Week 5 – Cost Management – Earned Value Analysis and Cost Reporting

Contents

1 Learning Objectives for this Chapter

Having completed this chapter you will:

- Complete a simple milestone analysis
- Appreciate the need for Earned Value (EV)
- Be able to calculate EV figures
- Construct a simple EV analysis
- Be able to interpret the findings of an EV Analysis

2 Introduction

We reviewed the general steps needed to ensure that our cost management activities will be effective:

- Get the systems/processes in place to collect and report on costs.
- Configure our systems to provide information that will allow analysis and action (Cost codes /WBS)

We also looked at some issues with the collection of labour information using time sheets. We concluded by looking at a method of calculating the cost baseline for a project.

When this baseline was drawn as a graph which showed the accumulated cost over the lifetime of the project it resembled an s-curve shape. All subsequent cost measurements could be made with respect to this baseline curve.

3 Overview of Earned Value

Many of the simple methods for assessing project progress are incomplete as they do not take into account more than one aspect of project performance. They can measure schedule progress or cost progress or quality progress. There was a need to use some form of integrated view of cost and time in order to achieve a holistic assessment of project performance.

A simple integrated method called Milestone analysis which combines analysis of:

- Achievement of significant milestones
- Budgetary spend for the work packages associated with those milestones

This approach has limitations; - its main drawback is that it is frequently too late to take action when you have detected a variance.

An S-curve is used as a basis for the earned value method of tracking cost and progress.

4 Milestone Based Analysis

Measurement of progress without reference to cost is only of limited value. The same can be said for the measurement of cost information alone without reference to progress. The Earned Value (EV) approach provides an effective integrated approach to the monitoring and control of project. However the EV approach requires quite sophisticated cost accounting techniques and significant amount of effort to set up and operate. There is a simpler but less rigorous alternative - milestone based analysis. A project manager will need to know:

- How much have we spent to date?
- What should we have spent to date?
- What have we achieved so far?
- What should we have achieved by this time?
- What are the final cost and delivery prospects for the project if our performance continues at the current level?

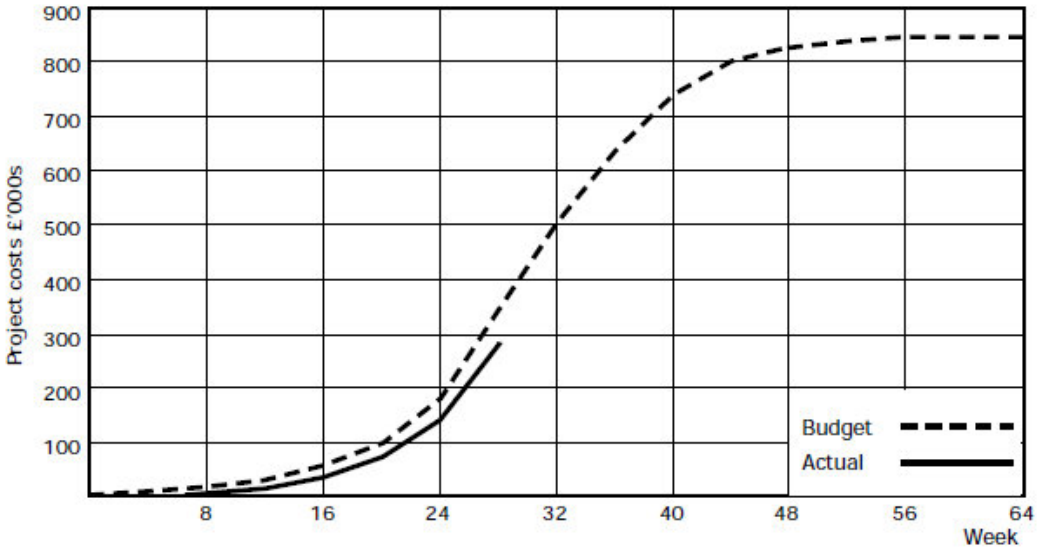

Figure 1 - Budget v actual spend

5 Steps to Milestone analysis

A) Firstly we need to Establish the milestones. A **Milestone** is defined as:" **"a significant point or event in the project and** is often marked by presentation of a significant deliverable or completion of a major body of work. This could be the publication of a draft report, successful completion of the testing of a piece of software etc.

