EARNED VALUE MANAGEMENT

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Abstract

Earned Value Management has been used with enterprise-level commercial and government projects. It has been shown to be a success, and an aid to integrating performance, cost and schedule data in project management, but it has not been widely embraced in the private sector due to its complexity. New methods by Quentin Fleming and Joel Koppelman for using simplified Earned Value Management may be instrumental to apply in smaller commercial projects as well as information technology projects.

EARNED VALUE MANAGEMENT

Earned Value Management has been widely adopted for the management of projects in the government sector. Today some project managers are developing ways to simplify the methodology, and encourage its application it in the management of commercial projects for small and midsize businesses.

This research paper will describe Earned Value Management as a methodology traditionally used in large commercial and government projects. The paper will explore how a more comprehensible and simplified type of Earned Value Management, Simple Earned Value Management, may work on smaller-scale projects. Many project managers frequently attempt to invoke feedback from the project team and stakeholders to improve project processes, and Earned Value Management has proven to be an effective performance measurement tool. This paper will describe how to use Earned Value Management successfully and issues to consider when using Earned Value Management. In addition, the methods and limitations of using Simple Earned Value Management will be described as well as which aspects of the Simple Earned Value Management process are unique to this methodology. The paper will conclude with discussion of why Simple Earned Value Management can and should be used on most projects.

Earned Value Management, which is also referred to as EVM, is a project management methodology developed to integrate a project baseline and accurately measure performance against that baseline. It is a way to measure a project's cost, schedule and technical performance. Most significantly, it has proved to be a reliable indicator of true cost performance, which no other project management technique has provided.

Earned Value has been used for many years, and called many titles, such as Planned Value of Work Accomplished (PVWA), Budgeted Cost of Work Performed (BCWP), Cost/ Schedule Control Systems Criteria (C/SCSC), and many others. As an integral part of the Cost/ Schedule Control Systems Criteria originally developed in factories and government agencies, it required practitioners to have specific training in a cumbersome vocabulary of terms to use it (Fleming and Koppelman, 2005).

In 1965, when it was developed by U.S. Air Force acquisition managers and later, the Department of Defense, it incorporated 35 criteria. These criteria were requirements to be satisfied for each C/SCSC project. In 1996, the C/SCSC criteria were rewritten and reduced to 32, and the methodology was termed Earned Value Management System, or EVMS. Following this, the National Defense Industrial Association (NDIA) attempted to simplify EVM further. In 1998, the NDIA accepted EVM through the American National Standards Institute and termed it the ANSI/EIA-748 Standard (Fleming and Koppelman, http://www.stsc.hill.af.mil/CrossTalk/ 2006/06/0606FlemingKoppelman.html).

The criteria required by EVM were imposing and limiting. While it is well tested in its history, the majority of project managers working smaller projects did not think the benefits it would bring could outweigh the value of their time and effort to learn it. In addition, many who did attempt to manage projects with EVM found it to be needlessly complicated, requiring more investment of time in the planning phase of a project than they desired to do.

In its fundamentals, EVM is not as difficult as this history suggests. Any time a project manager verifies that contracted work was accomplished before approving payment of it, they are using a form of Earned Value, and analyzing what has been achieved in comparison to what

has been spent. This rather simple and commonplace concept in project management necessitates the creation of a project performance measurement plan called in EVM parlance, the Planned Value, defined in accordance with project's scheduling system. Earned Value is measured against Planned Value. Earned Value or EV (which in past EV methodologies, was called Budgeted Cost of Work Performed, or BCWP) is related to the actual costs spent to pay for that work, providing an accurate measure of a project's true cost performance (Fleming and Koppelman, 2005).

Because of this ability to measure performance, EVM provides a benefit of objectivity. The performance of the resources on a project are compared with the original baseline schedule and the budget. This measurement of project performance enables even very different projects to be compared, which aids performance tracking over a portfolio of projects and helps all levels of stakeholders to have metrics of project performance to access and understand.

