NWD Comments Included

Scope

This reference document provides information regarding earned value management to encourage and assist in its application to ~~both~~ HTRW, Response: see reworded master document Military and Civil Works projects. Earned value management is widely recognized in both the public and private sector as a key tool for integrating cost, schedule and technical or physical performance for more effective project control and evaluation. The Project Management Institute (PMI) has placed such regard on the value of this tool that approximately 20% of the questions included in their Project Management Professional (PMP) registration exam relate to the proper application of earned value to managing project execution.

This document will provide a very simple example of the usefulness of earned value, a discussion of some simple techniques recommended for assigning the earned value to tasks or work packages, and provide some key terminology definitions/formulas related to earned value management. For those desiring a more in-depth understanding of the tool, a number of references are provided below.

Distribution

Project Manager (PM)

Project Delivery Team (PDT)

Resource Provider(s)

Deputy District Engineer for Programs & Project Management (DPM)

Corporate Board

Ownership

The BP/P2 Configuration Manager is responsible for ensuring that this document is necessary and that it contains current and relevant information.

References

Center for Project Management Knowledge and Wisdom[http://www.pmi.org/k&wc]

The Department of Defense Project Management Website[http://www.acq.osd.mil/pm/]

Earned Value Project Management, 2nd Edition, by Quentin W. Fleming and Joel M. Koppelman (Recommended by ESI International in association with The George Washington University's Master's Certificate Program in Project Management).

The Institute for Water Resources Project Management Web Depot (search on Earned Value)[http://www.pmcl.com/pmwd/]

The NASA Academy of Program and Project Leadership web resources[http://appl.nasa.gov]

The NASA Earned Value Management Tutorial and Resources[http://evm.nasa.gov]

The Project Management Institute Website[http://www.pmi.org]

Earned Value Management Example and Explanations

Susan's Lemonade Stand

Phil's young daughter Susan came to him with a great idea. Using her mom's secret recipe, she was sure she could put the Country Blend lemonade folks out of business in just 50 short days. All she needed was a lemonade stand and little venture capital. Phil inquired a little further and Sue presented him with this plan: She needed to sell 1000 cups of lemonade at the rate of 20 cups/day and Country Blend was toast!! Her only problem was that it would cost her 50 cents per cup to make the lemonade and she had no money and was wondering if Phil would put up the $500 she was lacking?

Recognizing Sue's genius, Phil immediately gave her the $500 budget that she required.

Ten days later, Phil inquired of Sue how she was doing in the lemonade business. She replied, "Things are going GREAT. I have only spent $90 of my $500 budget." Phil asked her how many cups of lemonade she had made. She said, "I am doing pretty good there also!! I just added today's business and I have made a total of 130 cups of lemonade."

Just what is the actual status of Susan's lemonade project? She is 20% into her planned schedule and has spent less than 20% of her budget – looks like her evaluation of "GREAT" is right on!! However, Phil asked her for just one other bit of information – how many cups of lemonade have you made? He knew that the only way to really integrate cost, schedule and technical performance to see how the project was going and what, if any, corrections were required was to apply a little earned value management to the situation.

The earned value tool requires four key pieces of information. With these four items, the earned value calculations open a wealth of cost, schedule and performance integration to help improve your capability to analyze and correct project deficiencies. The four key items needed are the total budget for the project ($500 in Sue's case – known as Budget at Completion (BAC)), the cost of the work that has been accomplished to date (Sue has spent $90 – known as Actual Cost of the Work Performed (ACWP)), the budgeted cost of the work that was scheduled to be performed to date (Sue had scheduled making 20 cups/day at $0.50/cup. Thus at the close of day ten she should have made 200 cups at a budgeted cost of $100. – known as Budgeted Cost of the Work Scheduled (BCWS)), and finally the "earned value" of the work performed to date, i.e. what was the budgeted cost of the work performed (for Sue the "earned value" was 130 cups at $0.50/cup or $65. – known as the Budgeted Cost of the Work Performed (BCWP)). So you see that Phil now has all the information he needs to determine the actual status of Sue's lemonade project.

