Earned Value Management Handbook

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1 Introduction

EVM is a good practice approach used for the planning, management and control of projects and programmes. These can range from large programmes to relatively small, internal company projects. The approach supports the establishment of a baseline project plan, and then the management of cost and schedule performance to that plan in an integrated way. The *Earned Value Management: APM Guidelines* (2008) provide guidance on the approach at a foundation level. This publication provides guidance at both the Foundation and the Practitioner level.

EV qualifications are currently offered at two levels: Foundation and Practitioner.

The text of this publication is structured according to the EVM Syllabus May 2011 (APM Group). The syllabus follows the EV process originally detailed in the *Earned Value Management: APM Guidelines.* Adherence to this structure makes this publication a useful study guide and a source of reference.

The primary purpose of the syllabus is to provide a basis for the accreditation of people involved with earned value. It documents the learning outcomes related to the use of earned value and describes the requirements a candidate is expected to meet to demonstrate that these learning outcomes have been achieved at each qualification level.

Foundation level

This level provides information and knowledge for individuals who have an understanding of the *Earned Value Management: APM Guidelines (APM, 2008)*, and who are currently actively involved, or are likely to be actively involved, in an earned value project environment. It allows them to contribute to the formal process of earned value management.

NB: Material relating to Foundation level knowledge and extracted from the *Earned Value Management: APM Guidelines* is shown in blue.

Practitioner level

This level provides information and knowledge for individuals who have worked, and are working, in an earned value management environment and have done so for a period of two years. This audience will include a wide range of people working on earned value based projects including project managers, control account managers, and project planners and project analysts.

A practitioner has achieved sufficient understanding of the theory and application of earned value management to allow them to work successfully in an earned value management environment. They should be capable of applying the tools and techniques independently but will have a team around them and advice and support available as required. A successful practitioner should, with suitable direction, be able to start applying the method to a real project but may not be sufficiently skilled to do this appropriately for all situations.

3 Definition

3.1 The definition of Statement of Work (SoW)

A SoW defines the scope of a project, including the overall requirements and deliverables for that project. It forms the basis for allocating work, budget and schedule requirements.

The extent to which the SoW fully describes the requirements of the project will have a direct impact on the ability of the EVMS to provide objective measures of performance against the original project requirement.

3.2 The definition, diagram and purpose of an organisation breakdown structure

Projects usually involve people from a variety of functions and departments across an organisation. A fundamental requirement of a well-managed project is clear people organisation. Where matrix management structures are used, this clarity in organisational definition is particularly important.

In order to clarify and define the organisation, an organisation chart or organisation breakdown structure (OBS) should be developed. Roles, responsibilities and accountabilities should be clearly defined for all staff and communicated across the project team. Staff being introduced into the project should have a clear knowledge of whom they report to, and for what work they are responsible.

Vague definitions of roles, responsibilities, authorities and accountabilities will lead to ambiguities and confusion in the management of the project.

3.3 The definition and structure of a Work Breakdown Structure (WBS)

The hierarchical sub-division of a project into discrete elements of work is known as a work breakdown structure (WBS). The WBS is developed by identifying high-level elements of work necessary to meet the project requirements. These major elements are then broken down into smaller components. This breakdown continues until the lowest level of detail deemed necessary for management visibility and control is established. All aspects of the contract are included and the WBS can be viewed as a graphical, hierarchical representation of the SoW.

When developing a WBS, it is advisable to concentrate solely on the work content of the project. Projects may use a work breakdown structure dictionary (WBSD), the purpose of which is to describe the entire scope of work to be undertaken within the project. It must capture the contract scope and all contract requirements. To enable this to be checked it must provide a ready reference between the WBS and contract elements. It also provides the basis for the SoW included on the control account plans.

For each element of the WBS, the dictionary should contain:

- a contract number;
- a WBS number and title;
- the WBSD issue number and date;
- the contract paragraph number;
- a SoW including all contract deliverables to be produced as part of the work element.

The WBS dictionary should include all elements to be sub-contracted and should specifically identify the sub-contractor undertaking the WBS element.

3.4 The definition and purpose of a control account

A WBS reflects the way in which work has been sub-divided. To assign work responsibilities to appropriate organisational elements the WBS must be interrelated with the OBS. The assignment of lower-level work breakdown elements to responsible organisations provides a key control point for management purposes and for cost collection.

The integration of the WBS and the OBS at the control account level can be displayed as a matrix, with the OBS elements listed on one axis and the WBS elements on the other. This is the responsibility assignment matrix (RAM), where each element is a control account (CA), with a control account manager (CAM) responsible for its completion to budget.