Earned Value also can provide a project team with an early forecast of the project's actual cost at the end of the project and if there are any problems to meeting the goals of the project successfully according to the project plan. This type of forecast has been shown to be accurate even when the project is only 20 percent complete, allowing time to identify the source of the problem, and time to correct and adjust the variables that would solve the problem (Fleming and Koppelman, 2005). If reviewed at the 20 percent complete mark, many projects with unfavorable Earned Value can be adjusted and still result in a favorable outcome.

EVM is most thoroughly understood by examining an example project with and without use of EVM. In a project that does not use EVM, a spending plan will be developed for the project and submitted for review and approval by senior management. The example project has a $1,000,000 budget to be used over a 1 year project timeline. In its first quarter, the example

project shows that $300,000 will be required. The project is expected to remain within the $1,000,000 total budget, and the project manager is expected to monitor the performance throughout the project.

Our current status at the point of review is the end of the first quarter. The approved spending plan called for $300,000 to be used in the first quarter. This reflects the project's Planned Costs. The expenditure for the first quarter is in line with this plan, exactly $300,000. One could conclude that the project was currently exactly on target. However, these figures are misleading.

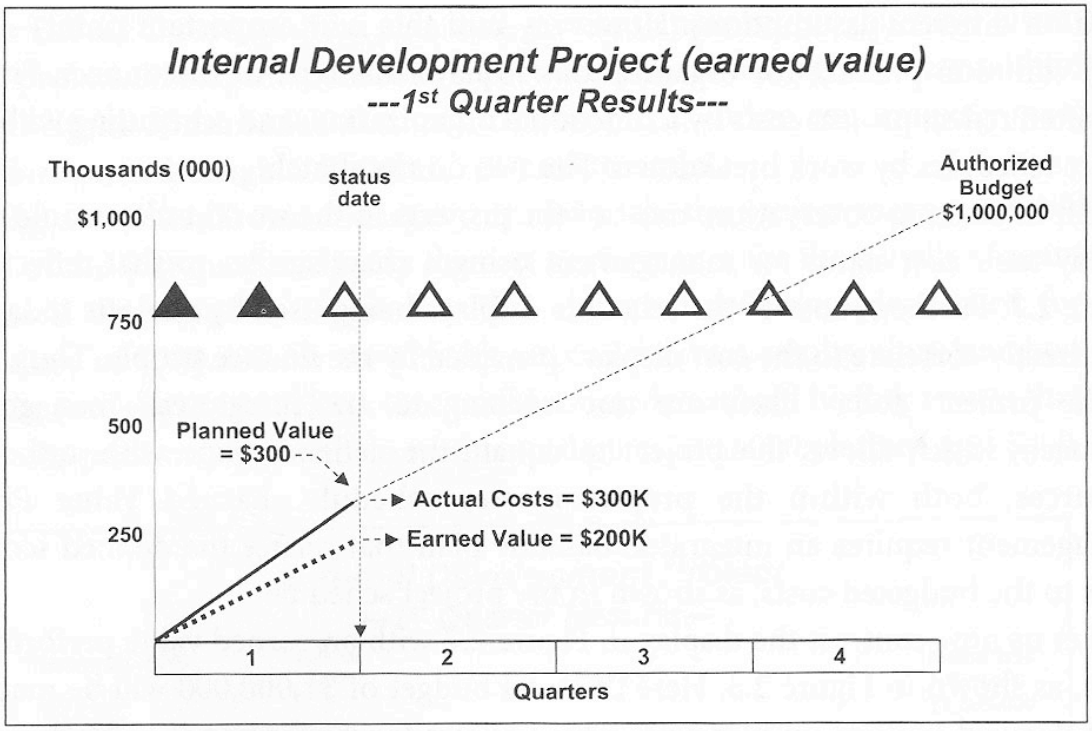
The figures as they are represented, the Planned Costs and Actual Costs, do not reveal the project's true cost performance. The project stakeholders receive no information about the amount of work completed relative to the expenditure. In fact, what these figures reveal is simply that the project funding is on track. The project needed $300,000 in its first quarter, and it was funded with $300,000 in its first quarter. Was an appropriate amount of work effort performed for that $300,000?

