

Earned Value Management Guidelines

Effective Date: April 21, 2009

Status: Revision 1

Supersedes: NA

Document Owner: Director, Environmental and Engineering Program

Introduction

This paper provides guidance and recommendations for the application of earned value management and forecasting on WSDOT capital projects. With the implementation of the Project Management and Reporting System (PMRS), Project Managers (PMs) may be required to use earned value management as one tool to monitor progress and to develop cost and schedule forecasts for active projects.

What is Earned Value Management?

Earned value is a technique that project management practitioners have developed to measure project performance and progress based on a combination of schedule, costs, and work performed with a focus on early warning of trends in either of these areas.

The Project Management Institute (PMI) defines earned value management as:

***Earned Value Management (EVM).** A management methodology for integrating scope, schedule and resources, and for objectively measuring project performance and progress. Performance is measured by determining the budgeted cost of work performed (i.e., earned value) and comparing it to the actual cost of work performed (i.e., actual cost). Progress is measured by comparing the earned value to the planned value.*

To implement earned value management, the PM must first make a detailed plan of both time and budget, then make a corresponding detailed valuation of the work on the project before it starts. As the project progresses, the PM must assess at predetermined reporting periods and earning rules (1) how much value should have been achieved according to the plan, (2) how much value has been produced and (3) how much money has been spent. These three assessments form the basis for all earned value analysis techniques. With a few simple calculations, a PM can easily determine the project's health in terms of both cost and schedule and use these data to forecast project trends.

Implementing earned value management may require changes in the way WSDOT projects are planned and measured. The defined WSDOT processes for earned value management and the accompanying policies and procedures develop a consistent framework for implementation. The PM must be aware that earned value management is just one project management technique. To maximize its benefit, corrective action must be taken to address potential issues as they are identified. In other words, earned value management will help identify problems, but the PM must solve them.

Benefits of Earned Value Management

Any project with a well-thought-out plan of work, a cost accounting structure and a timely data collection system with consistent status cut-off points for measuring progress can make use of earned value management techniques. Each of these elements is addressed as part of PMRS. The following features generally make WSDOT transportation projects well suited for using earned value management techniques:

- Defined objective (design a highway)
- Work takes place over an extended period of time with a known beginning and end
- High labor effort (TE3s, TE2s, TE1s, TT3s, TT2s, TT1s)
- Tasks of a creative nature (engineering)
- Cost and time limitations (Legislative Budget Process)

Applications of earned value management techniques are scalable to individual projects as determined by their size and complexity. Small projects can use a simplified approach, while more costly, complex and time consuming projects may require more effort. The development of Control Accounts is a specific example of how earned value management can be scaled to fit the specific needs of a project. Control Accounts are the points in the project's work breakdown structure (WBS) where scope, schedule and costs for each work element are planned and tracked. For example, simple projects with few deliverables may use one Control Account for all environmental work where larger more complex projects might have separate Control Accounts for each major permit or environmental process. Refer to the Control Account Guidelines on the WSDOT Project Management Web Portal for more information.

Application of earned value management provides the following benefits for WSDOT:

- Early warning of cost and/or schedule issues.
- Early warning of issues both internal and external to the project if external interfaces have been included in the project schedule.
- More accessible data to facilitate making effective and efficient business decisions.
- Improved public confidence by being more accountable with project progress.

Furthermore, overall project management, team integration and communication improve because of the "up-front" planning, monitoring and discipline that the earned value management technique requires.

Earned Value Management Basics

Following are the key earned value management elements according to PMI:

- ***Planned Value (PV) – The authorized budget assigned to the scheduled work to be accomplished for a schedule activity or work breakdown structure component.***
This is the time-phased spending (aging of dollars) plan (cost and schedule) and is comprised of engineering (WSDOT and consultants), right-of-way, construction and other estimated costs. Establishing the planned value includes development of "earning rules" for each Control Account. In other words, assign a value to the completion of each work task. There are many acceptable methods of establishing earning rules, but the key is to use them consistently from the start to finish of the project and ensure that they are as objective as possible.