A CA will normally comprise a number of WPs, although in some cases a control account may be a single work package. Each work package should have the following attributes:

- a defined scope of work;
- information on measure of achievement;
- traceability up through the WBS;
- a budget;
- details of assignment of responsibility;
- start and finish dates.

If it is not possible to define a work package to the detail mentioned above, then it should be identified as a planning package within the CA.

3.4.1 Process discussion

Once the work breakdown structure (WBS), and the dictionary, if used, have been completed, they should be reconciled back to the requirement, along with any other formal agreements, to ensure that all aspects of the project have been included.

It is important that the CA is identified for each work area. The CA is the main action point for the planning and control of project work. It is the point where management responsibility for the individual CAs is assigned. A manager may be responsible for many CAs, but a CA should have only one manager.

The CA in an integrated management system is the lowest level in the structure at which comparisons between actual costs and budgeted costs are normally required by management. However, analysis will also be done at lower levels, as required for local control. Most management actions taken at higher levels are triggered by significant problems identified at the CA level. For this reason, the levels selected for the establishment of the organisation and the CAs should be carefully considered at the outset of the project.

3.5 The definition and purpose of a responsibility assignment matrix

A responsibility assignment matrix (RAM) is a diagram or chart showing assigned responsibilities for elements of the project's work. It is created by combining the WBS with the organisation breakdown structure (OBS).

The RAM shows the level of control that has been established. If the accounts identified are too big or too small, too many or too few, they should be reconsidered and changed accordingly.
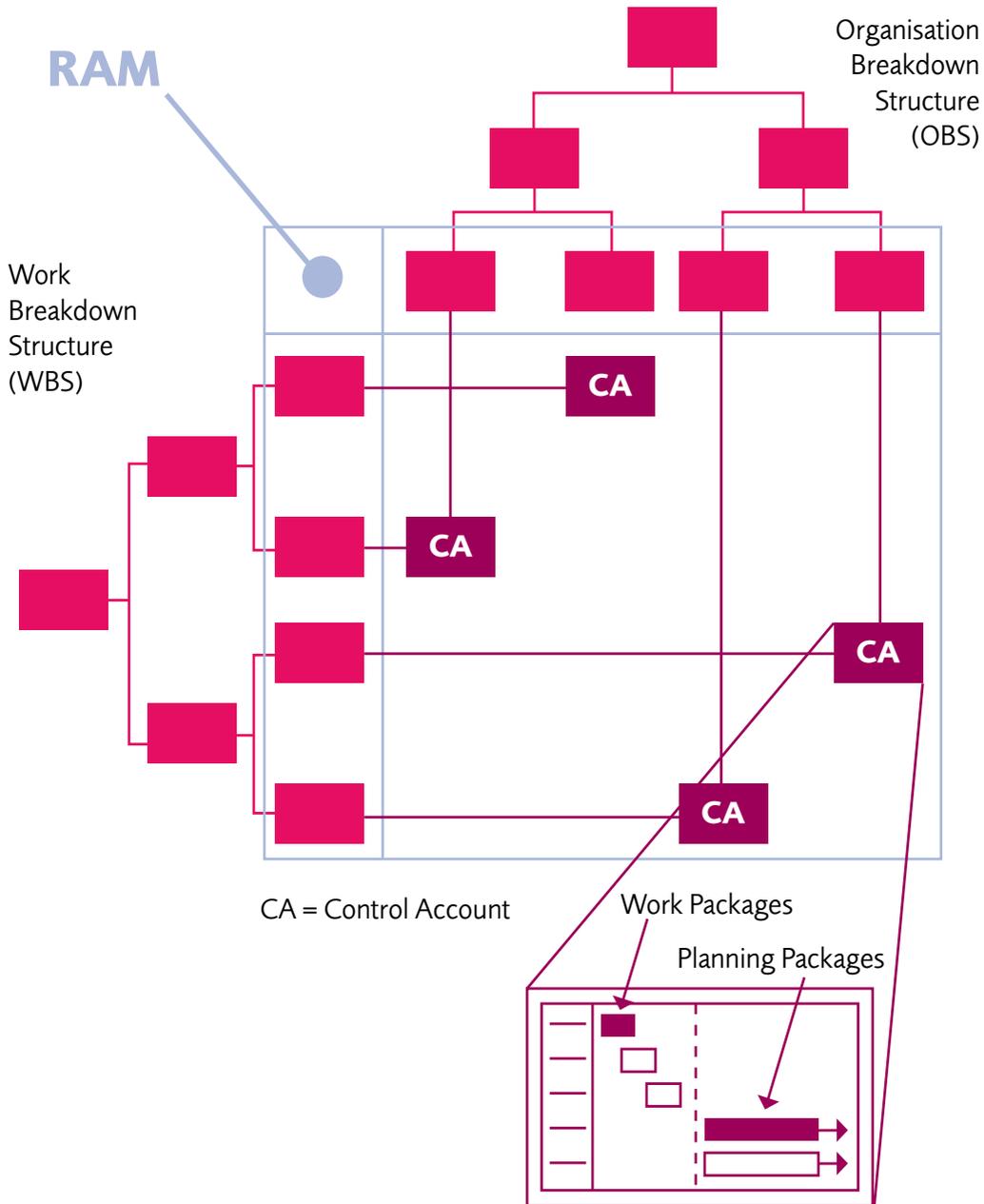
Figure 5: Responsibility Assignment Matrix