This example project can now be reviewed for cost performance, this time applying EVM. Using EVM, the total budget of $1,000,000 is developed with detailed bottom-up estimating. The performance will be measured throughout the project. Milestones are identified, and each milestone receives a weighted value of $100,000. At the completion of each milestone, when a deliverable work package is finished, the project will have earned $100,000.

Work that is accomplished at the end of the first quarter (our current status) is called Planned Value in EVM, or PV. (In past EV methodologies, PV was called Budgeted Cost of Work Scheduled, or BCWS.) Planned Value incorporates two concepts measured simultaneously:

the work that is scheduled and the budget associated with that work. The Work Baseline Structure and Project Schedule called for an accomplishment of three milestones in the first quarter, the equivalent of $300,000 of work, or Planned Value.

The chart below shows the project's current status using EVM.



(source: Fleming and Koppelman, 2005, Earned Value Project Management, pp.18, Figure 2.3, Earned value project management: 3 dimensional)

The chart shows that the project has completed 2 out of 3 milestones planned to be completed in the first quarter, representing an Earned Value of $200,000, against a Planned Value of $300,000. It is apparent that the project is behind schedule. Because the project accomplished only $200,000 of work out of the $300,000 planned achievement, the project is running a negative $100,000 Schedule Variance.

EV - PV = Earned Value Schedule Variance or SV

$200,000 - $300,000 = -$100,000

The chart also shows the Actual Costs, or AC, of $300,000. (In past methodologies, AC was called Actual Cost of Work Performed or ACWP.) The project has been funded $300,000 in Actual Costs to achieve $200,000 worth of Earned Value. Therefore, there is a negative $100,000 Cost Variance.

EV - AC = Cost Variance or CV

$200,000 - $300,000 = -$100,000

These metrics can now be used to predict the final costs and schedule results of the project. The success of this project is clearly at risk, but the stakeholders have information at hand, and an opportunity to identify the problems and take measures to improve its outcome.

Two other metrics are of critical importance with EVM, and these are indexes. Indexes measure the performance as a ratio, permitting comparison across projects. If a project is progressing exactly as planned, the indexes will be 1.00. When a project is greater than 1.00, a project is progressing better than planned. When below 1.00, the progress is worse than planned.

The Schedule Performance Index, or SPI, on our example project reveals that the project's SPI is .67. The SPI is a schedule-efficiency factor that can be used to indicate how much time will be required to finish the authorized work of the project. At the rate of performance at the end of the first quarter of the project, it will probably take much longer than one year to complete the project if no changes to the project plan are made.

EV / PV = Schedule Performance Index or SPI

$200,000 / $300,000 = .67

Another way of looking at the resulting SPI or schedule efficiency factor, is that for every dollar of work planned to be completed in the first quarter of the project, only $.67 was completed. The SPI can also be used with Critical Path Method, or CPM, to predict the project's completion date, and when combined with CPI, or Cost Performance Index, the two ratios can help forecast the total funds needed to complete the project successfully according to plan (Fleming and Koppelman, 2005).

The Cost Performance Index, or CPI, on our example project reveals that the CPI is .67, or a $100,000 cost overrun. The CPI is a cost-efficiency factor used to indicate how much money the project will require to complete the entire authorized work. The CPI is calculated by comparing the Earned Value with the money spent on accomplishing the Earned Value.

EV / AC = Cost Performance Index or CPI

$200,000 / $300,000 = .67

Another way of viewing the CPI or cost efficiency factor, is that for every dollar spent, only $.67 of work was completed. By itself or with the SPI, the CPI is useful in forecasting a statistical range of estimated final costs.

One could revisit the project, reconsider the problems causing the work slowdowns, estimate what it will take to correct the issues, and re-estimate the entire project with bottom-up estimates. This is the most accurate method of calculating the final costs, however, because the level of detail required for accuracy takes a commitment of time, the most frequently used methods for forecasting final costs are to use earned value statistical forecasting and provide a statistical range into which the Estimate at Completion or EAC would fall.

The first method used in earned value statistical forecasting is to take the total budgeted funds (Budget at Completion or BAC) and divide it by the CPI.

