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Earned value management in project and programme management

Management de la valeur acquise en management de projet et de programme

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 258, *Project, programme and portfolio management*.

Introduction

The purpose of this document is to provide guidance to those individuals involved in earned value management. It describes practices to provide benefits for project or programme planning and control.

This document provides guidance on concepts, responsibilities, integration and processes for the implementation of earned value management.

It provides information on performance metrics captured by an earned value management system.

It complements ISO 21500 and ISO 21503.

The target audience of this document includes, but is not limited to, the following:

a) executive managers and those individuals involved in sponsoring projects or programmes;

b) individuals managing projects, programmes or earned value management systems;

c) individuals involved in the management of or performance of project management offices or project or programme control staff;

d) developers of national or organizational standards.

The application of this document may be tailored to meet the needs of any organization or individual, so they may better apply the concepts and practice of earned value management.

Earned value management in project and programme management

1 Scope

This document provides guidance for practices of earned value management in project and programme management. It is applicable to any type of organization including public or private and any size or sector, as well as any type of project or programme in terms of complexity, size or duration.

This document provides the following:

a) terms and definitions;

b) descriptions of the purpose and benefits of earned value management;

c) the integration and relationship with project or programme management;

d) an overview of the processes and process descriptions;

e) basic requirements for an earned value management system;

f) use of an earned value management system.

It does not provide guidance on the use of specific processes, methods or tools in the practice of earned value management.

Annexes A, B and C describe cost, schedule and performance analysis, commonly used formulae with associated interpretations, and the integration of earned value with other project or programme management processes.

2 Normative references

There are no normative references in this document.

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at https://www.iso.org/obp

3.1.1
activity
identified piece of work that is required to be undertaken to complete a project or programme

Note 1 to entry: It may also be considered a work element.

3.1.2
actual cost
cost incurred for work performed

Note 1 to entry: Actual cost is also known as "actual cost of work performed".

3.1.3
budget at completion
total forecasted cost for accomplishing the work related to a *work package* (3.1.19), *activity* (3.1.1) or *control account* (3.1.4)

3.1.4
control account
management control point where scope, budget, *actual cost* (3.1.2) and schedule of a project or programme, *work package* (3.1.19) or *activity* (3.1.1) are integrated

3.1.5
earned value
value of completed work expressed in terms of the budget assigned to that work

Note 1 to entry: Earned value is also known as budgeted cost of work performed.

3.1.6
earned value management
method that integrates project or programme scope, actual cost, budget, and schedule for assessment of progress and performance

3.1.7
estimate at completion
forecasted total cost to accomplish the work on project, programme, *work package* (3.1.19) or *activity* (3.1.1)

3.1.8
estimate to complete
forecasted cost of the work remaining of a project, programme, *work package* (3.1.19) or *activity* (3.1.1)

3.1.9
integrated baseline review
assessment to establish a common understanding of the *performance measurement baseline* (3.1.13) for verification of the technical content of the project or programme

3.1.10
management reserve
amount of budget external to the *performance measurement baseline* (3.1.13), withheld for management control in response to unforeseen events or activities that are a part of the scope

3.1.11
network schedule
graphical representation indicating the logic sequencing and interdependencies of the work elements of a project or programme

Note 1 to entry: Network schedule is also known as a "network schedule diagram", "logic diagram" or "network logic diagram".

3.1.12
performance measurement
quantitative units of measure that are placed to track progress

3.1.13
performance measurement baseline
total time-phased scope of work and budget plan against which project or programme performance is measured, not including *management reserve* (3.1.10)

3.1.14
planned value
time-phased budget (3.1.16) authorized for the work scheduled

Note 1 to entry: Planned value is also known as budgeted cost of work scheduled.

3.1.15
technical performance
measure of the results of functionalities or capabilities achieved for the project or programme during implementation

Note 1 to entry: It may be incremental.

3.1.16
time-phased budget
allocation of the cost to accomplish the work over established periods of time or phases

3.1.17
undistributed budget
cost for authorized work that has not been distributed to a *control account* (3.1.4)

3.1.18
work breakdown structure
decomposition of the defined scope of the project or programme into progressively lower levels consisting of elements of work

3.1.19
work package
one or more groups of related activities that are within the *control account* (3.1.4)

3.2 Abbreviated terms

The following abbreviated terms are used in this document.

AC	actual cost
BAC	budget at completion
EAC	estimate at completion
ETC	estimate to complete
EV	earned value
EVM	earned value management
IBR	integrated baseline review
MR	management reserve
PMB	performance measurement baseline
PV	planned value
UB	undistributed budget
VAC	variance at completion

4 Overview of earned value management

4.1 Earned value management

Earned value management is a structured method used to provide a performance measurement system for review of past and forecasted performance of a project or programme.