Taken from the *Earned Value Management: APM Guidelines* (2008)

3.6 The factors influencing the appropriate details in a statement of work

4 Planning

4.1 What is a work package?

The work package is the lowest level at which performance data is normally analysed. It is therefore important to balance the length and scope of the work package against reporting cycle lengths, and to consider when and how to earn 'value'. Each work package must have a clearly defined start condition and finish point, with all deliverables defined. The scope of each work package must be unambiguously defined with the procedures to be followed identified. Each work package comprises a number of activities to be performed.

See section 4.22 on page 71 for more information on the types of work packages.

4.2 What is a planning package?

Planning packages (PPs) represent work that cannot yet be planned as work packages because of a lack of detailed information. Normally this is future work that is not scheduled to be started for at least three full months from the current date. Work in the near future that cannot be planned in work packages may indicate a problem of work definition.

PPs are structured below the control account level, have a defined scope of work and are allocated a time-phased budget. They have scheduled start and finish dates (hence a duration) and a defined budget and scope.

Planning packages must be converted into work packages before work can commence upon them, i.e. before they can 'earn' achievement, or have costs booked against them. The budget is withdrawn from the planning package and is used to establish work packages as their start date nears and the details of the tasks become clearer. The resulting work packages will contain the detailed activities, logic, milestones, resources and achievement measures.

4.3 What is an activity?

Each work package comprises a number of activities to be performed. Each activity can be assigned to only a single work package. Each activity is a stepping stone towards completion of its parent work package. **Figure 9** shows a schematic of the relationship between work packages, planning packages and activities. The activity is where duration, resources and costs are estimated; dependencies are shown between activities.
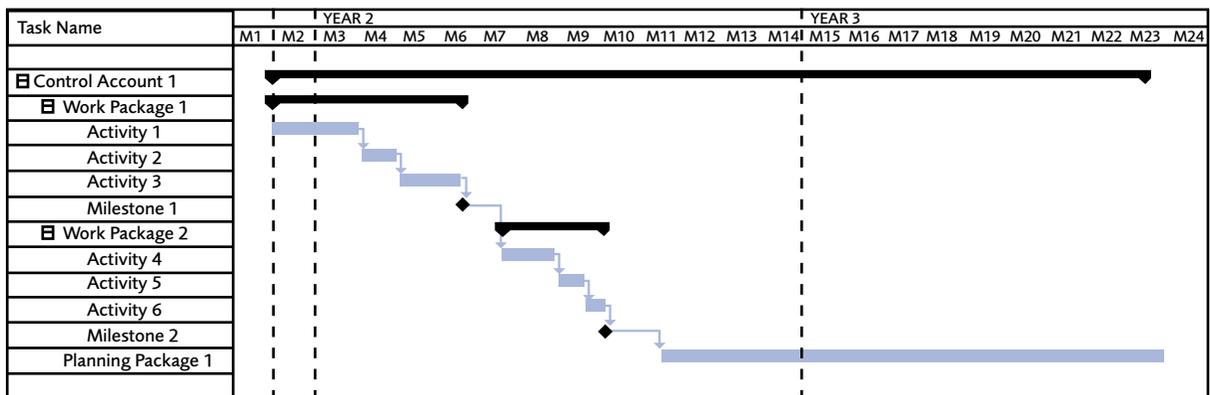
Figure 9: The relationship between control account, work package and activity
Taken from the *Earned Value Management: APM Guidelines* (2008)

