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A GENTLE INTRODUCTION TO EARNED VALUE ANALYSIS

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ABSTRACT

Every country whether in the developing stage or already developed stage has the need for infrastructure development to further the economic, social, technical growth of the country. All infrastructure projects require 4 important 'M' those are Men, Machine, Money and Material. And to complete the project in the estimated amount we have to implement project control & monitoring system to track the progress of the project. Here we are using variance analysis for cost, schedule and time control to check the progress of the project with respect to baseline of the project. Earned Value Analysis (EVA) is a project performance evaluation technique which has been adapted for application in project management. The technique helps in comparison of budgeted cost of work to actual cost.

KEYWORDS: Earned Value Analysis, Project Management.

INTRODUCTION

Earned Value is a project management technique to measure, at a specific date, the progress and performance of a project against the plan, and to estimate future performance. Earned Value considers 3 dimensions: 1) planned expenditures, 2) actual expenditures, and 3) budgeted expenditures for actual work accomplished. This provides a superior view into the project state than only looking at the first 2 dimensions.

When we speak of Earned Value we generally are speaking of a methodology. While Earned Value is just one element of this methodology it is also the key element. The simplest way to think of Earned Value is to equate it with physical progress. As the name implies it is something that is gained through some effort. In project management this value is earned as activities are completed consequently; Earned Value is also a measure of progress. As we shall see later there is a direct relationship between Earned Value and per cent complete. The attributes of Earned Value are threefold. First it is a uniform unit of measure for total project progress or for any sub-element of the project. Second it is a consistent method for analysis of project progress and performance. Third it is a basis for cost performance analysis of a project.

Earned Value also is a consistent method for analysis of project performance. Suppose you ask the bricklayers and the carpenters how they're doing. You are likely to get different answers, influenced not only by how they are actually doing but also by how they calculate their plan and their progress. As we shall see below in the discussion of "How," using Earned Value establishes a particular method for determining what the plan to date is and what the progress actually achieved is.

Earned Value provides the basis for cost performance analysis. If you want to know what's happening to the cost of your project before it is completed you need to know what the planned cost at any time was and also what the cost of the completed work is.

CONCEPT OF EVA

Earned Value analysis is a method of performance measurement. Earned Value is a program management technique that uses "work in progress" to indicate what will happen to work in the future (as shown in figure 1). Earned value management is system for planning and controlling the project cost performances. EVM establish work packages earned value baseline by integrating project scope, time schedule and cost objectives. This baseline is called as cost control and is used for performance evaluation of project on a given date. Analysis of variance from the baseline provides the cost related information's for problem identification, trend analysis and corrective actions such as re-

planning and revising budget. Earned value analysis serves two main purposes. It analyses cost changes which is resulting in time and cost over-run or under-run so that timely corrective actions are taken such as modification of cash flow, updating financial forecast and project profitability expectations. Analysis of variance from the baseline using earned value analysis gives variety of variances which are analyzed to provide current status of project, to initiate corrective actions and to forecast future trends.

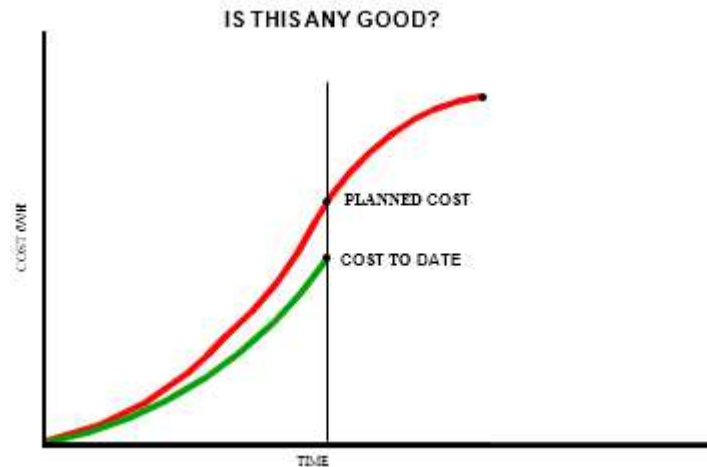


Figure 1: Future

TERMINOLOGY

A. Planned Value (PV)

The planned value (PV), formerly called the budgeted cost of work scheduled (BCWS), also called the budget, is that portion of the approved total cost estimate planned to be spent on an activity during a given period.