BAC / CPI = Minimum Estimate at Completion

$1,000,000 / .67 = $1,492,537

The second method commonly used in earned value statistical forecasting is to take the CPI and multiply it by the SPI, and use the result to forecast the maximum amount of money needed to complete the project. This factors in the cost overrun and the fact that the project is behind schedule already, and is a "worst case scenario" projection of the project costs.

CPI x SPI = EAC Ratio

.67 x .67 = .4489

Then take this ratio and use it to calculate the maximum EAC.

(BAC x EAC Ratio) + Minimum EAC = Maximum Estimate at Completion

($1,000,000 x .4489) + $1,492,537 = $1,941,437

The result of the above EVM calculations tell the project team that given what is known about the project currently, if there are no changes to improve performance, the Estimate at Completion will range between $1,492,537 and $1,941,437.

Another method can be used to give the project team an Estimate to Complete the project from the current status position, and provides an estimate of the final cost of the project with correction of past performance issues and without correction of past performance issues. This method does not provide a statistical range, but an estimate.

BAC - EV = Estimate to Complete, from Current Status to Completion

$1,000,000 - $200,000 = $800,000 (if past performance is corrected)

(BAC - EV) / CPI = Estimate to Complete, from Current Status to Completion

$800,000 / .67 = $1,194,029 (if past performance is not corrected)

From these figures, we can calculate the Estimate at Completion, given what we know right now.

AC + ETC = EAC (if past performance is corrected)

$300,000 + $800,000 = $1,100,000

AC + ETC = EAC (if past performance is not corrected)

$300,000 + $1,194,029 = $1,494,029

(Nankivel, J., 2009, http://pmstudent.com/itchy-for-earned-value/)

The above shows that the EAC if performance is not corrected is very close to the minimum EAC in the statistical range provided earlier, which was $1,492,537.

There is more data that these factors and variables can be used for, but to almost any project manager, the results of the calculations already make a strong case for using EVM and improving the real cost performance on a project. The Estimated Cost to Complete and the Estimate at Completion reveal that it would be more beneficial to increase the budget allocation for human resources or other technical resources, extend the timeline, or curtail the scope. The consequences of permitting a poor performance to go unchecked would ultimately lead to failure.

Considering the benefit this knowledge could have to many projects, it is unfortunate that many project managers avoid using EVM. EVM could be used on projects of all sizes, but the commitment of time and effort involved in meeting the original 32 criteria for implementation is simply too much for most project teams.

Project managers Quentin Fleming and Joel Koppelman advocate adoption of EVM not only for large projects, but also for smaller projects more likely to be produced by small to mid-size businesses. They have developed a ten-step process called Simple EVM, that defines EVM by its most essential requirements. Fleming and Koppelman believe these steps can be substituted for the original criteria, and still qualify as EVM (Fleming and Koppelman, 2005). By creating these ten steps, they have attempted to make EVM more accessible in its utility, while reducing the effort required to implement it.

The first step defined in this process is Step 1: You must define the scope (objectives and deliverables) of the project. This is perhaps the most important step and it is also the most difficult to do effectively. A Work Breakdown Structure (or WBS) is created and used in this process. The WBS is a deliverable-based hierarchical outline that looks like an organization chart. It describes the major parts of a project and its deliverables, and may include software, hardware, services, data, or other products. All important deliverables must be included in a WBS. If a major effort or deliverable can not be identified in a part of the WBS, it should be considered outside the scope of work.

Each level in a WBS provides more detail about the work to be accomplished. By describing the major sections of a project and its deliverables, a WBS allows management to focus on logical groupings of work, called sub-projects or work packages.

Many project managers will abandon scope definition before defining the scope in its entirety. The task requires special communication skills and characteristics. A project manager must elicit information from stakeholders and the people who may be assigned to work on the project, and have the perseverance and patience to probe for information by asking questions,

listening completely to answers, and doing follow-up questions based on the responses. He or she also needs to interpret, analyze and document what has been learned, and create a WBS as an output from this process.