4.4 The definition of rolling wave planning

The requirement for a periodic conversion, from planning package to work package, is the result of setting up the project using rolling wave planning, whereby only the current phase of a project is planned in detail and future phases are planned in outline. The conversion process is a fundamental aspect of project control using EVM and results in a more controlled project baseline.
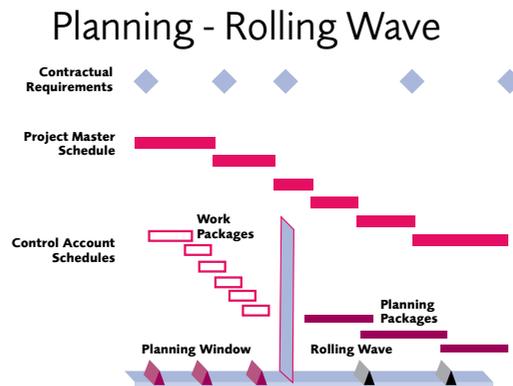

Figure 10: An illustration of rolling wave planning
Reproduced with kind permission from BAE SYSTEMS

4.5 What is a schedule?

Scheduling is the process of determining when project activities will take place, depending on defined durations and preceding activities. Schedule logic specifies when an activity should start or end on the basis of duration, predecessors, external predecessor relationships, resource availability or target dates.

Schedules can be created to reflect various elements of the WBS, from the highest-level plan to detailed work package schedules containing the lowest level of activity. These schedules form the basis for assessing actual progress and comparing actual cost against work performed.

All contractual milestones should be included within the schedule from the start of the project. These contractual milestones should be logically linked to appropriate activities so that any changes to forecast dates are applied throughout the schedule.

It is essential in any EVMS that activities on the current critical path are identified. This will enable variances from the plan to be appropriately categorised – e.g. 'late but float remains' as opposed to 'late and on critical path'. To preclude excessive workload on large projects, a project may choose to exclude the lower levels of schedules from the network used for critical path analyses. However, the lower-level schedules must always support the summary-level schedule so that all analyses have the same basis.

The overall scheduling process permits the integrated planning of project resources with the cost and schedule objectives of the project, and provides a means of measuring progress against planned effort. Scheduling and work scope definitions are prerequisites for basic project management and effective cost control.

4.6 Setting budgets

Budgeting is the process of distributing or allocating cost targets to individual segments of work. Strict budget element relationships must exist at all times in order to ensure that the sum of the parts is equal to the whole. The hierarchy of budget elements is shown in Figure 11. This illustrates how the intermediate summations are defined leading to the contract budget baseline.

Figure 11: Budget element hierarchy
Taken from the *Earned Value Management: APM Guidelines* (2008)

4.7 The difference between budgets and funds

Within an EVM system the concept of budgets is different from the concept of funds. While a budget represents the cost performance target for a specific effort, funds represent the money available for expenditure in the accomplishment of the effort. Budgets are established for the relevant elements of the work breakdown structure and are time-phased.

Budget cannot be spent; it is the funds that are consumed. Funds are authorised by the customer or by the company on a total or periodic basis.

The formulation of estimates at completion (EACs) provides the project with visibility of the anticipated/out turn funds required by forecasting the actual funding requirements for any approved statement of work element.

4.8 The definition of cost types and rates that may be used

Projects usually involve many different types of costs that need to be summarised through various levels of detail. As work packages are subdivisions of work, then each work package will comprise a number of differing types of costs. Separate work packages should not be raised for different cost types. Within earned value management systems, specific terms are used to denote types of budgets, and each area of the budget has specific inclusions/exclusions. Budgets (in terms of pounds, hours or other measurable units) should be allocated to every work package within each control account.

Budgets should separately identify labour, material, sub-contract and any other direct costs. Please refer to sections 4.6 and 4.15.

It is the summation of all budgeted work that forms the performance measurement baseline.

6 Analysis, review and action

6.1 The formulae for earned value variance and indices

All variances are measured in terms of cost and apply equally to all methods of measurement. There are five types of variances/ indices commonly used.