B) Establish the date on which the milestone will be achieved

C) Establish the cost associated with achieving the milestone

D) Plot a milestone to budget curve. This should resemble the s-curve plotted for the budge Baseline

E) Plot actual expenditure against milestone achievement on the same graph as below (see the graph below)

F) Analysis of the graph shows that the week 1 milestone was achieved as per the schedule, however the level of costs is low. The low relative level of costs continues and milestone 2 appears to have been delivered slightly early! The following milestone has happened later than expected and the level of costs still remains low. Continued analysis done in this way will expose trends in progress and costs.

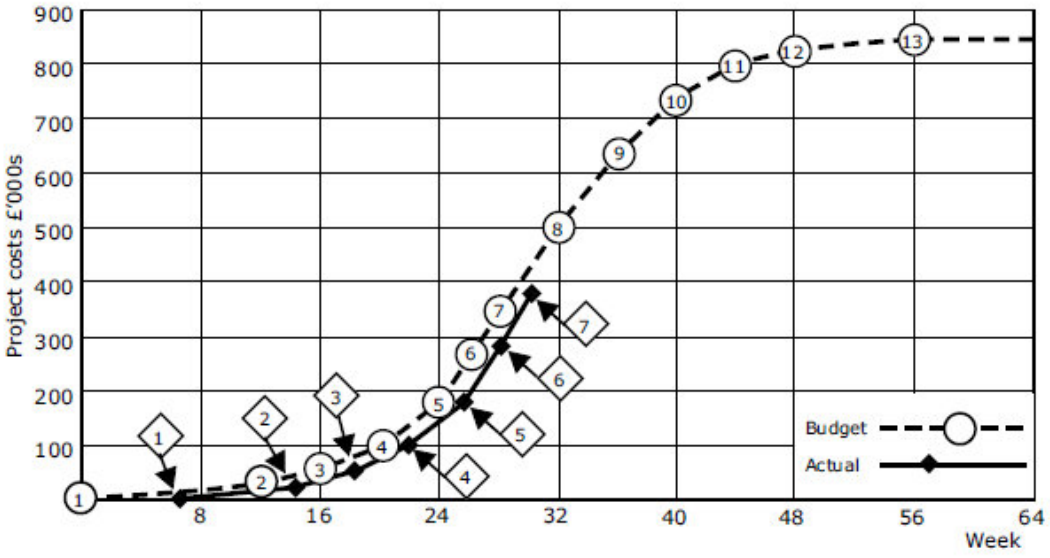

Figure 6 - Milestone Based Analysis

6 Limitations of Milestone Analysis

Coarser measurement than earned value so it can be too late to react to significant variances. It is also difficult to forecast project outcomes using its results.

7 Earned Value Analysis

Earned Value analysis is a more rigorous approach. In contrast to Milestone Analysis this approach was able to provide information in time to take corrective action. In addition it would even allow the project manager to make some predictions about the future performance of the project.

At its core it was all about comparing the cost incurred for a piece of work with the costs budgeted for it. Earned value calculations can be performed with three basic pieces of information:

1. Our Cost baseline figure at time now (BCWS – Budgeted Cost of Works Scheduled)
2. Percentage completion (PC) of the activity at time now.
3. The Actual Cost incurred so far for the activity (ACWP – Actual Cost of Works Performed)

From these three we can calculate a number of variances and indices.

Some of the terminology used in EV can be summarised as follows:

ACWP Actual Cost of the Work Performed at the measurement date (i.e. from invoices, labour records, timesheets etc)

BCWP Budgeted Cost of Work Performed – this is the amount of money or labour time that the amount of work actually performed at the measurement date should have cost to be in line with the budget or cost estimate. It is usually necessary to take into account work that is in progress in addition to tasks actually completed.

BCWS Budgeted Cost of Work Scheduled – this is the budget or cost estimate for work scheduled to be complete at the measurement date. It corresponds with the time-scaled budget.

CPI Cost Performance Index – this factor that indicates the measure of success in achieving results against budget. Anything less than unity indicates that the value earned from money spent is less than that intended.

Schedule Performance Index – this can be used as a measure of progress performance against plan, but is less commonly used than the CPI. Anything less than unity shows progress slower than that planned.