Earned value management is a method of performance management. Performance management should provide for the planning, implementing and controlling of the performance of a project or programme in accomplishing the scope of work of the project or programme.

4.2 Purpose and benefits of earned value management

The purpose of earned value management is control and analysis of the project or programme. Earned value management facilitates analysis and decision-making for, but not limited to budget, schedule, human resources and materials.

The earned value management system may include communication of the status from metrics established for the project or programme, improvements, corrective action development, and a common framework and vocabulary.

An earned management system is a set of procedures, tools and methods for establishing and maintaining project or programme control.

The application of earned value management should result in three overall benefits:

a) developing objective measurement techniques;

b) availability of data for project or programme management decisions;

c) providing a system to monitor the project or programme.

Specific benefits may include, but are not limited to, the following:

— forecasting of future performance and estimate at completion based on past performance;

— objective metrics for comparison of project or programme performance across an organization and between or among organizations;

— development of budgets and baselines;

— compilation of estimates;

— objective measurement of completion of work packages that is done in a consistent manner;

— comparison of work performed against actual performance and budget;

— highlighting of inconsistencies in the measures in earned value reports;

— consistency of the reporting and performance measurement framework by regular earned value reporting.

4.3 Guidelines for an earned value management system

An earned value management system should provide for consistent performance metrics. To achieve a consistent view of performance metrics, the system should integrate the baselines established for the project or programme including the scope of work that should be defined through the work breakdown structure, and performance measurement baseline. The system should also allow for formal, controlled incorporation of changes in baselines, authorized users and procedures.

To implement an earned value management system, the project or programme control metrics and processes should be documented and understood in the organization or organizations doing the work. The system should be established to allow systematic review of the data, common assessment methodologies, targeted levels of performance, and an assessment feedback process. The system may be able to be tailored to accommodate different project or programme subject area integration, more than one organization reporting, and other tailoring as deemed necessary to control the project or programme or provide an integrated programme view.

The core data contained in an earned value management system should be the earned value, actual cost, the planned value, estimate to complete, and budget at completion. The earned value management system should be able to show the planned status, as well as the actual status of the project or programme.

To implement an earned value management system, the system requires a common agreement on the assignment of "value" and "performance", which may be tailored for projects or programmes based on organizational considerations.

The review of metrics of performance should be accomplished on a regular, scheduled basis to allow for comparison and analysis of performance.

An earned value management system should be able to do the following:

a) determine what work is to be accomplished, by whom and when;

b) establish resource requirements;

c) measure work achievement and record associated costs;

d) report deviations from the plan for which metrics have been established;

e) forecast the completion date and cost;

f) plan and implement corrective and preventive action plans;

g) authorize scope changes; any approved changes to the prior approved baselines contained in the earned value management system should be controlled, traceable and documented.

4.4 Earned value management planning

Earned value management planning should enable:

— establishing project or programme objectives, as well as the integrated view of the planning of the overall projects or programmes,

— monitoring of project or programme progress to measure deviations from the plan, and

— planning by the users of the performance management system for project or programme, objective assessment of progress and use of resources.

4.5 Using earned value measurements and performance metrics

Earned value measurements should be used to determine performance metrics to assess the status of a project or programme at a selected point in time. These metrics should enable informed decisions about the management of the project or programme. The metrics derived may be used to compare actual project or programme cost and schedule performance with the performance measurement baseline. The performance measurement baseline should be used to establish variance thresholds for cost and schedule that when exceeded identify significant variances for further analysis and management attention.

The information acquired by using the earned value performance measurements should be used to determine:

— progress of a project or programme,

— progress towards work accomplished,

— completion of the deliverables, and

— progress towards delivery of a project or programme.

These measurements, combined with the agreed upon variance threshold, should be used to determine the cost and schedule variances, and cost and schedule performance indices.

The information should also be used to forecast future performance of the project or programme. The data to establish a project or programme performance forecast, based on historical performance, should include, but are not limited to, the following:

a) estimate to complete;

b) estimate at completion;

c) variance at completion;

d) to complete performance index.

The information gathered in calculating these values should be captured in an earned value management report.

NOTE See Annex B for the parallel application of earned schedule.

5 Earned value management process steps

5.1 General

The earned value management process steps are shown in Figure 1.

