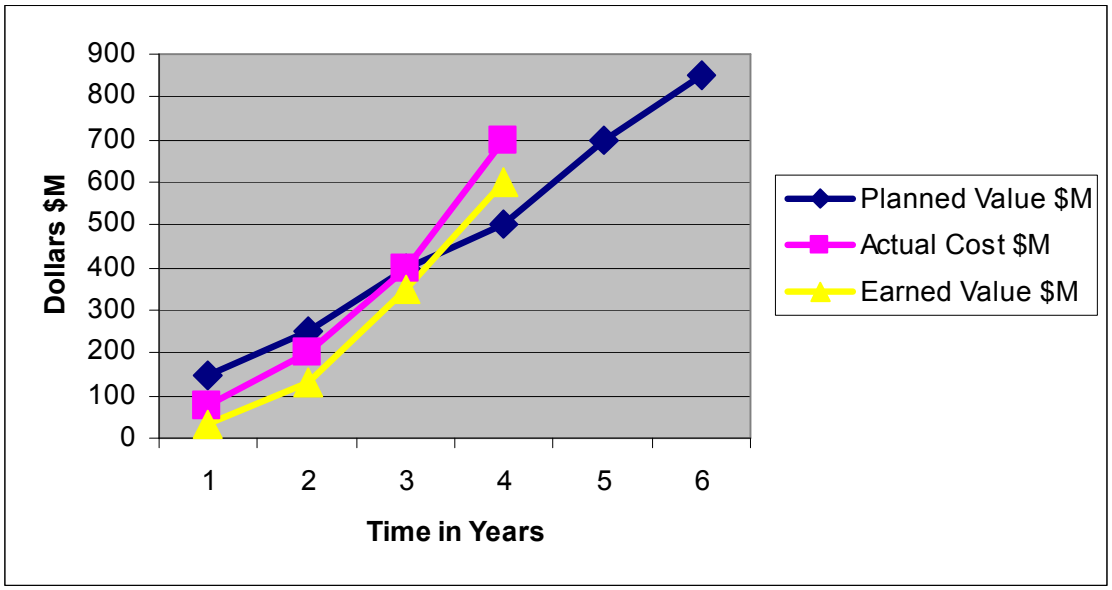
Recall from the initial graph that our Budget at Completion (BAC) was $850M. This represents the final Planned Value number at the end of the baseline budget. Now we can use our Cost Performance Index to give us our Estimate at Complete (EAC).

BAC/CPI = EAC

$850M divided by 0.857 is $992M, therefore our EAC is $992M. In other words, since we are getting 86 cents out of every dollar, the project will cost $992M instead of the $850M that was planned.

At this point one can simply perform a few more simple calculations to find ways to express the same thing. We can subtract actual costs from the EAC to get an "Estimate to Complete (ETC)" number, or we can take the BAC minus the EAC to get a Variance at Completion (VAC), that is "How much over budget will we be at the end of the project".

Graphical representation.

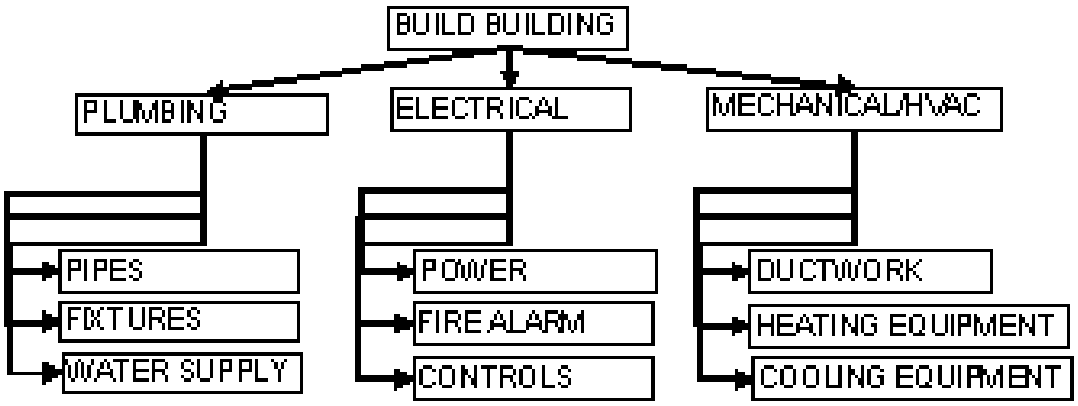


Here is the graphical representation, now including Earned Value. The Planned Value is still in Blue, Actual cost in Pink, and Earned Value is in yellow. Notice the point after year three, when EV surpassed the PV, indicating that the project finally got ahead of schedule. Schedule Variance is the distance between the yellow line and the blue line, and of course Cost Variance is the distance between the yellow line and the pink line (Earned Value minus Actual Costs).

So this new graph provides the Earned Value, which gives the proper context in which to consider Planned Value and Actual Costs. This yellow line "completes" the picture.

Project Planning. Remember that Planned Value and Earned Value both come from the same baseline budget; as work is completed, the budgeted dollar amount associated to that work becomes part of the Earned Value number instead of just being in the Planned value column. But how did they get to be numbers in the first place?

This relates to the planning phase of the project. Before any work began the first step that was taken towards Earned Value management was to define the work to be accomplished using a Work Breakdown Structure. This is a high level example of a portion of the Work Breakdown Structure for our project.



Once a Work Breakdown Structure has been established, then each node of the WBS must be assigned a Planned Value. This may be accomplished in any logical manner, but the most common practice is to utilize scheduling software that supports the assignment of resources and their costs to each activity node.

As work is completed, the project manager uses pre-defined earning rules for the transition of the project's planned values to also count towards earned values. One easy way to do this is to give no credit whatsoever for work in progress on a task, until it is finished, at which time 100% credit is assigned. So the planned value for the task remains a "planned value" until the task is complete, then it is also an "earned value".

Another more common approach is the 50/50 rule, which means assigning 50% credit when work starts, and the remaining 50% upon completion. So if a task has not started, then it is simply a Planned Value. Once it starts, then half of the estimated dollars count towards Earned Value. Once it is finished, the rest of the dollars count for Earned Value. Some projects do variations of this such as 25/75 or 20/80. MOST SIMPLE PROJECTS will use one of these rules, which helps to maintain a uniform approach, require fewer resources, and eliminate subjectivity from the estimates. More complex projects might choose to use "percent complete" estimates or other more complex formulas. In construction, for example, percent complete estimates are commonly used, since they are already part of their normal industry practice in applying for payments.

The results of this pre-planning (setting up a WBS, assigning Planned Values, and using earning rules to define when to get credit for Earned Values) yield a harvest of valuable information that really puts a project into perspective!

REFERENCES

Defense Acquisition University EVM Gold Card, https://acc.dau.mil/CommunityBrowser.aspx?id=19577&lang=en-US, January 2009.

Construction Photos used during presentation with permission from webmaster, http://burjdubaiskyscraper.com/, December 4, 2008.