These quantities can be used in the following expressions:
CPI = BCWP / ACWP
SPI = BCWP / BCWS

8 Why Earned Value?

Ways of assessing the progress of the project can include:

- Getting reports on the amount of work completed at point in time
- Monitoring the achievement of certain milestone dates.
- Gathering information on project spend over time

To this list you could also add the task of reviewing the quality and completeness of the results produced by the project so far. However each of these measures reflects only a single aspect of the project and, considered in isolation, are unreliable as indicators of **total** project performance. Take for example the graph shown below which shows project progress over time

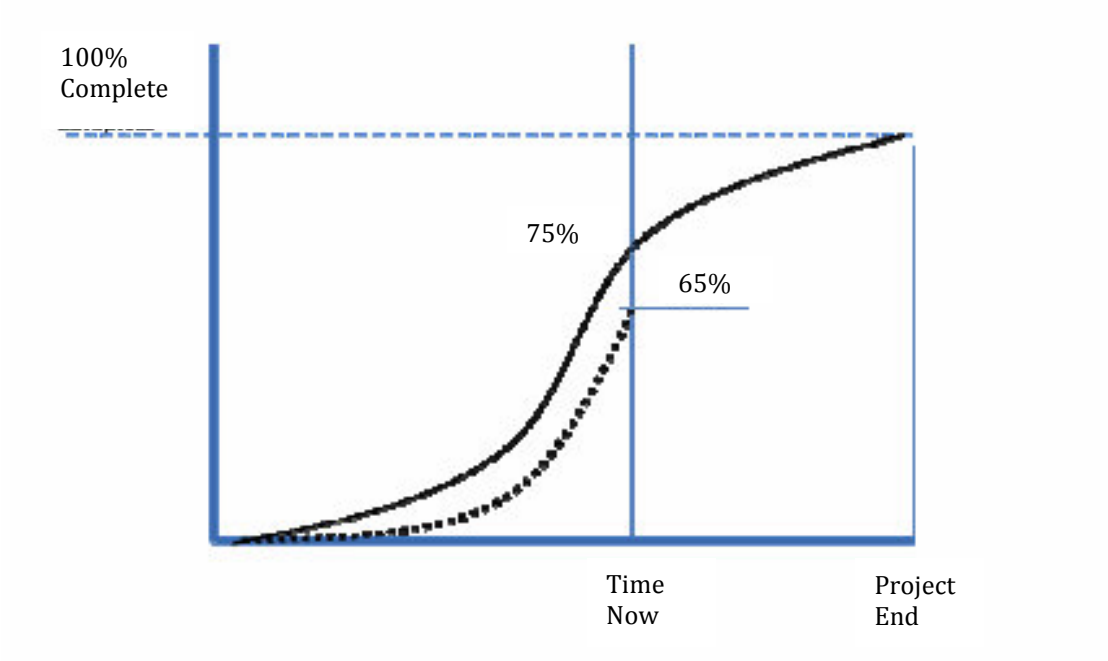

Figure 1 – Progress against Time

The solid curve represents the % of work planned to be completed at any point in time. At the time of measurement (called “time now”) the planned completion was 70%. However measurement indicates that actual completion stands at 65% (the dotted line). This may indicate to the project manager that the project will be late. The project manager may interpret this information as indicating that a faster pace of work by the team may bring things back into line.

However this analysis does not take into account the cost situation at this point in time. An analysis of expenses to date may reveal there is a corresponding cost under spend on the project. This would validate his assessment. However it is possible that analysis of expenses might instead reveal a cost overrun at that point. This may require an entirely different action to correct. Therefore, in order to achieve a holistic assessment of project performance, an integrated view of cost and time is required

9 Using Earned Value

Earned Value Analysis is an early warning tool that allows project managers to identify potential problems early enough to take corrective action. It measures actual accomplishment on the project and compares it to planned accomplishment. In other words it tracks and compares the costs incurred for a piece of work with the costs, which were budgeted for that piece of work.