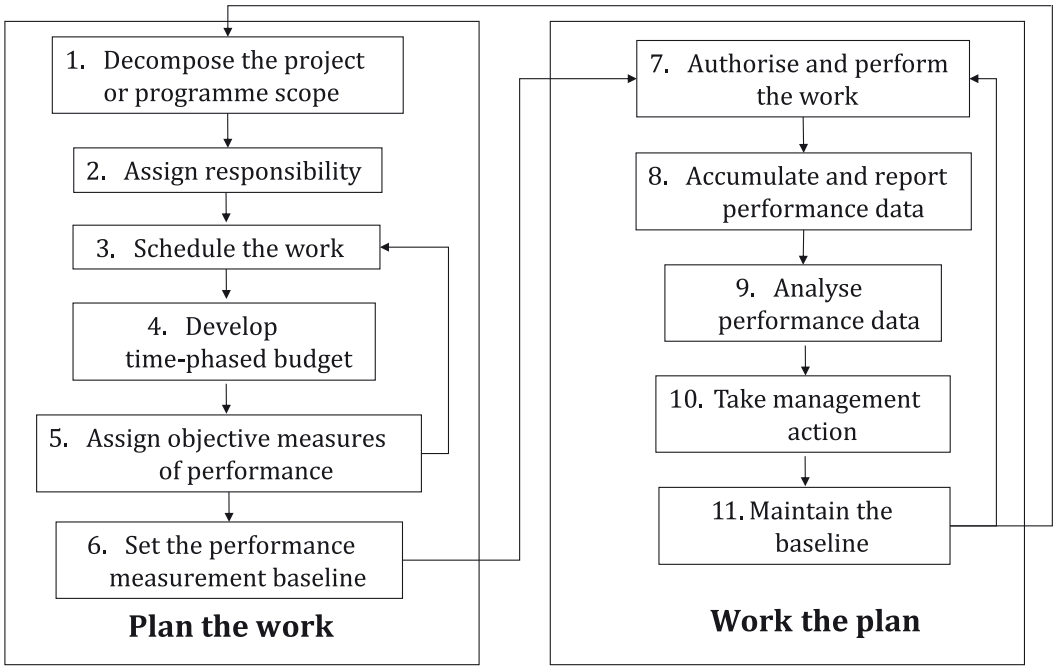


Figure 1 — Earned value management process steps

The earned value management process steps should consist of the steps described in 5.2 to 5.12.

5.2 Step 1: Decompose the project or programme scope

Generally, the entire project or programme scope of work should be decomposed into manageable elements using the following guidelines:

a) project or programme scope should be decomposed into a work breakdown structure;

b) work breakdown structure should include the entire scope of work for the project or programme;

c) scope of work elements in the work breakdown structure should be mutually exclusive.

The characteristics of a work breakdown structure necessary to apply earned value management should be as follows:

— complete, ordered, and logical decomposition of the work breakdown structure is key to earned value management, as well as the integration of other elements of project or programme management, such as technical control, and schedule management;

— work breakdown structure should be developed to the level needed to manage the project or programme as well as utilized for work authorization, tracking and reporting;

— identifying at each level the appropriate managers or those individuals identified for the project or programme should be responsible for the required reports.

5.3 Step 2: Assign responsibility

Responsibility should be assigned using the following guidelines:

a) performance responsibility should be assigned for each element of work and the project or programme in total;

b) management responsibility should be clearly defined;

c) internal managers within the organization should be assigned the responsibility for work to be performed externally.

Responsibility should be assigned for the performance of each work element decomposed in the work breakdown structure. The point at which the integration of the organizational breakdown structure and the work breakdown structure occurs should be the control account. The individual responsible for the control account should be the control account manager.

5.4 Step 3: Schedule the work

A schedule for the work, which identifies activities, durations, milestones and interdependencies at an appropriate level, should be the basis for earned value determination and should be created using the following guidelines:

a) activities should be identified at or below the level of the work breakdown structure elements;

b) decision points determined to be significant, constraints, and interfaces should be identified as major milestones;

c) authorized work should be scheduled to define the sequence of work;

d) required activity and milestone interdependencies should be identified that are necessary to meet the requirements of the project or programme;

e) defined deliverables, milestones, technical performance goals, or other objective measures of performance should be clearly identified and used as indicators of performance.

Elements of the work should be scheduled in a logical sequence that identifies durations, activities, milestones and interdependencies. In projects or programmes involving several layers of schedules, the schedule should be vertically and horizontally traceable, see Figure 2. In other words, work should be traceable throughout the project or programme to each level of the schedule consistent with the level of planning.