Planned Value = Physical work + Approved Budget. PV can be looked at in two ways:

1. Cumulative PV is the sum of the approved budget for activities scheduled to be performed to date.
2. Current PV is the approved budget for activities scheduled to be performed during a given period. This period could represent days, weeks, months, etc.

B. Actual cost (AC)

Actual cost (AC), formerly called actual cost of work performed (ACWP), is the total of direct and indirect costs incurred in accomplishing work on an activity during a given period. It can be looked at in terms of cumulative and current.

1. Cumulative AC is the sum of the actual cost for activities performed to date.
2. Current AC is the actual costs of activities performed during a given period.

C. Earned Value (EV)

The earned value (EV), formerly called the budgeted cost of work performed (BCWP), is an estimate of the value of the physical work actually completed. EV is based on the original planned costs for the project or activity and the rate at which the team is completing work on the project or activity to date. EV is the quantification of the “worth” of the work done to date. Earned Value (EV) tells you, in physical terms, what the project accomplished. EV can be presented in a Cumulative and Current fashion.

1. Cumulative EV is the sum of the budget for the activities accomplished to Date.
2. Current EV is the sum of the budget for the activities accomplished in a given period.

When the three key parameters are properly recorded along the project life, Project Managers are able to calculate two types of performance measures. The first type of performance measure is variances which represent the difference between the current status of the project and its baseline, in monetary terms. The **Cost Variance (CV)** is used to follow up the project budget. A negative (positive) value points out that more (less) has been spent for the executed activities than what was originally planned. The **Schedule Variance (SV)** is an indicator that provides PMs with a value that represents whether the project is on schedule or not. A negative (positive) value means that the project is behind (ahead of) schedule.

The **variances** can be derived as follows:

- Cost Variance: $CV = EV - AC$
- Schedule Variance: $SV = EV - PV$

Another type of performance measures are indices, also calculated from the three key parameters of EVA. The indices are again used to display how well the project is performing, now relatively in comparison with the baseline. Again two types of indices can be distinguished. The first type of index is the **Cost Performance Index (CPI)**, which expresses the cost efficiency of the executed work. A CPI of less (more) than one means that the project is currently running over (under) budget. The second index is the **Schedule Performance Index (SPI)**. The SPI shows whether the project is performing on schedule or not. A SPI of more (less) than one means that the project is ahead of (behind) plan.

The **indices** can be derived as follows:

- Cost Performance Index: $CPI = EV / AC$
- Schedule Performance Index: $SPI = EV / PV$

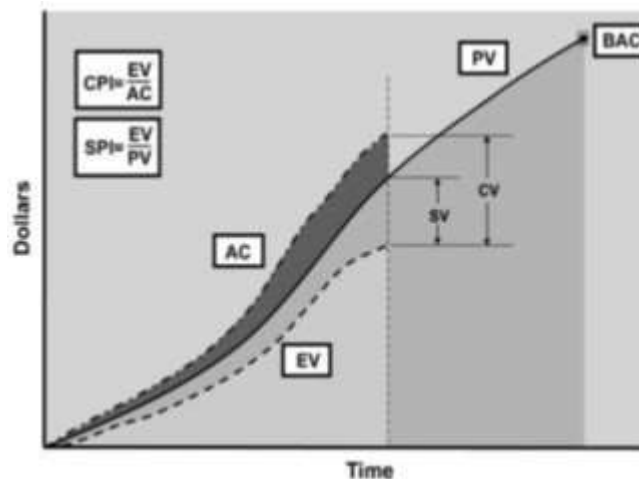


Figure 2: EVA Parameters

METHODOLOGY

1. Establish the Work Breakdown Structure (WBS) to divide the project into manageable portions.
2. Identify the activities to be scheduled that represent the entire project.
3. Allocate the costs to be expended on each activity.
4. Schedule the activities over time.
5. Tabulate, plot and analyze the data to confirm that the plan is acceptable. To use the information generated by the Earned Value calculations:
6. Update the schedule by reporting activity progress.
7. Enter the actual costs on the activities.
8. Execute the Earned Value calculations, print and plot the reports and charts.
9. Analyze the data and write the performance narrative.