The next step defined in Fleming and Koppelman's process is Step 2: You must determine who will perform the defined work, including the identification of all critical procurements. The people performing the defined work of the project must be chosen as early as possible. Will the project use more experienced workers who are also more costly or less experienced workers who are less costly, but may attach an element of risk due to their relative inexperience? Can an organization handle the project completely internally or must outside resources be procured? Such make-or-buy decisions are essential to defining scope because of the need to determine the costs of such resources and the contracts involved. Outsourcing work involves non-forgiving formal legal arrangements where contracts must be properly executed and changes to the contracts, such as those caused by a change in the scope of the project, can be costly. Regardless of whether the human resources working on the project are an internal or outside team, the cost of these resources must be estimated and their progress on the project must be reported.

The third step in the process is Step 3: You must plan and schedule the defined work. The EVM process must have a formal scheduling system showing the approved scope of work, with each task set into a time frame. In EVM, the scheduled work and the budget attributed to that work constitute the Planned Value. As the work is completed, it "earns its value", becoming Earned Value for the project. The schedule is what describes the progress of time on the project,

and all tasks (Planned Value) are measured in their completion as Earned Value, against the passage of time on the schedule.

One aspect of project management that EVM does not capture and track is critical tasks. In EVM, it is as if all tasks have equal importance and affect the success of the project. A project manager must go beyond EVM to develop a method to track the progress of critical tasks, their dependencies and constraints. Some method of critical path methodology is usually used to manage this aspect of the project. Critical tasks must be managed aggressively at the same time as schedule variances to ensure a project stays on track to successful completion.

The fourth step in the Simple EVM process is Step 4: You must estimate the required resources and formally authorize budgets. The project manager must estimate all the tasks, including changes, in each level of the WBS. After the estimate is completed, it is submitted to management for review. Management will assess the requested resources, and if accepted, the budget is authorized. Reserves or contingencies should not be included in individual budgets. If these exist, they should be excluded and owned by the project manager. The estimate presented for authorization must be realistic to support a viable project baseline.

Both Planned Value and Earned Value include the scheduled work of the project and the authorized budget to do that specific work. EVM can only be implemented if the tasks are estimated to the degree that they will be able to be measured as sub-projects or Control Account Plans (CAPs) throughout the project.

The next step is Step 5: You must determine the metrics to convert planned value into earned value. Within the baseline schedule, the project manager must set up measurable milestone points to measure the work that has been completed. Specific milestones, each

representing a set of tasks, are placed at points in time along the timeline and measured. When these points are completed, the budgeted values assigned to them are earned.

Following this step is Step 6: You must form a performance measurement baseline and determine the points of management control referred to as Control Account Plans (CAPs). A requirement of Earned Value is to have an integrated project baseline. This means the scope of work includes the baseline schedule and authorized budget, and that these three constraints are analyzed in relationship to each other. This integration applies to each element of the Work Breakdown Structure.

A project manager must determine the points of management focus, or Control Account Plans. CAPs may be sub-projects or the teams responsible for a section of the project, and are a way for management to measure performance. Earned Value is measured by the completion of the work in each CAP. Projects completed under contract usually include in their CAPs indirect costs, fees and profits, but projects completed internally usually exclude these items from their CAPs and define each CAP as direct labor hours only.

The entire project and all its tasks are divided into CAPs. Each CAP incorporates the concept of scope of work, the time frame allotted for it, a budget, and a team responsible for the work.

The next step is Step 7: You must record all direct costs by project consistently with the authorized baseline budgets, in accordance with the organization's general books of accounts. Project managers must be kept informed about the accounting on the project to be accountable for cost management. Many organizations are organized by function, and do not manage or track

project costs closely. It is essential that they do know the Actual Costs or AC, to implement EVM.

If organizations measure Earned Value too frequently, such as on a weekly basis, they will fail to track Earned Value effectively, because they will only be capturing Planned Value and Earned Value from reports on internal resources. Indirect costs, purchases, travel and other costs reported monthly will not be accurately captured by weekly accounting. If measured weekly, the reporting must be capable of providing information about all expenses with accuracy.