To perform Earned Value Analysis you need the following to be in place first:

- A detailed Work Breakdown Structure
- A corresponding cost coding system
- An efficient mechanism for collecting cost data
- An efficient mechanism for collecting work progress data

10 Building up an Earned Value Graph

Earned value analysis can be constructed in tabular or in graphic form. We will use the graphic form here to illustrate the concepts. Graphs are a particularly useful reporting tool because they give clear and quick indication of performance trends. Graphs can be supported by more detailed information in tabular or spreadsheet format. Easy understanding of the concepts can be complicated by the various abbreviations used. However the principle of EV is based on a small number of simple arithmetic calculations and formulae. Let us start with the budget baseline we constructed in Chapter 3 (Illustrated below).

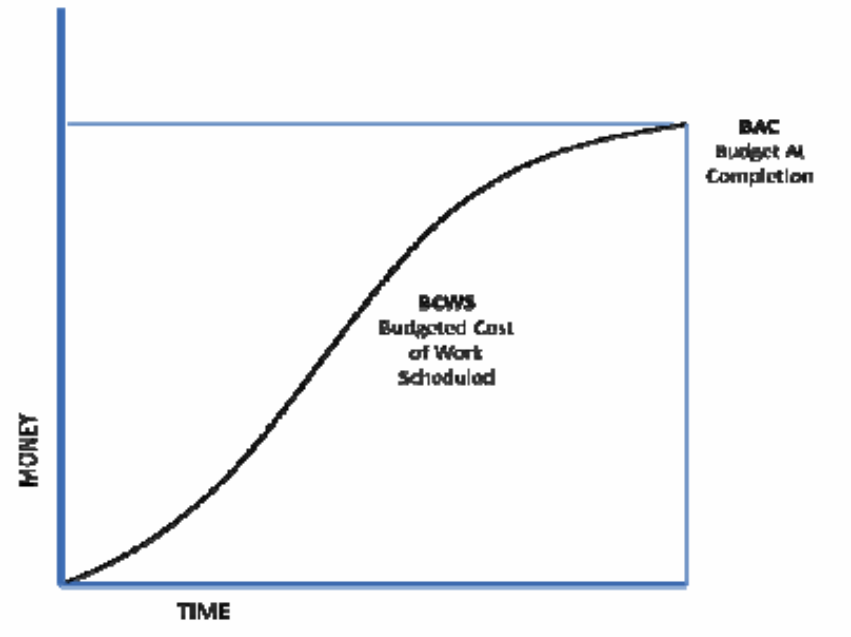

Figure 2 - BCWS & BAC

This is a representation of the cost baseline of the project over time. It represents the accumulated costs at each point in the project cycle. In Earned Value Analysis this is called “The Budgeted Costs of Work Scheduled“ or BCWS. It is also referred to as the Planned Value (PV).

BCWS is defined as:" **the budgeted cost for the work scheduled to be completed on an activity or a work package"**

At the end of the project this figure should equal **the approved project budget for the activities** i.e. the **BAC (Budget at Completion).** This graph becomes the centre of all earned value calculation.

Once the project starts it is almost certain that some planned schedule and costs baselines will vary. In order to detect these variances, measurements take place at regular intervals (each measurement time is usually referred to as **"time now"** or "date now"). The next stage is to complete some calculations on the value "earned" to date against what value had been "planned to be earned".

Our monitoring systems should be able to provide us with the following three pieces of information at "time-now" for each Work Package to be measured:

A) **PC (Percentage Complete) is a measure of the activities performance and measures the proportion of the activity which has been completed at 'time-now' (the earned progress)**

Note: Certain assumptions and rules may be required in order to give a realistic interpretation of this % progress figure. The three common rules are:

The 50-50 rule: When the task begins it is deemed to be 50% complete. It is 100% complete only when all work is done

The 0-100% rule: (The All or Nothing rule) The action remains at 0% until complete

T**he Proportionality rule:** Divide the time taken to date for the task by the total time scheduled for it.