Step 1: Establish the WBS

The WBS is the roadmap for analyzing the project progress and performance. It provides a multi-level structure for analyzing the project at varying degrees of detail. A properly defined WBS also provides that each element of the structure at each level is the responsibility of an individual who has management authority over that element and all the elements that roll up into that element. Furthermore the WBS must contain the full scope of the project. Otherwise the information generated will not represent the total project. While this personal responsibility might bring to mind an Organizational Breakdown Structure (OBS), the WBS should not be confused with an OBS. Either structure can

function as the framework for analyzing the project performance. However, an OBS is generally employed in a matrix organization where the functional management of the organization wants to analyze the performance of their functional unit on the project. The WBS is organized along the component lines of the project.

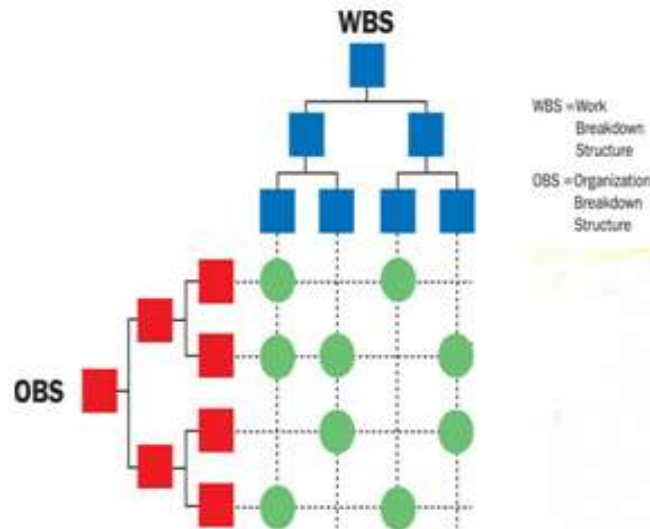


Figure 3: WORK BREAKDOWN STRUCTURE.

Step 2: Identify the Activities: The second step is to identify the activities of the project. The WBS provides the framework for identifying the project components as illustrated in figure 5.1 each activity should be assigned to one element in the WBS. The completion of this step will produce the project schedule of activities, typically in a CPM network.

Step 3: Allocate the Costs: The third step is to identify and allocate the costs to be expended for each activity. Since an activity represents a finite symmetrical bell shape, front loaded triangle, back loaded triangle, equal triangle, lump sum at the beginning or end of the activity. However detailed discussion of the application of resource curves is beyond the scope of this paper.

Step 4: Schedule the Activities: The fourth step is to calculate the schedule of the activities. This step generally provides the spread of the resources over the entire time duration of the project. It generates the traditional S-curve of the project plan or baseline also called the BCWS Curve.

Step 5: Tabulate, Plot and Analyze: The final step is to tabulate and plot the information that was loaded and then to analyze this information. The purpose is to assure that the allocation of resources is properly planned. This includes analysis of individual resources to see if the maximum requirement during any time period is available. It also includes review of cash flows if dollars are entered to see if the financing plan for the project supports the schedule. Third it provides a review to see that all project resources and costs that are budgeted are entered into the program. Of course correction of any anomalies discovered during this step is implied to be a part of this step. Figure 5.2 represents a very simple illustration of this process. It also illustrates with this very simple example, that the result is the traditional S-curve.

Once these five steps are completed, the project team will have the basis for conducting periodic analysis of the project progress and performance. That process is explained in the next four steps.