- ***Earned Value (EV) – The value of work performed expressed in terms of the budget assigned to that work for a schedule activity or work breakdown structure component.***
This is the key measure of the earned value management technique and requires the project team to determine the progress made on a task based upon the pre-established earning rules. The team would determine the percent complete for the task, and apply that percentage to the planned value (budget) for the task to get a dollar value for the work completed. $EV = \% \text{ complete} \times PV$
- ***Actual Cost (AC) – Total costs actually incurred and recorded in accomplishing work performed for a schedule activity or work breakdown structure component.***
Actual costs include amounts paid to outside agencies, consultants and contractors as well as WSDOT in-house labor and expenses. The application of earned value management requires the ability to capture actual costs (or a reasonable estimate of actual costs) for the performance period. It is imperative that actual costs and earned value are based upon the same status data date to ensure a reliable evaluation. Refer to the Estimated Outstanding Cost Guidelines on the WSDOT Project Management Web Portal for additional information.
- ***Cost Variance (CV) – A measure of cost performance on a project. It is the algebraic difference between earned value (EV) and actual costs (AC). $CV = EV - AC$. A positive value indicates a favorable condition and a negative value indicates an unfavorable condition.***
CV indicates whether actual project expenditures are exceeding the planned amount for the corresponding value achieved. In other words, has WSDOT spent more or less than planned to achieve a defined level of progress.
- ***Cost Performance Index (CPI) – A measure of cost efficiency on a project. It is the ratio of earned value (EV) to actual costs (AC). $CPI = EV / AC$. A value equal to or greater than one indicates a favorable condition and a value less than one indicates an unfavorable condition.***
CV tells the PM if costs are being expended efficiently. In other words, are we getting more, less or the planned value for actual amounts spent?
- ***Schedule Variance (SV) – A measure of schedule performance on a project. It is the algebraic difference between the earned value (EV) and the planned value (PV). $SV = EV - PV$.***
SV tells the PM if the actual progress achieved is ahead of or behind the baseline schedule.
- ***Schedule Performance Index (SPI) – A measure of schedule efficiency on a project. It is the ratio of earned value (EV) to planned value (PV). $SPI = EV / PV$. An SPI equal to or greater than one indicates a favorable condition and a value of less than one indicates an unfavorable condition.***
SV tells the PM if effort is being expended efficiently. In other words, are we getting more, less or the planned value for effort (time) expended?

- ***Estimate to Complete (ETC)*** – *The expected cost needed to complete all the remaining work for a schedule activity, work breakdown structure component, or the project.*
The ETC can be calculated based on either performance to date or a more subjective assessment based on other factors. For example, higher than anticipated right-of-way costs may not show up in a simple calculation but should be included in the evaluation to reflect accurately the cost of completing remaining work.
- ***Estimate at Completion (EAC)*** – *The expected total cost of a schedule activity, a work breakdown structure component, or the project when the defined scope of work will be completed. EAC is equal to the actual cost (AC) plus the estimate to complete (ETC) for all of the remaining work. $EAC = AC + ETC$. The EAC may be calculated based on performance to date or estimated by the project team based on other factors, in which case it is often referred to as the latest revised estimate.*
Other formulas may be used to calculate EAC based on the specific circumstances of the project. These formulas are found on WSDOT’s Project Management Web Portal. Whichever EAC formula is selected, it must be used consistently from start to finish of the project.

Establishing Earning Rules

Earning rules are a critical element to the successful use of earned value management. Earning rules are established as part of project planning and represent objective methods in which performance and progress will be measured once the project is underway. They are typically applied to the work breakdown structure (WBS) at the Control Account level. Earning rules:

- Are pre-determined at the start of the project.
- Establish a baseline for performing the work.
- Mitigate subjectivity in measuring progress.
- Are agreed on by the parties involved in performing and receiving the work and are documented in the project management plan (PMP) and internal/external agreements.
- Standardize performance measurement for similar types of work.
- Do not change during the course of the project.
- Ensure that no more than 100% of the budgeted value can be earned regardless of actual costs.

There are several methods for measuring performance objectively. No single earning rule will work for all activity types and multiple methods may apply within a project. The method chosen must be appropriate for the type of work performed.

Identifying earning rules will significantly reduce the work completed evaluation process and minimize the “subjectivity” of work performed. The following provides earning rule guidance and definitions in the selection and application of earning rules to the type of work WSDOT typically performs:

- **Weighted Step Method** – The weighted step method is used for longer-term elements where steps or interim milestones are identified as “check in” points with specific criteria defined to evaluate progress.

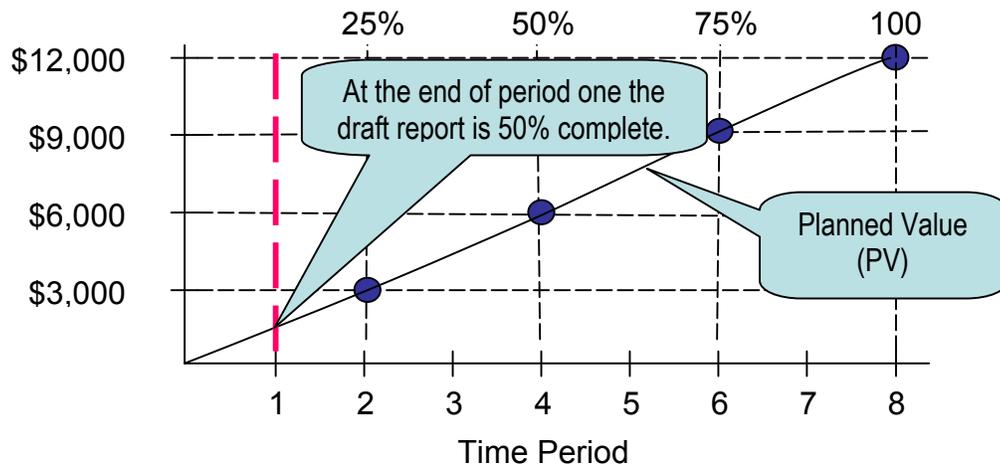
Each step reflects the level of effort and budget required for each activity or step. The steps or interim milestones are identified and agreed to by the parties involved and documented in the Project Management Plan (PMP). Any percentage may be used; the key is to define what level of effort the percentage represents as part of the planning effort.

