International Journal of Emerging Engineering Research and Technology
Volume 2, Issue 4, July 2014, PP 160-165
ISSN 2349-4395 (Print) & ISSN 2349-4409 (Online)

Earned Value Management System

Radhika Gupta

Civil Engineering Department, Prof. Ram Meghe College of Engineering and Management, Amravati, India
radhika.0627@gmail.com

Abstract: *A management of technical projects is becoming a challenge to professional engineers. In the increasingly competitive marketplace and in the Construction Industries in which the effective project planning and control approaches are required. Successful project managers demand that their projects meet the technical objectives of the project as well as completed on schedule and within the budget. Many project managers manage their project performance by comparing planned to actual results. With this method, one could easily be on time but overspend according to the plan. A better method is earned value management method because it integrates cost, schedule and scope and can be used to forecast future performance and project completion dates. It is an "early warning" program/project management tool that enables managers to identify and control problems before they become insurmountable. The earned value concept allows projects to be managed better – on time and on budget.*

Keywords: *Schedule, Cost, Scope, Effective Tool.*

1. INTRODUCTION

Earned Value Management System (EVMS) has been recently keeps cropping up in news articles. One of the major reasons is that more and more government contracts are now demanding upon Earned Value Management reports. Many government contractors are project-oriented. We have all heard about problems with completing projects on time and on budget and for government contractors there is more publicity when something goes wrong. Hence, government agencies are demanding on EVMS. EVMS is a methodology to help projects come to successful completion whether in construction industries, information technology, or software development. EVM is considered one of the most powerful and productive concepts utilized in managing today's complex projects in private, commercial or government environments. It has the ability to combine measurements of Scope, Schedule, and Costs. It is a single integrated system.

Earned Value Management is able to provide accurate forecasts of project performance problems which are an important contribution for project management. Earned Value analysis is a method of performance measurement that uses "work in progress" to indicate what will happen to work in the future. Earned Value is an enhancement over traditional accounting progress measures. Traditional methods focus on planned accomplishment (expenditure) and actual costs. Earned Value goes one step further and examines actual accomplishment. This gives managers greater insight into potential risk areas with clear picture. Earned Value Management System is not a specific system or tool set, but rather, a set of guidelines that guide a company's management control system. Earned Value Management allows us to integrate project scope, schedule and cost objectives against a baseline plan for accomplishment of project objectives. Popularity of EVM has grown significantly in recent years because EVM help in substantiate contract disputes.

2. OBJECTIVE OF EVMS

Following are the objective of Earned Value Management System (EVMS) given by the (Humphreys Associates).

1. Relate time phased budgets to specific contract tasks and/or statements of work.
2. Provide the basis to capture the work progress assessment against the baseline plan.
3. Relate Technical, Schedule and Cost performance.
4. Provide valid timely and auditable data /information for proactive management action.
5. Supply managers with a practical level of summarization for effective decision making.

3. KEY PARAMETERS OF EVMS

Earned Value Management introduces a few key parameter terms such as Budgeted Cost of Work Scheduled (BCWS) or Planned Value (PV), Budgeted Cost of Work Performed (BCWP) or Earned Value (EV) and Actual Cost of Work Performed (ACWP) or Actual Cost (AC).

The above key parameters are defined below-

1. Budgeted Cost of Work Scheduled (BCWS) or Planned Value (PV) – The sum of budgets for all work packages scheduled to be accomplished within a given time period.
2. Budgeted Cost of Work Performed (BCWP) or Earned Value (EV) – The sum of budgets for completed work packages and completed portions of open work packages.
3. Actual Cost of Work Performed (ACWP) or Actual Cost (AC) – The actual cost incurred in accomplishing the work performed within a given time period. Key parameters of EVMS are shown in "Figure.1" and "Figure.2".