Step 6: Update the Schedule The first step in the periodic process is to update the schedule with the period progress. This is generally done whether Earned Value is used or not. The project schedule activities are reported as started, completed or with a remaining duration as appropriate. The percent complete of unfinished activities should also be reported. Here is where the practitioner should avoid subjectivity. For physical work it may be easy to determine the percent complete. If 1000 cubic yards of concrete are planned to be poured and 300 yards have been done to date then the activity is 30% complete. For efforts that are not so easily measured special earning rules might have to be

employed. Full discussion of earning rules is also beyond the scope of this paper. Two examples are presented to illustrate the point. One common rule is to report per cent complete according to completed milestones within the activity. For example if the activity is the creation of a design drawing progress might be reported as follows: 10% when the preliminary research and background study are completed, 20% when the drawing draft is completed and passed on to drafting, 40% when the first draft is printed, 50% when the first draft is reviewed, 60% when the second draft is completed, 75% when the client review is completed, 90% when the final draft is completed and 100% when the drawing is issued for construction. The key in defining this kind of rule is that each “milestone” is discrete and its achievement is easily recognized by such evidence as transmittal memos.

A second common rule that is quite effective when the project has several thousand activities is to use the 50-50 rule. In this rule each activity is considered 50% complete when its start date is reported and it is 100% complete when the activity finish date is reported. Reporting progress provides the basis for the Earned Value calculations.

Step 7: Enter the Actual Costs: The second step in the periodic process is to enter the actual costs into the schedule. This information comes from the time sheets and invoices to the project. Whether the data is entered manually or electronically is a matter of choice depending on the degree of integration between the company’s financial accounting system and the project control systems. In any case it is necessary to determine which costs are to be allocated to which activity. By proper integration of the financial and project Accounting systems is facilitated to the point of total automation. However human analysis of the actual data is recommended to assure that improper data doesn’t inadvertently enter the system.

Step 8: Calculate, Print and Plot The next step in the periodic process is to calculate the Earned Value and to print reports and plot charts for analysis. The Earned Value is simply the percent complete of an activity times its budget this provides the key value in the Earned Value process. Other calculations include the schedule, cost variances, performance indices, estimates at completion and percent Complete of the upper elements of the WBS. Referring to Figure 5.3 will aid in understanding the following calculation discussion. Purpose of this method is we will look at the basic impact of cost performance on the EAC. The intent is to show that Earned Value is a key forecasting tool for managing a project. Referring to Figure 5.3, let us assume a project is having some trouble meeting its cost goals. At the data date the actual cost is greater than the planned cost for the completed work ($ACWP > BCWP$). If performance continues at the same trend we can easily see that at completion the actual cost (EAC) far exceeds the budget (BAC). The simplest Formula for arriving at the EAC at the time of the data date is:

$$EAC = (BAC - BCWP) / CPI + ACWP$$

This formula determines the unfinished or unearned work ($BAC - BCWP$) and divides it by the CPI. To that is added the sunk cost or the cost of the completed work ($ACWP$). From this we can see that poor cost performance a CPI less than 1 would result in an EAC that is greater than the BAC. More complex formulas are used which factor the CPI to give it more or less influence on the EAC.

One more calculation is noteworthy since it is specifically made possible by the use of Earned Value. That is the per cent complete at the upper levels of the WBS. While progress is typically recorded at the activity level of detail (the bottom of the WBS), those responsible for the project at higher levels of the WBS want to know the same kind of information as the “activity managers.” The process involves rolling up the data through the WBS. Budgets and actual costs are easy to roll up; simply add the values of the lower elements to get the value of the parent element. However how does one roll up per cent complete? The answer is of course Earned Value. Since Earned Value is directly related to per cent complete. One can simply add the Earned Value of the lower elements to get the value of the parent element. Then one can use this information at the upper levels to back calculate the percent complete of the upper elements. Just as Earned Value equals the BAC times the percent complete at the lower levels, so does per cent complete equal BAC divided by Earned Value for any element in the WBS.

Step 9: Analyze and Report. The final step in the Earned Value process is to analyze the data and the report. The result of that analysis is the scope of this study does not allow detailed discussion of the analysis process. However from the above the planner can recognize the significance of the various calculations discussed above.

SUMMARY AND CONCLUSIONS

Earned Value Analysis is a powerful tool in the control of performance evaluation. Earned value analysis is the most effective technique for providing information on any project's performance. It communicates scope, schedule and cost status information to project stakeholders. Properly used, earned value analysis is a flexible process that provides timely information on the project health. Effective use of earned value concepts can provide a competitive edge in successfully delivering projects.

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