Example:

The work package is to write and approve Report X. The project manager and specialty group manager agree to use the weighted step method to measure progress. The specialty group manager estimates \$12,000 to write the report. Percentages and budget assigned as follows:

- 25% - draft report presented for review, budget = \$3,000
- 50% - responses to comments developed and incorporated into the document as needed, budget = \$3,000
- 75% - final document submitted for approval, budget \$3,000
- 100% - document approved, budget = \$3,000

The work package cannot exceed the percentage designated until the weighted step is reached. Work that extends over more than one reporting period can use progressive percentages as long as they do not exceed the weighted step. As identified in the graph below, the draft report overlaps two reporting periods. At the end of period 1, the draft report is halfway completed. The Project Manager can report 13% complete for the period. This method allows interim reporting as long as it does not exceed the first weighted step of 25%.



For the construction phase, consider identifying weighted steps at the completion of major construction activities such as earthwork, drainage, paving, or completion of a phase/stage. Steps may also designate region project document reviews as required by the Construction Manual.

Advantages:

- Requires objective, measurable steps and specific criteria for advancement.
- Allows for partial credit against activities/steps.

Disadvantages:

- Requires preplanning and documentation of the specific criteria to measure against.
- **Remaining Effort** – The remaining effort method determines the actual physical percent complete through a calculation. To arrive at a physical percent complete, the focus of the effort must be on examining and quantifying, in terms of resources and related costs, the remaining work that must be accomplished to complete the respective activity – regardless of the WBS level of that activity (either summary or varying degrees of detail beneath the summary).

Once this is determined, these estimated remaining values, also known as Estimate To Complete (ETC) must be added to the already expended actual resources and costs to arrive at the current forecast of the effort required to complete the defined activity, also known as the Estimate At Completion (EAC). This forecast value then becomes the base for the calculation of physical percent complete. The percent complete is based on actual expenditure to date divided by the EAC.

$$\text{Physical Percent Complete} = \frac{\text{Actual Costs to Date}}{\text{Actual Costs to Date} + \text{Current Estimate to Complete}}$$

Or

$$\text{Physical Percent Complete} = \frac{\text{Actual Costs to Date}}{\text{Current Estimate at Completion}}$$

Example 1:

An activity, “Design Retaining Wall” is planned to take 20 days to accomplish with a budget of 120 hours and a cost of \$4,800. It is scheduled to be accomplished during a period extending over two reporting periods. At the end of 10 days work (also the end of the first reporting period), the actual cost to date is \$2,400 and 60 hours (at \$40.00 per hour) have been expended on the activity. At first glance, the work appears to be on schedule and on budget – at 50% complete.

However, when the supervisor assesses the status of the activity, he/she determines that it will take another 100 hours to complete the work. Thus, the work is really only 37.5% complete not the 50% that would have been reported if only the budget/planned values were addressed. Obviously, if the supervisor plans to change the assigned staff with a higher pay rate, then the percentage completion will be even lower.

Further, if the activity still requires a number of days to complete greater than 10, there will be schedule slippage as well.

Example 2:

Project X is planned to import 100,000 tons of gravel borrow at \$18 per ton (\$1.8 million total). It is planned to take 10 working days within a three-week timeframe extending over two reporting periods. At the end of 5 working days (coinciding with the end of the work period) 50,000 tons have been imported; actual cost to date is \$900,000.

The work appears to be 50% complete. Upon completion of recent survey work, due to field conditions, it is estimated it will require 60,000 tons of gravel borrow and one additional working day to complete the work. Therefore, the work is 45% complete with additional costs of \$180,000 for the additional gravel borrow.

Advantages:

- Requires objective, measurable activity.
- Allows for partial credit against activity.

Disadvantages:

- Requires assessment for each activity.
- Estimating percent complete requires analysis of remaining resources.

- **Level of Effort (LOE) Method** – This method is based on the passage of time, frequently used for activities such as project management. The value earned is based on time expended over total scheduled time; typically, earned value will equal the planned value. It is measured in terms of resources consumed over a given period and does not result in a deliverable.