Recapping the lemonade project we have the following key pieces or information:

Budget (BAC) = $500.00

Actual Cost of the Work Performed (ACWP) = $90.00

Budgeted Cost of the Work Scheduled (BCWS) = $100.00

Earned Value or Budgeted Cost of the Work Performed (BCWP) = $65.00

Phil is now ready to see how this project is actually performing as an integrated whole - schedule, cost and technical or physical performance. First he decides to see how the Lemonade Project budget was doing. The Cost Variance (CV) is determined by subtracting the actual cost of the work performed (ACWP) (in USACE this is the total expenditure to date as recorded in CEFMS) from the amount budgeted to do that work (BCWP). For the lemonade project this becomes CV = BCWP – ACWP = $65 - $90 = minus $25. The lemonade stand is currently over budget! If the CV = 0 then the project is on budget. A negative CV indicates over budget, and a positive CV indicates under budget performance. This still doesn't tell us just how badly over budget we are but it lets us know we need to check further.

Phil decides to check the Cost Performance Index (CPI) to get a handle on the cost efficiency of the effort to date. To determine the efficiency, Phil divides the budgeted cost of the work performed (BCWP) by the actual cost of the work performed (ACWP). For the lemonade project we have CPI = BCWP/ACWP = $65/$90 = 0.72. This means for every dollar Sue has spent so far she has only accomplished 72 cents worth of the work she had planned to do with that dollar. If the CPI equals 1.0 then we are getting exactly what we budgeted for. A CPI less than one indicates we are not as efficient as we had planned (earning less than $1 for every $1 spent) and a CPI over one indicates we are more efficient than originally planned (earning more than $1 for every $1 spent).

Phil decided to make a similar check on the schedule variance (SV) and the schedule efficiency (Schedule Performance Index (SPI)) for the lemonade stand project. The SV is found by subtracting the budgeted cost of the work scheduled (BCWS) from the budgeted cost of the work performed (BCWP). For the lemonade project SV = BCWP – BCWS = $65 - $100 = minus $35. Sue's project is behind schedule. Again a SV of zero means the project is right on schedule. A negative SV indicates a project behind schedule and a positive SV indicates a project ahead of schedule. To see just how badly the lemonade project is doing Phil decides to calculate the schedule efficiency (SPI). SPI = BCWP/BCWS = $65/$100 = 0.65. This means that you are only accomplishing 65% of the work that you had planned on accomplishing each day on your schedule.

Phil decides that Sue's evaluation of current project performance "GREAT" is not precisely accurate and begins to wonder if she will be back for an increase in budget if things continue as they are currently going. Phil decides to estimate how much this project will cost at completion (known as the Estimate at Completion (EAC)). He can find this by dividing the total project budget (known as the Budget at Completion (BAC)) by the cost performance index (CPI). For the lemonade project the EAC = BAC/CPI = $500/0.72 = $694.44. Phil gets this sinking feeling that Sue is probably going to be back for another loan increase so he calculates how much money Sue will need to finish the project (known as the Estimate to Complete (ETC)). The ETC is calculated by subtracting the actual cost of the work performed (ACWP) from the estimated cost at completion (EAC). For the lemonade project the ETC = EAC – ACWP = $694.44 - $90.00 = $604.44. So it appears likely that at his next visit with Sue she will change the story from "GREAT" to "I just need to borrow another $104 and everything will be FINE!"

Phil decides to make one more quick calculation to see just what Sue would have to do from now on to bring this project in as she originally estimated. What efficiency would Sue be required to maintain from now through project completion to remain within the original budget (known as To-Complete Performance Index for Budget at Completion (TCPI (BAC)). This efficiency index is calculated by dividing the work remaining by the money remaining. The work remaining is determined by subtracting the budgeted cost of the work performed (BCWP) from the budget at completion (BAC). The money remaining is determined by subtracting the money spent to date (ACWP) from the budget at completion (BAC). For the lemonade project, the efficiency required to come in at budget is TCPI (BAC) = (BAC – BCWP)/(BAC – ACWP) = ($500 - $65)/($500 - $90) = 435/410 = 1.06. From today forward, Sue will have to perform at 106% of her originally budgeted efficiency, i.e. she will have to do $1.06 worth of work for every dollar spent. While this doesn't sound impossible, project experience indicates that very few projects are able to perform much beyond 104%. If we couple this rule of thumb with the fact that so far Sue has only performed at 72% of her budgeted efficiency (only got 72 cents worth of work for every dollar spent), we see why Phil decides to write off his $500 as an educational expense!

This example has only provided a small subset of what you can do with earned value management. Earned value also provides a wealth of other predictive tools to aid the PDT in early identification of problems. Earned value is not designed to allow early punishment of team members but rather early action while it is still possible to overcome problems. Early warning becomes the basis for better management and greater success leading to pleased customers and quality accomplishment.