SV   **Schedule variance** – the cost comparison of what has been earned with what was budgeted. It measures the difference in value between the work planned and the work actually accomplished:
$$SV = BCWP – BCWS$$
$$SV\% = (SV/BCWS) \times 100$$

CV   **Cost variance** – the cost comparison of what has been earned with what has been spent:
$$CV = BCWP – ACWP$$
$$CV\% = (CV/BCWP) \times 100$$

VAC   **Variance at completion** – the cost comparison of the budget at completion with the current estimate at completion:
$$VAC = BAC – EAC$$
$$VAC\% = (VAC/BAC) \times 100$$

SPI   **Schedule performance index** – an indication of how far behind or ahead of the planned work the project is (in terms of the value of the work accomplished); it tends towards 1.0 as the project progresses. It is of less value as the project nears completion:
$$SPI = BCWP/BCWS$$

CPI   **Cost performance index** – the index of earned value to actual costs. Below 1.0 is unfavourable; above 1.0 is favourable:
$$CPI = BCWP/ACWP$$

In addition to these variances being shown on a cumulative spend graph, the indices can also be plotted cumulatively through the life of a project to show improving (or worsening) performance.

6.2 The difference between schedule status and earned value progress

It is essential to update the status of schedules in a timely manner to gain an objective understanding of the achievement of milestones and deliverables, and to monitor how task dependencies are affected by any task movement.

When updating the schedule status, the following should be considered:

- activity actual start/finish dates;
- estimate of time remaining to complete the task;
- estimated start and finish dates for future activities.

Schedule status may then be determined by comparing how much time the activity is ahead of or behind the baseline schedule.

The following aspects of schedule assessment may be performed at both detail and project level:

- review of the critical path activities;
- review of schedule against key milestone forecasts;
- review of future resource requirements.