Example 1:

A 50-day LOE activity is on day 35 at the project status data date. Seventy percent of scheduled time has elapsed; therefore, earned value is 70%.

Example 2:

After evaluating and scheduling their project the project team determines they can accomplish the work earlier than required by the CPMS Legislative Ad date milestone. The project team sets a target Ad date 90 days in advance of the CPMS Ad date. A Level of Effort activity is setup to monitor the 90-day difference between the target Ad date and Legislative Ad date.

Six months after the project begins the Level of Effort activity is showing only a 30-day difference between the target and Legislative Ad dates. This LOE activity identifies the schedule is slipping, without comparing the baseline. Evaluation of the activities is required to determine what activities are causing the slip and determine if they can meet the target date and/or the Legislative date.

Advantages:

- Does not require status checks, simple to do.

Disadvantages:

- Provides no measure of progress and therefore is often questioned when the earned value always matches the planned value regardless of whether any physical work was completed.

- **Units Produced Method** – Ratio of units produced to the total specified at completion. Units must be nearly identical.

Examples:

- Drilling 10 holes, 4 completed – 40% complete

- Paving 5 miles, completed 4 miles – 80% complete

For work in progress, earned value is estimated based on partial work completed. For example, in the drilling example above, if drilling is 50% complete on the 5th hole, earned value might be reported as 45% complete.

Advantages:

- An objective and easy way of determining Earned Value for an activity.

Disadvantages:

- Limited to production type atmosphere where similar items have fixed unit prices.
 - Does not consider labor fluctuations.
- **Fixed Formula** – This method is generally used for short-term elements. 50/50 and 0/100 are the percentages generally used. The 50/50 method records 50% complete when the work is scheduled to begin. It would remain at 50% until the element is completed. The 0/100 method is used when there is no real value gained until the activity is complete. Only a minimal amount of resources should be assigned to this element using this rule.

Advantages:

- Works well for short-term items.
- Requires minimal effort.

Disadvantages:

- Not effective for longer-term items.

There may be other work efforts that can not be categorized into one of these earning rule methods. In this instance, the PM and the performing group will need to develop and agree on a method that most objectively assesses progress for the particular project.

Earned Value Management Application to Project Elements or Phases

Within WSDOT, earned value management can benefit Pre-construction activities (WSDOT in-house design, consultants and right-of-way) using the earning rules previously discussed. However, there are instances that require special attention when addressing construction and overhead costs.

- **Construction** - The WSDOT Construction Manual addresses the requirements of Contractor construction schedules. Schedules and their associated costs are thoroughly reviewed by WSDOT construction management staff and there is a close correlation between the percent of construction dollars spent and physical percent complete. Because of this close association, the recommendation is that the Project Manager:
 - Distribute the bid amount of the construction contract over the construction summary schedule included in PMRS to establish planned value (PV). This distribution should correlate to the Contractor's planned work activities or deliverables.

- Use contractor pay notes and daily inspection reports to assess earned value (EV).
- **Overhead – WSDOT** Overhead costs are distributed to active WSDOT capital projects based on actual amounts expended the prior month. Currently, there is no formula that forecasts overhead allocation to each project in a predictable manner. Consequently, there may be a significant variance between forecasted and actual overhead amounts. The challenge for the Project Manager is that earned value calculations can be significantly impacted and they have no control over this cost. The impact is more significant on smaller projects where overhead costs may represent a larger percentage of total project costs. The recommended method of addressing allocated overhead is as follows:
 - Establish a separate control account for overhead allocation and develop an estimate based on the most reliable method available (i.e., percentage of project capital expenditures or historical amounts on the project) and set this as the planned value (PV).
 - Collect actual costs (AC) against the established control account
 - Each month, as part of the earned value variance analysis, exclude the overhead control account from earned value calculations.

Forecasting and Earned Value

The Project Management Institute (PMI) defines forecasts as:

Forecasts. Estimates or predictions of conditions and events in the project's future based on information and knowledge available at the time of the forecast. Forecasts are updated and reissued based on work performance information provided as the project is executed. The information is based on the project's past performance and expected future performance, and includes information that could impact the project in the future, such as estimate at completion and estimate to complete.

As defined above, the earned value measurements, estimate to complete (ETC) and estimate at completion (EAC), are key components of project forecasts.

A PMRS requirement is that Project Managers provide an estimate at completion (EAC) for each active project on a monthly basis. This forecast is important because it provides an ongoing reassessment of project costs and schedule to enable Project Managers, Program Management and WSDOT Executives to gauge project/program performance, identify trends and facilitate proactive decision-making or corrective action to affect the outcome of the project/program positively. Project Managers may use information obtained from the Project Team (including Specialty Offices), Consultants, Contractors/Suppliers and outside parties in developing project forecasts.