



## Earned Value Management Fundamentals

### Introduction

Earned Value Management (EVM) is the systematic project control approach relating to the integration and measurement of cost, schedule, and scope of a project. It provides both the client and contractor with the ability to examine the details of a project's schedule and cost data performance. But only if baseline changes have been implemented in a timely manner.

The objective of EVM is to provide project performance information that can be utilised as an aid to project management decision making. For EVM to be effective it requires a high degree of data integrity in the following areas: --

- Clear requirements and work scope definition
- Integration of schedule and budgets – for example setup of a cost loaded programme
- Objective quantity progress measurement tracking
- Integrated cost collection mapped to WBS
- Project structures to allow for meaningful project summarisation and analysis
- Change control process to maintain the integrity of the baseline plan
- Business System to support the provision of timely and accurate data generation

Some may believe a project's performance can be assessed using two data sources, the budget and the actual cost. The comparison of the budget against actual cost simply indicates what was planned to be spent against what was actually spent at that given time. But, does not provide information relating to the value of work completed or delivered for the money spent?

Using the above approach, whilst physical progress is measured, it does not compare the completed progress to the planned progress, nor to the actual costs incurred at the same given point in time. As the graph in Figure 1.1 illustrates, budget is compared against the actual cost, which does not answer the following questions of if the project is:

- Ahead or behind schedule?
- Achieving value for money?
- Under or over spending?

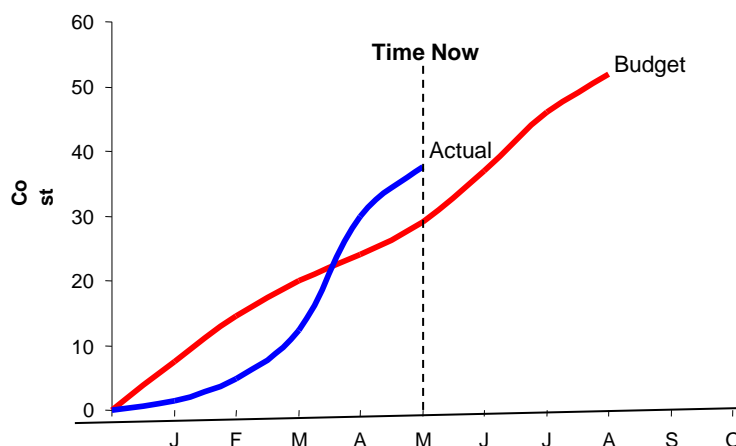


Figure 1.1 – Actual vs. Budget



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With Earned Value Management, unlike in the example above, there are three sources of data: -

- Budget (Planned Value – PV) – What the project planned to complete?
- Actual Cost (Actual Cost - AC) – What was actually spent to complete the work?
- Earned Value (Earned Value - EV – What work was completed, Progress?)

The Earned Value graph shown in Figure 1.2 shows the PV (Red), AC (Blue) and the EV (Green). The EV graph is the same as the Actual vs. Budget graph with the added Earned Value line, which is the measure of the progress the project has achieved. In addition to tracking Actual Cost and Budget, the Earned Value indicates the value of work completed.

The benefits are:

- Confirms if the project is ahead or behind schedule by comparing the EV (what was achieved) against the PV (what was planned), and outputs a financial Schedule Variance (SV)
- Confirms if the project is under or overspending by comparing the EV (what was achieved) against the AC (what was spent), and outputs a financial Cost Variance (CV)
- Provides a statistical forecast of the costs at completion (iEAC) based upon current spend, remaining work and progress to date

This information can be used to support decision making and help mitigate future issues.