B) **BCWP (the Budgeted Cost of the Work Performed) – this is a measure of the value of the actual work done to date. It is also known as the Earned Value (EV).**

It is calculated by applying your percentage complete figure (PC) to the Budget at Completion

Figure as follows:

BCWP = PC × BAC

C) **ACWP (the Actual Cost of Work performed) – this is the amount of money payable for the actual work completed to "time-now".**

Having gathered this information we can draw a graph, which might look like this one:

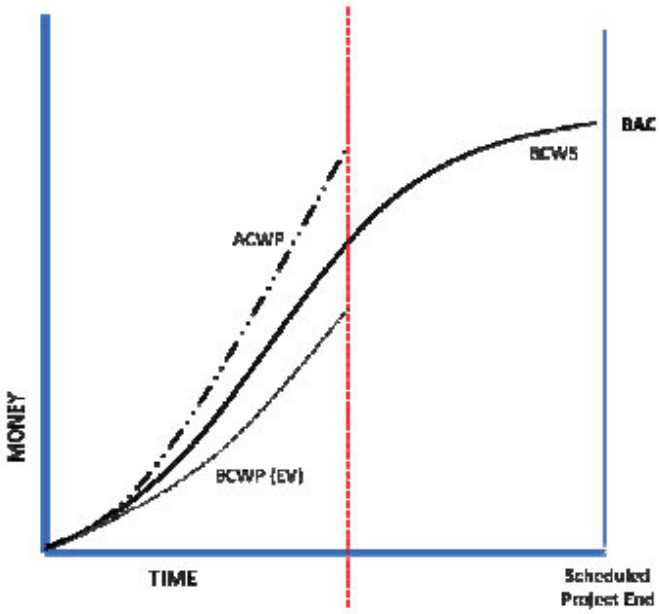

Figure 3 - Adding BCWP and ACWP to the graph

11 Analysis of the Graph

The first step in analyzing your information is to identify some variances. There are two common variances - I will show the two calculations together:

CV (Cost Variance) = **BCWP** - ACWP
SV (Schedule Variance) = **BCWP** – BCWS

(Note that each variance involves a subtraction from BCWP)

How should you interpret the result?

Well, in each case a negative number is a bad thing!

- A negative CV means a cost overrun.
- A negative SV means the project is behind.

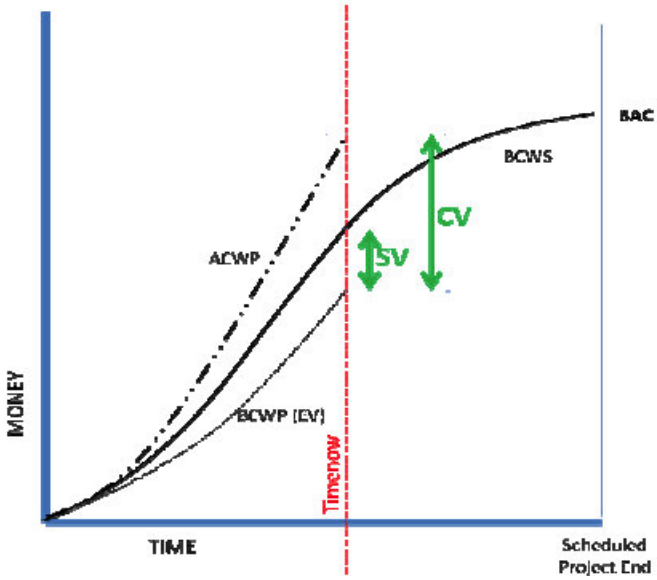

Figure 4 - CV and SV

12 Calculating Indices

Another approach is to calculate a performance index for the project. This can be useful when comparing the performance of a number of different projects. We can calculate Cost and Schedule performance indices.

Cost Performance Index (CPI) is a measure of the rate at which the project performance is meeting cost expectations

CPI = BCWP/ACWP

A value less than 1 indicates that the project is spending more than it is earning and may
ultimately exceed budget if not corrected.

Schedule Performance Index (SPI) is a measure of the rate at which the project performance is meeting schedule expectations

SPI = BCWP/BCWS

A value less than 1 indicates that the project is behind schedule and may finish late if not corrected.

13 Earned Value Example

Let's take an example to illustrate what we have learned so far:

Let's assume that our Project has a total activity budget of €3,000 (BAC) and project duration of 10 days. According to the Cost Baseline we had budgeted that work completed up to today would cost us €2,500. (BCWS)

By assessing the outputs of the work we reckon we are 50% complete on the activities so

BCWP = PC × BAC

BCWP = 50% × 3,000 = €1,500

Looking at our cost collection system we learn that we have spent €1,200 (ACWP)

How is the project doing?