The next step defined in Fleming and Koppelman's process is Step 8: You must continuously monitor the earned value performance to determine cost and schedule departures from the baseline plan: both schedule variances (earned value less the planned value) and cost variances (earned value less the actual costs). When cost and schedule results are measured for their Earned Value against the baseline plan, management will focus on exceptions to the baseline plan. A negative Earned Value Schedule Variance means that the project is behind schedule in its work. The tasks that are not completed must be assessed for their criticality, and the impact that task has on other tasks on the critical path. If late tasks are on the critical path, every effort must be made to complete them so the project can get back on schedule.

Earned Value Management is extremely useful because it can inform the project team about the cost efficiency of the project at its current status and in the future. When a project spends more money on Planned Value than it receives in Earned Value, this a cost overrun. Cost overruns are usually not recovered over the course of a project, and can usually be considered a "sunk expense". Corrective action to the project plan – either by adding workers, extending the timeline or decreasing the scope – can improve the outcome.

The next step is Step 9: Using earned value data, you must forecast the final required costs based on actual performance and keep management apprised so they can take corrective actions if necessary. Unlike any other method of project management, Earned Value is capable of forecasting the total costs of a project. Referred to as the Estimate at Completion or EAC, this figure can be estimated with unprecedented accuracy.

When a project is shown to be have poor performance, improvements in the performance can only come from future work on the project. If the results on the project are not satisfactory to management, using Earned Value, the project manager can calculate the value of future work with and without correction to the current plans. In this way, a project manager can make a stronger argument for what is required to meet management's expectations.

The last step in Fleming and Koppelman's process is Step 10: You must manage the authorized scope by approving or rejecting all changes, and incorporating approved changes into the project baseline promptly. The project performance measurement baseline created at the beginning of the project is the foundation of the project. Any changes to the authorized scope must be approved or rejected, and if approved, the baseline must be updated. If changes are not managed and the baseline does not include approved changes, the baseline is invalid. A project manager must have authority to approve or reject changes to the project in a timely way. Every proposed change to the scope of the project must be managed. Maintaining a baseline and ensuring it incorporates any approved changes can be a challenge, but it is absolutely necessary for EVM.

The ten steps described in this research paper for a Simple Earned Value Management implementation can be applied to any project of any size in any industry, and be beneficial. The

majority of the steps described in this process should be taken in every project. In fact, it is only steps 8 - 10 that are completely unique to EVM. The unfortunate reality in many projects is that even among steps 1 - 7, frequently a step is skipped or hastily and ineffectively completed. To properly implement Simple EVM, no steps in this process can be skipped or EVM will be invalidated and the benefits of accurately measuring cost performance or forecasting total Estimate at Completion will be lost.

Many project managers are hesitant to implement Earned Value Management. Project managers have believed it would take too much time and effort and is too complex for small projects. It also can be criticized because it does not consider the critical path. With EVM, every task has the same weight. This is good for managing cost performance but more information is needed for effective schedule management. Perhaps at some point a method will be developed to track tasks along the critical path, integrated with EVM. Currently, the project manager's analysis of the data and the critical tasks are absolutely necessary to inform the team about which tasks to prioritize, where resources must be added, and how much work is needed to get back on schedule. The project manager also must perform due diligence to meet the requirements to implement EVM, and execute the calculations necessary to benefit from EVM. Some project managers may believe that the calculations are difficult, but with minimal effort, most project managers would easily be able to do the mathematics required.

Earned Value Management does have clear benefits to project management. It can warn a project manager early in the project that a project is at risk, when there is still time to change its outcome. As early as at 20% of project completion on the timeline, a project manager can use the Earned Value and Actual Cost metrics to establish the Cost Performance Index, and forecast the

Estimate at Completion. According to Quentin Fleming in an interview on the PM Podcast (http://www.thepmpodcast.com/index.php?option=com_content&task=view&id=98&Itemid=9), there is strong evidence that as early as 20% complete, poor EVM performance in a project is a strong indicator of the project outcome. This can be changed with the knowledge EVM delivers. Resources can be added, funds can be appropriated, or the scope can be trimmed.

EVM gives the field of project management extremely powerful metrics to use in improving management of projects. With the introduction of Simple EVM requirements, EVM is more easily administered for all projects and its implementation should be considered by all project managers.

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