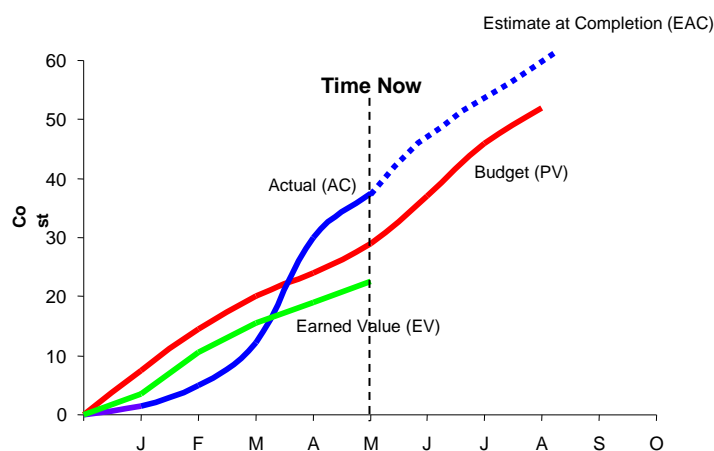


Figure 1.2 – EV Graph

### SCHEDULE PERFORMANCE

EV can be compared to the expected PV. This will be achieved through the analysis of the Current Programme EV, against the PV (Budget) held in the Baseline.

#### Schedule Variance (SV)

Schedule Variance (SV) indicates if the project is ahead or behind schedule and is assessed by comparing the Planned Value (PV) and the Earned Value (EV).

This is calculated as follows:

$$SV = EV - PV \quad (\text{Expressed in } \pounds)$$



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A positive result indicates the work is ahead of schedule; a negative result indicates the work is behind schedule. At near project completion, SV begins to converge to SV of 0, because EV will equal the PV, meaning all the work scope has been delivered.

### What Does £10M negative Schedule Variance Mean?

It could mean the project has not completed the work it had planned in the baseline. However, depending on which activities are behind schedule in the baseline plan, the project may or may not be behind schedule, if the activities are on or near the critical path then the project could be behind schedule, but the delay may relate to other issues such as incorrectly profiled activities. **Note**, an accurate SV relies on the baseline change (NiCEs) and extension of time (EoT) being implemented in a timely manner. Also, the project won't know whether it actually has a schedule issue until the critical path is reviewed.

**Schedule Performance Index (SPI)** is a measure of Schedule Efficiency. The SPI measures the value of work performed against the work scheduled.

This is calculated as:

$$SPI = EV / PV$$

A result equal to or greater than 1 indicates on or ahead of schedule, a result less than 1, indicates behind schedule. At completion, SPI is always 1.

An SPI of 0.80 indicates that the work is behind schedule. Which can be defined in two ways: The work is 20% behind baseline schedule or working at 80% efficiency.

## COST PERFORMANCE

Cost performance measures the Actual Costs (AC) compared with the Earned Value (EV). The Cost Variance is a measure of the cost of accomplishment, what was spent to complete the progressed scope of work.

**Note:** Again, the accuracy of the CV analysis is dependent on the timely implementation of change into the baseline. If the change is not implemented in a timely manner, CV analysis needs to take account of the value of the change (NiCEs) that has not been implemented into the baseline which has contributed to the variance.

### Cost Variance (CV)

Cost Variance (CV) indicates if the project is under or over spending and is assessed by comparing the Actual Cost (what was spent to date) and the Earned Value (what work was completed to date).

This is calculated as follows:  $CV = EV - AC$

A positive result indicates a cost efficiency and a potential saving, and implies the work is being delivered for less than the budget, while a negative result indicates a cost over-run, where the progress of work is costing more than budget.

### Cost Performance Index (CPI)

Cost Performance Index (CPI) is a measure of Cost Efficiency. The CPI measures the value of work performed (EV) against the actual spend (AC) and can assist with identification of potential problem areas which may impact the cost performance of the project.

This is calculated as follows:  $CPI = EV / AC$



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A result equal or greater than 1 indicates that the cost of delivering the work is equal or less than that expected. Less than 1 indicates that delivery is costing more than expected.

CPI is essential in analysing performance trends and conducting projections of the project 'At Completion' status and final outturn cost.

### What can indicators tell the project...? What should the project do...?

1. **CPI = 0.85 and SPI = 1.05**

**Project Status**

Over-achieving but overspent for the achievement

Money may be being spent unnecessarily on overtime or labour, plant material costs are higher than budgeted, etc, etc.