Determining Budgeted Cost of the Work Performed (BCWP)/Earned Value

By now you are all thinking this earned value management stuff is really nice, but we don't have work packages or tasks that proceed in such a simple and linear manner as $0.50/cup! Correct!! However, there are many, many simple techniques that can be used to assign the earned value to a work package or task without much effort and still get an accurate representation of project accomplishment to use for early warning and project management. I will illustrate with just two simple techniques that could easily apply to effort on USACE projects. They are known as the 50-50 rule and the 0-100 rule. For work packages or tasks that, prior to completion, provide incremental information that can be used in successor work packages or tasks, a possible technique would be the 50-50 rule. Assign 50% of the total effort as the earned value (BCWP) when effort begins on the task. The final 50% is assigned only when the task is completely finished. For a work package or task that must be totally complete before successor tasks can be undertaken, you could use the 0-100 rule. Assign no earned value when the task is initiated and assign the total value of the task as earned value (BCWP) only when it is 100% complete. Such a task might be writing of the final study report. You can't send the report for printing and binding until it is completely written. Consequently, you have earned no value until it is finished and you could use the 0-100 rule. These are just two simple examples and you should look at the reference publications for others.

Another thing that becomes quite clear from the above example is that great care must be used in establishing your initial WBS so that work packages or tasks are of short enough duration to make meaningful measures and, at the same time, not create an administrative nightmare for updating purposes (another good reason to use 50-50 or 0-100 schemes for assigning earned value). The relationship between CEFMS and P2 is being designed to provide significantly better actual cost/task data than has been possible without an unmanageable burden using the CEFMS/PROMIS connectivity.

Earned Value Management Key Terminology and Formulas

Earned value provides you with at least 40 or 50 different calculations that can be used to provide an objective and predictive assessment of variance in project parameters of cost and schedule. It provides a basis for common understanding by all members of the PDT. It is incorporated in the P3e NAS and most other project management software for ready use by the PDT. It allows consistent analysis from project manager to project manager. It is highly recommended as the standard procedure for PMBP in assessing project status.

Definitions

The following are some key definitions and formulas used in earned values management. For more detail and additional definitions/formulas please see the reference section of this document.

ACWP (Actual Cost of the Work Performed) – The costs actually incurred and recorded in CEFMS/P2.

BAC (Budget at Completion) – The sum of all WBS costs established for the project as the baseline budget or an approved revised baseline budget.

BCWP (Budgeted Cost of the Work Performed) – The sum of the budgets for completed work packages or tasks and completed portions of open work packages or tasks.

BCWS (Budgeted Cost of the Work Scheduled) – The sum of the budgets for the work packages scheduled to be completed at a point in time plus the apportioned budgets for work packages or tasks scheduled to be partially complete at that time.

CPI (Cost Performance Index) – A measure of the efficiency of the dollar value budgeted for the work performed as a percentage of the dollars spent to do that work. It indicates how many dollars of scheduled effort were accomplished for every dollar spent.

CV (Cost Variance) – A measure of the difference between the cost budgeted for the work performed and the actual cost to do that work.

EAC (Estimate at Completion) – An estimate of the total cost to complete the project at the current performance efficiency.

ETC (Estimate to Complete) – An estimate of the remaining cost to complete the project at the current performance efficiency.

SPI (Schedule Performance Index) – A measure of the efficiency of performance against the schedule. It indicates how many days of scheduled effort were earned for every day worked.

SV (Schedule Variance) – A measure of the difference between the budgeted dollar value of work performed versus the budgeted dollar value of the work scheduled to be completed. Comparing budgeted cost of accomplished work to budgeted cost of scheduled work indicates the difference caused by schedule changes.

TCPI (BAC) (To-Complete Performance Index within budget amount) – Work remaining divided by money remaining per the original budget estimate. Provides the efficiency improvement required over the budgeted efficiency to finish the project within the baseline budget.

TCPI (EAC) (To-Complete Performance Index within projected estimate to complete) – Work remaining divided by money remaining based upon the total estimate at completion assuming the project efficiency remains unchanged from the current efficiency.

Variance Formulas

CV = BCWP – ACWP

SV = BCWP – BCWS

CV (%) = CV / BCWP

SV (%) = SV / BCWS

Performance Indices

CPI = BCWP / ACWP

SPI = BCWP / BCWS

% Complete = BCWP / BAC

% Spent = ACWP / BAC

TCPI (BAC) = Work / Money = (BAC – BCWP) / (BAC – ACWP)

TCPI (EAC) = Work / Money = (BAC – BCWP) / (EAC – ACWP)

Other

EAC = BAC / CPI

ETC = EAC - ACWP