6.3 Typical earned value reports, graphs and progress charts

6.3.1 Reporting graphs

Figure 14 demonstrates the performance of a project using the earned value data elements. It provides a quick view of project status and prevailing trends. It may be used as a basis for forecasting the project end conditions. It can also include, if required, the EAC and the forecast completion date for the previous reporting periods.
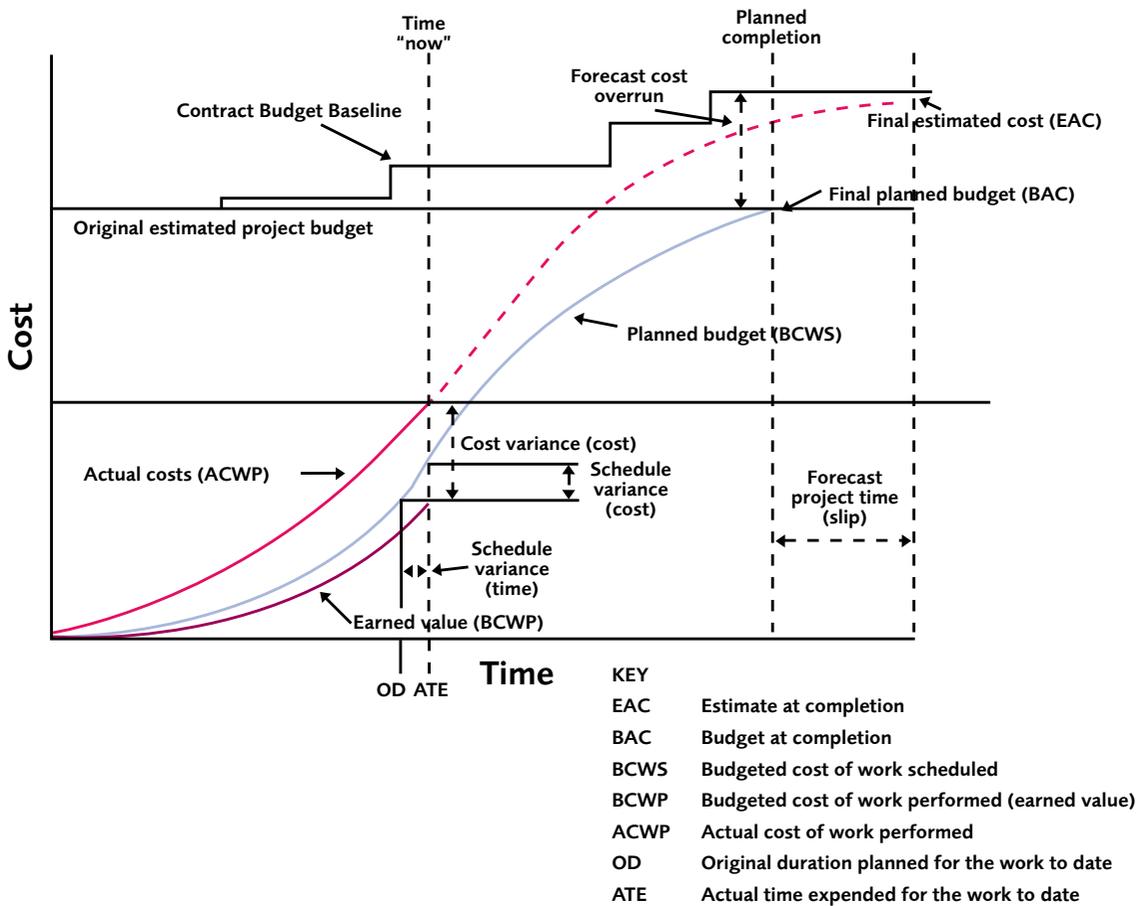
Figure 14: EV graph including trend analysis
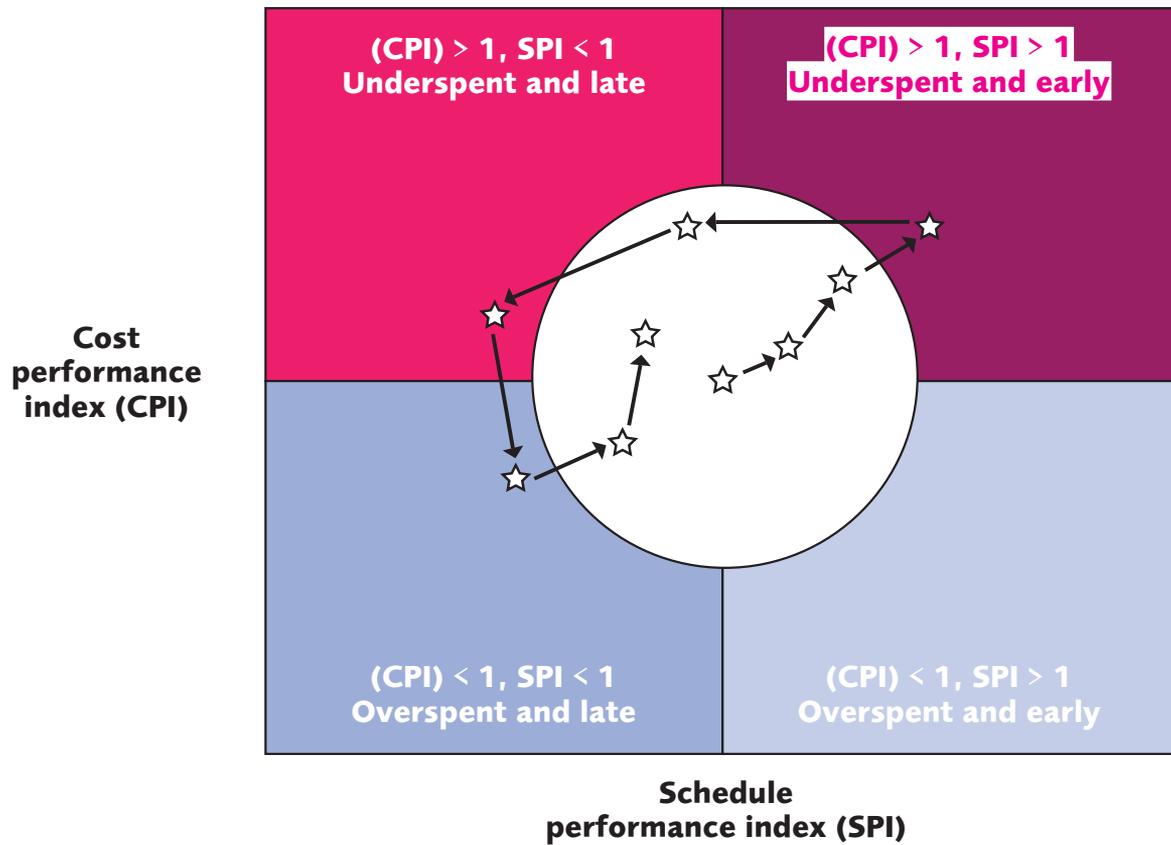Taken from the *Earned Value Management: APM Guidelines* (2008)

Figure 15: Bulls-eye chart
Taken from the *Earned Value Management: APM Guidelines* (2008)

6.3.2 Performance trend charts

The bulls-eye chart (Figure 15) shows the change in schedule performance index and cost performance index at each reporting period. The graph gives a summary view as to whether performance is improving or deteriorating and whether the variances are outside the agreed thresholds. The central circle shows the maximum variance thresholds. The CPI and SPI are plotted on the graph at each reporting cycle in the project.