2. **CPI = 1.05 and SPI = 1.05**

**Project Status**

Over-achieving and under spending

No Action. But it may be prudent to review resources to capture potential further cost efficiency. etc, etc

3. **CPI = 1.05 and SPI = 0.85**

**Project Status**

Under-achieving against schedule but overachieving for the spend.

Team seems to be performing well, but may be under-resourced and have had other delaying factors, such not gaining site access on time or late material delivery etc, etc.

4. **CPI = 0.85 and SPI = 0.85**

**Project Status**

Under-achieving and overspent for the achievement.

Team could be under-resourced / under-performing. Labour plant material cost are higher than budgeted. etc, etc

### Independent Estimate at Complete (iEAC)

The iEAC is a calculated forecast of the cost at completion factored by the past historical cost and schedule performance, SPI & CPI. Its aim is to statistically assess the 'Integrity' of a bottom up estimate and current forecasts.

iEAC is calculated as follows:

$$iEAC = ACWP + ((BAC - BCWP) / CPI * SPI)$$

If the CPI and SPI are equal to 1, the formula will output a result equal to the future budget for the remaining work plus the actual costs to date. But if the CPI and SPI is less than 1, the formula outputs an outturn cost that reflects past performance and will be greater than the budget for the remaining work, plus the actual costs to date.



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### BOTTOM UP FORECAST COST TO COMPLETE

The iEAC formula can be used to assess the reasonableness of the project teams bottom up forecast. However, the project, commercial and project control teams should compile a bottom up forecast at least annually, and maintain a monthly update of the forecast through analysis of risk and trends.

When starting a bottom up forecast the following should be considered:

- Establish forecast cut-off date and define total scope, confirm change instructions that will be included in forecast and change and trend register.
- Programme and dates of the remaining activities and milestones.
- Key quantities, resources and labour rates
- Past performance and trends;
- Costs incurred to date;
- Risks and Opportunities

### Earned value management implementation overview.

An Earned Value Management System needs to be implemented to capture the Actual Cost (AC), Planned Value (PV) and the Earned Value (EV). The establishment of an EVM system should be setup in accordance with the APM EVM Guidelines (32 criteria) or ANSI-748, which is outlined in Figure 1.3. The systems should be setup to address the point illustrated below and to ensure the integration of programme and cost reporting.