If we look at schedule first we calculate the Schedule Variance as follows:

SV (Schedule Variance) = **BCWP** – BCWS

SV = €1,500 - €2,500

SV = - €1,000

This tells us we are behind schedule.

Let's look at Cost:

CV (Cost Variance) = **BCWP** – ACWP

CV = €1,500 - €1,200
CV = €300

..But our costs are lower than our original estimate!

Using Performance Indexes we get:

SPI = BCWP/BCWS

SPI = €1,500/ €2,500
SPI = **0.6**

CPI = BCWP/ACWP

CPI = €1,500/ €1,200
CPI = **1.25**

14 Forecasting

Earned Value Analysis also enables the project manager to make some forecast of future project performance. We have seen how CPI and SPI can indicate the rate of project performance. They can also be used to predict likely project outcomes if the rate of performance continues.

We can attempt to forecast a revised completion date by dividing our scheduled project duration (10 days) by the SPI, which gives a total revised project duration of 16.6 days! In the worked example above we also calculated a CPI of 1.25. We can predict the total project cost by dividing BAC by the CPI figure which gives a figure of €2,400, which is a saving of €600.

This revised estimate is also called the Estimate At Completion (EAC)

EAC = BAC/CPI

From the EAC figure we can estimate how much will be spent on the project (presuming past experience is a reliable guide). This is called the Estimate to Complete and is calculated by subtracting the actual costs incurred so far from the EAC.

ETC = EAC - ACWP

Finally we can estimate the budget variance at completion (VAC) as the difference between what was budgeted (BAC) and what will actually be spent (EAC)

VAC = BAC - EAC

The Graph below illustrates these calculations.

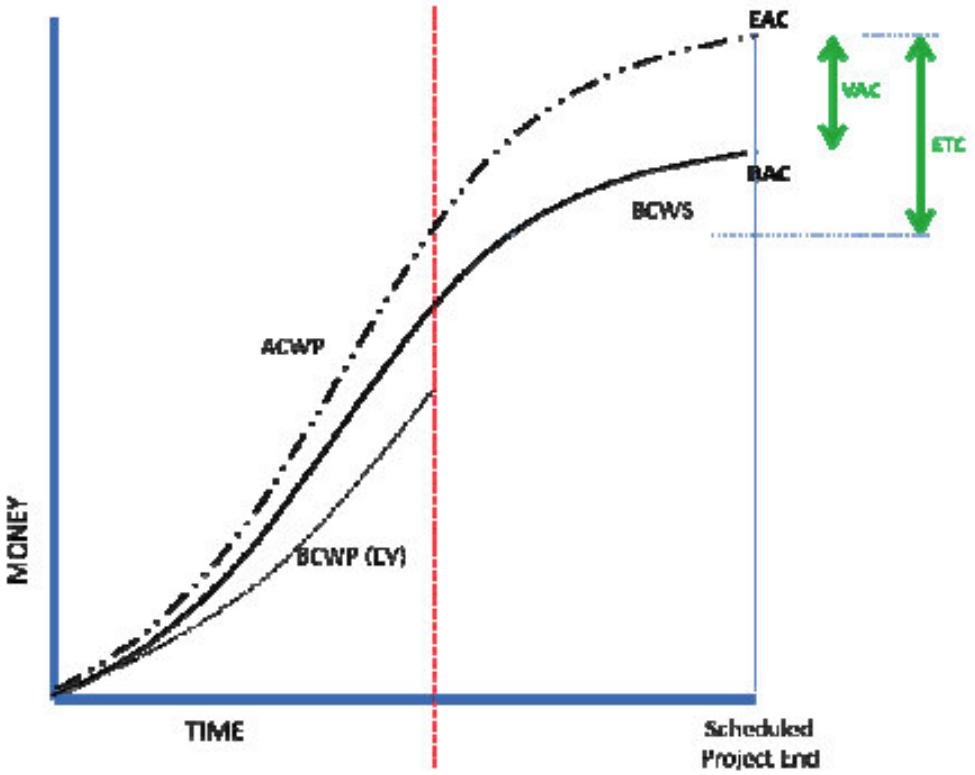

Figure 5- EAC, ETC and VAC

15 References & Resources

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