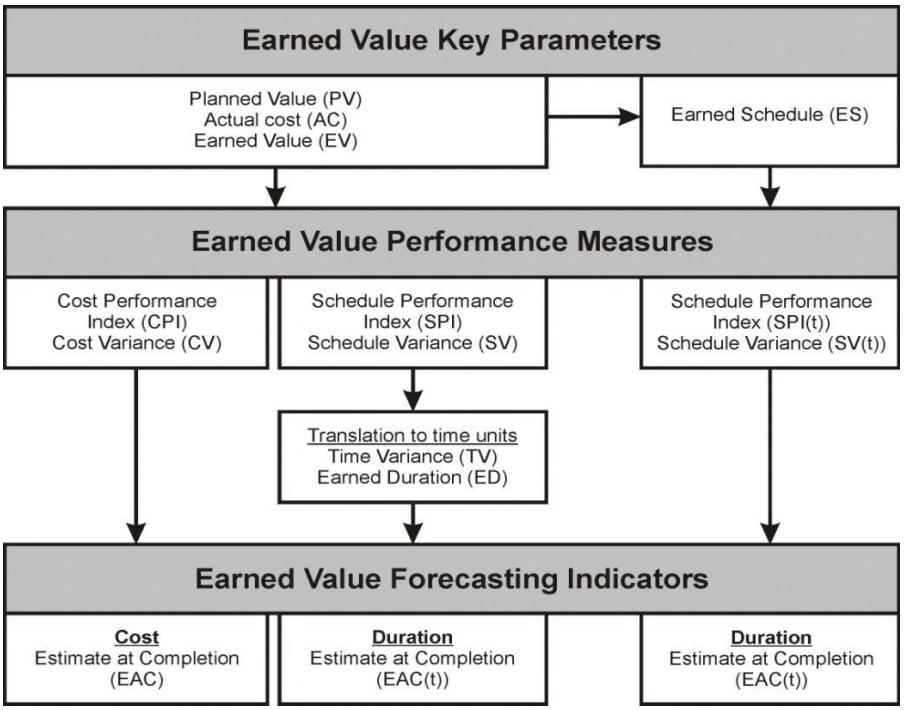

Figure.1 *Key Parameters of EVMS*

4. Performance Measurement Baseline (PMB) – The sum of all work packages Budgeted Cost of Work Scheduled (BCWS) for each time period, calculated for the Earned Value Analysis for total project duration. The PMB forms the time-phased budget plan against which project performance is measured.
5. Budget At Completion (BAC) – The sum of all the budgets allocated to a project. In addition to the PMB, there generally is an amount of management reserve, which is a portion of the total project budget not allocated to specific work packages and withheld for management control processes. The BAC consists of the PMB plus all management reserve.
6. Schedule Variance (SV) – The difference between the work actually performed (BCWP) and the work scheduled (BCWS). The schedule variance is calculated in terms of the difference in dollar value between the amount of work that should have been completed in a given time period and the work actually completed.
7. Cost Variance (CV) – The difference between the planned cost of work performed (BCWP) and actual cost incurred for the work (ACWP). This is the actual dollar value by which a project is either overrunning or under running its estimated cost.
8. Cost Performance Index (CPI) – The ratio of cost of work performed (BCWP) to actual cost (ACWP). CPI of 1.0 implies that the actual cost matches to the estimated cost. CPI greater than 1.0 indicates work is accomplished for less cost than what was planned or budgeted. CPI less than 1.0 indicates the project is facing cost overrun.

9. Schedule Performance Index (SPI) – The ratio of work accomplished (BCWP) versus work planned (BCWS), for a specific time period. SPI indicates the rate at which the project is progressing.
10. Estimate At Completion (EAC) – It is a forecast of most likely total project costs based on project performance and risk quantification. At the start of the project BAC and EAC will be equal. EAC will vary from BAC only when actual costs (ACWP) vary from the planned costs (BCWP).
11. Estimate To Complete (ETC) – The difference between Estimate at Completion (EAC) and the Actual Cost (AC). This is the estimated additional cost to complete the project from any given time.
12. Variance At Completion (VAC) – The difference between Budget at Completion and Estimate at Completion (EAC). This is the dollar value by which the project will be over or under budget.