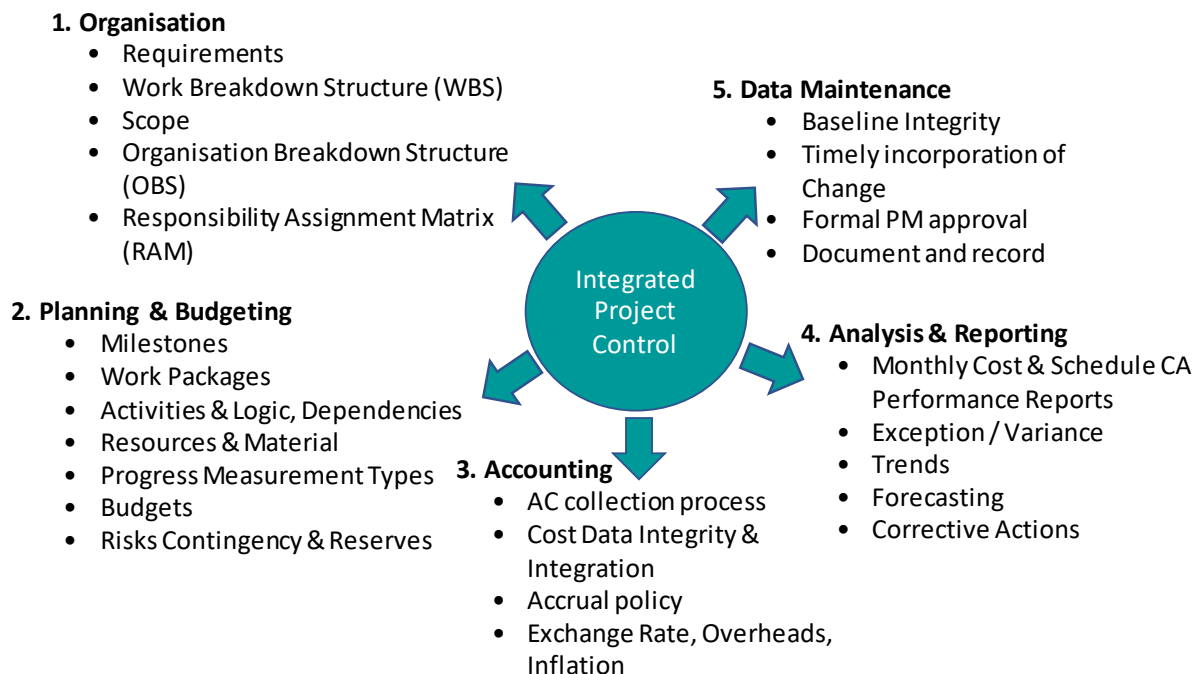


Figure 1.3



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### Wider performance analysis

Although EV provides measures of performance, more detailed analysis may be required to assess the productivity. It is advisable to establish quantity tracking systems to ensure progress is measured objectively. The trackers can be used monthly to support the EV analysis and to validate the period percent complete claims.

### Assurance review

Common issues that affect projects performance are: -

- Poorly defined project management and control process.
- Insufficient requirement and work definition
- Unrealistic schedules
- Underestimated budgets.
- Inadequate cost control and accounting practices
- Inadequate progress substantiation.
- Poor change management

These issues can be reduced through periodic assurance reviews to validate and improve: -

- Requirements: are understood and captured within the work scope.
- Integration: validate deployment of EV project control on the project and the supply chain.
- WBS: ensure clear scope definition, reporting, cost collection boundaries are in place and WBS relates back to user requirements.
- Scope: - ensure full scope of work required to deliver the requirements is defined and captured.
- OBS: ensure the organisation is defined to the level at which work is assigned.
- Budgets: ensure budgets are setup within the financial system and align with the schedule structure.
- Risk Management: ensure identified risks and their potential impact have been taken into account when building the schedule and the estimate.
- Baseline Change Control Process: ensure the integrity of the project baseline is being maintained.
- Performance Measurement: ensure project cost and schedule performance is reported monthly, and the project are preparing valid cost forecasts (EACs).

### CONCLUSION

The implementation of EVM systems and process will not solve a projects difficulty but will help drive: -

- greater performance clarity
- involvement from the delivery teams
- consistent and standardised reporting at all levels of the project
- early warnings notice to allow mitigation actions to be established to help change cost and programme overs run.

However, ultimately it will ensure project performance information is readily available to assist with informed cost and programme decision making.



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### Earned Value Brief History

- 1960s - Earned value-based performance management began in the 60s, based on US Department of Defence (DoD) Cost / Schedule Control Systems Criteria (C/SCSC).
- 1970s-80s – The DoD promoted the use of Earned Value in response to bearing cost and schedule risk in cost-plus contracts. Contractors pushing high tech, newly developed weaponry, Military having critical schedule needs (“Arms Race”)
- 1990s – Policy moved Earned Value into all US Federal agencies
- 1991 Dick Cheney cancelled the A12 Avenger programme due to cost and programme performance issues highlighted by EVA.
- 1995 to 1998, ownership of EVM (32 criteria) was transferred to industry by adoption of ANSI 748-A standard. Expanded beyond the U.S. Department of Defence and used by NASA and DoE
- 2006 UK MoD mandate EV on Project Over £20M

It is well documented that project cost and schedule overruns at the 15-20% completion point will not be less than the overrun to date. Which means if a project has a CPI of 0.85, when it is at the 20% point (e.g. 5 Month into a 24 Month project), it will maintain that level of cost performance through the remainder of the project and will not improve but is more likely to decrease. (Source: More than 700 DoD contracts since 1977). This is because, if a project has underestimated the near-term planning (when detailed known plans should be in place) there is little hope the project will do better on the long-term planning.