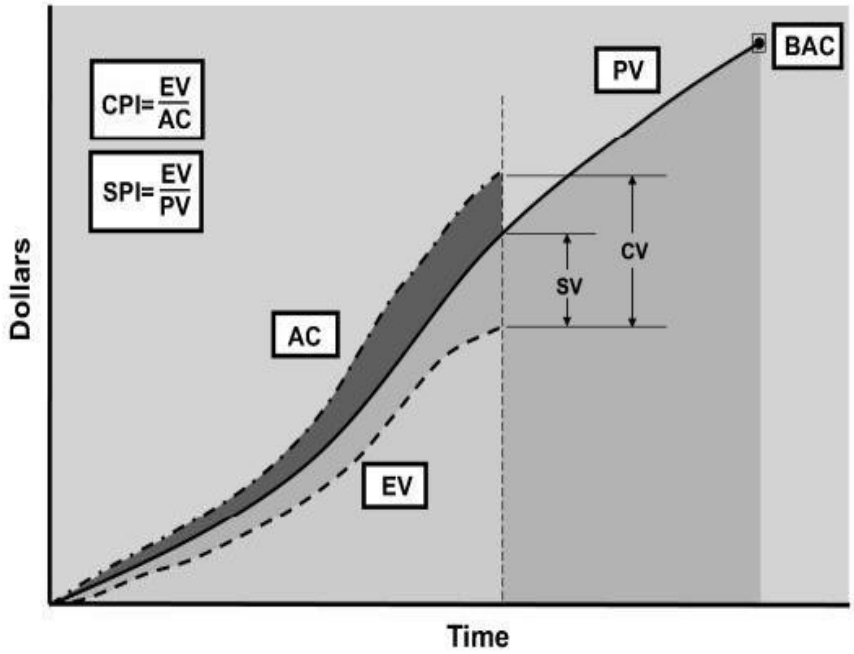

Figure.2 *Earned Value Basics*

As of first quarter of year 2002 there is a shift in using the terms Planned Value (PV), Earned Value (EV) and Actual Cost (AC) instead of Budgeted Cost of Work Scheduled (BCWS), Budgeted Cost of Work Performed (BCWP) and Actual Cost of Work Performed (ACWP). The Earned Value Management terms and formula and their Interpretation is given in Table 1.

Table 1. *Earned Value Terms and Formula*

Earned Value Management Terms	Description	Interpretation
PV (BCWS)	Planned Value	What is the estimated value of the work planned to be done?
EV (BCWP)	Earned Value	What is the estimated value of the work actually accomplished?
AC (ACWP)	Actual Cost	What is the actual cost incurred?
BAC	Budget at Completion	How much did you budget for the total job?
EAC	Estimate at Completion	What do we currently expect the total project to cost?
ETC	Estimate to Complete	From this point on, how much more do we expect it to cost to finish the job?
VAC	Variance at Completion	How much over or under budget do we expect to be?

4. ILLUSTRATIVE EXPLANATION OF EVMS

This section described the EVMS terms and its significance by taking an example of construction projects. "Figure5" presents a several activity of a construction project's schedule (Agata Czarnigowska) a number of tasks of the first stages of the project. Table 2 contains input data collected by the end of the seventh week of the schedule and status indicators calculated on their basis. Inputs are marked grey-

1. A budget for each tasks and for the whole project (BAC),
2. Percentage complete (PC) of each task as measured or estimated during inspection (it is represented by black lines over schedule bars and values above them),
3. Budgeted costs of works scheduled up to the end of week 7 (BCWS),
4. Actual costs of works performed (ACWS).

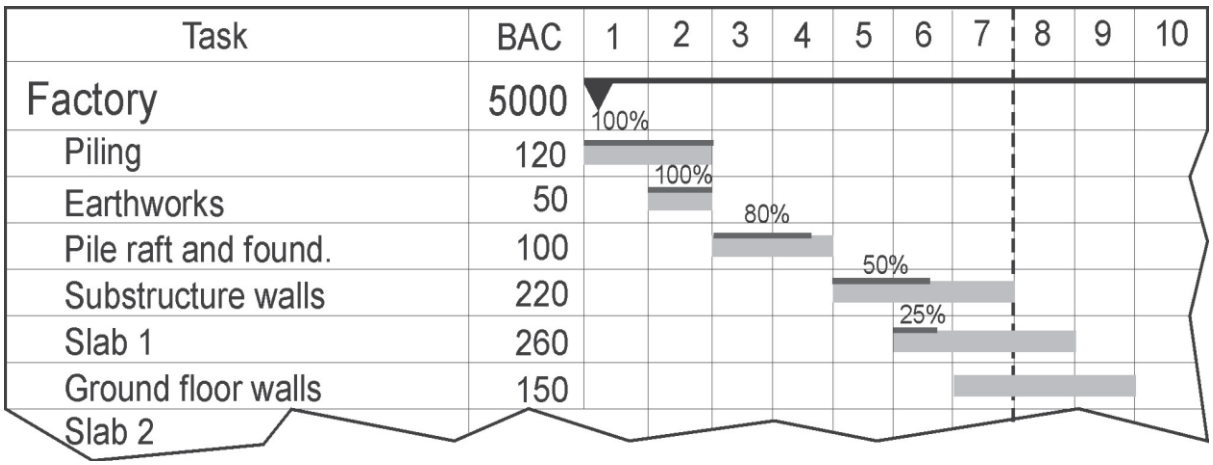

Figure 5. *Schedule to serve as basis for calculations –Factory*

Table 2. *Earned Value calculations – Factory end of week 7*

Task	BAC	PC (%)	BCWS	BCWP	ACWP	SV	CV	CPI	SPI	EAC	TCPI
Factory	5000	8.50	71333	42500	44500	-28833	-20,00	96	60	523529	100,44
Pilling	120	100	120	120	120	0	0,00	100	100	12000	-
Earthwork	50	100	50	50	60	0	-10,00	83	100	6000	-
Pile raft & foundation	100	80	100	80	75	-20	5,00	107	80	9375	80,00
Sub. Walls	220	50	220	110	110	-110	0,00	100	50	22000	100,0
Slab 1	260	25	173	65	80	-108,33	-15,00	81	38	32000	108,33
Ground foundation walls	150	0	50	0	0	-50,00	0,00	-	0	-	100,00
	-	0	0	0	0	0	0	-	-	-	

The progress of the whole project (PC) is calculated according to formula-

PC= BCWP/ BAC =425/5000 =8.50%

BCWS, BCWP, ACWP and variances SV and CV for the whole project are sums of values of all tasks. The project's CPI and SPI are calculated on the basis of its BCWS, BCWP and ACWP. SPI indicate that by the end of week 7, the tasks "Pile raft and foundation", "Sub. Walls" and "Slab 1" have not been completed to the planned extent, so they are delayed. Therefore, the whole project is behind schedule in terms of scope of works i.e. less work has been done than it was planned. CPI indicates that "Earthworks" and "Slab 1" proved more expensive than planned. Some savings on "Pile raft and foundation" compensated this additional cost only in part. So the project as a whole is over

budget. If the project was to be finished on budget, it would have to be continued with an improved cost performance index (TCPI). If the project was to proceed with current CPI, its total costs would be EAC.

5. BENEFITS OF EVMS

Following are some of the benefits of EVMS, described by Fleming and Koppleman as the legacy of using the criteria on government contracts for three decades (1996). Note that they do not separate benefits of earned value data from the benefits of the criteria, perhaps because the reliability of data depends on the disciplined application of the management practices described by the criteria.

1. It is a single management control system that provides reliable data.

2. It integrates work, schedule and cost using a work breakdown structure (WBS).

3. The associated database of completed projects is useful for comparative analysis.

4. The cumulative cost performance index (CPI) provides an early warning signal.

5. The schedule performance index (SPI) provides an early warning signal.

6. The CPI is a predictor for the final cost of the project.

7. It uses an index-based method to forecast the final cost of the project.

8. The "to-complete" performance index allows evaluation of the forecasted final cost.

9. The periodic (e.g. weekly or monthly) CPI is a benchmark.

10. The management by exception principle can reduce information overload.

6. CONCLUSION

Earned Value Analysis is a better method of program/project management because it integrates cost, schedule and scope and can be used to forecast future performance and project completion dates. It is an "early warning" program/project management tool that enables managers to identify and control problems before they become insurmountable. It allows projects to be managed better on Time and on budget. It is observed that the implementation of EVMS in construction makes more viable and effective. It helps managers in making evidence based decision about project scope, resources, and cost in overall project oversight. As a competitive purpose, the strategic management needs for enhancing cost and schedule control capabilities under globalized competition require to furnish EVMS techniques. The main contribution of the EVMS process was the motivation of the project manager and his staff concerning the cost management and the goal to finish the project on budget. The EVMS process provided more perception about the costs and their related elements of scope, contracts, performance, suppliers, risks, procurement, communications, quality, people and negotiations. EVMS inspires the participants to pay more attention to costs and progress, motivates the participants to discuss the cost elements with more intensity and optimize the costs resulting in a project that was finished on time and on budget.

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AUTHOR'S BIOGRAPHY

MS. RADHIKA GUPTA,

PG STUDENT,

CIVIL ENGINEERING DEPARTMENT

PRMCEM, AMRAVATI