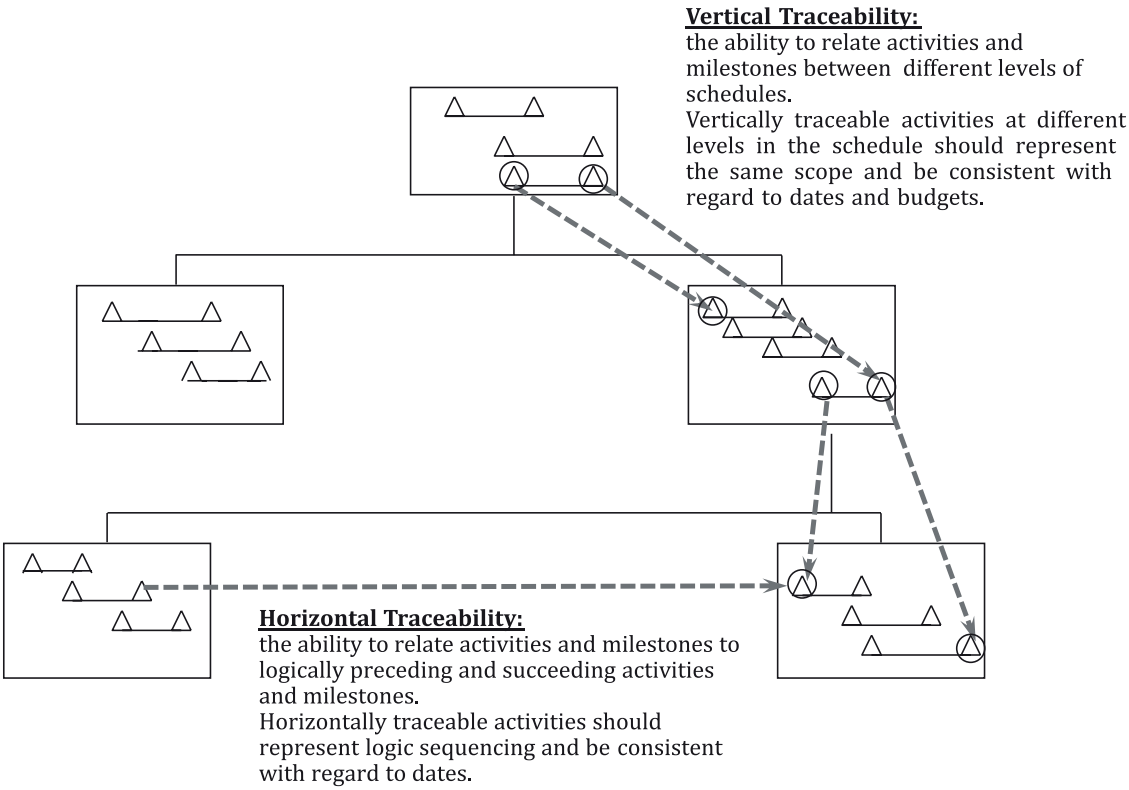


Figure 2 — Detailed schedule — Vertical and horizontal traceability

The logical relationship between activities should be established and maintained throughout the project or programme. As developed and approved, the schedule should be used by management to plan and monitor the work performed on the project and related programme, if one exists. The schedule or schedules should provide a means for evaluating actual progress against pre-defined objectives.

Activities and milestones within one project or across projects may be linked with dependencies. The network schedule should allow the critical path and the float to be determined for activities and milestones.

A schedule should be established at the activity level to provide the basis for assigning resources and developing the time-phased budget.

5.5 Step 4: Develop time-phased budget

Budgets should be assigned to work breakdown structure elements and may separately identify labour, material, subcontract or other costs. By assigning budget to work planned in a schedule, the budget becomes time-phased.

For work not yet planned in detail, budget, including undistributed budget, should be time-phased over the expected period of performance of the work.

An additional budget may be set aside for management reserve for any unanticipated activities that are within the scope of the project or programme.

The time-phased representation of the total planned value for all work breakdown structure elements, including the undistributed budget, is defined as the performance measurement baseline. The performance measurement baseline should represent the formally authorized plan.

The total budget at the completion of an activity, work breakdown structure element for a project or programme is termed the budget at completion for that activity or work breakdown structure element. The budget at completion of the performance measurement baseline plus management reserve should be equal to the project or programme budget.

Resources should be assigned to activities using the cost of such resources to determine the time-phased budget for the project or programme using the following guidelines:

a) activities should have budget values assigned, which are expressed in terms of currency, labour hours or other measurable units;

b) budgets assigned to activities should be distributed over the duration of the activities;

c) budgets assigned to the scope of work, not yet planned in detail, should be distributed over the project or programme to reflect the expected outcome;

d) management reserve budgets, which are clearly designated, may be created that are not assigned to specific activities or scope;

e) management reserve should not be included in the performance measurement baseline and budget at completion.

5.6 Step 5: Assign objective measures of performance

The objective measures used to measure work performance should be specified using the following guidelines:

a) accomplishment of an activity should be expressed in terms of the budgetary value or earned value of the activity;

b) objective measures of performance should be used to quantify the degree of completion of activities;

c) earned value of a completed activity should always equate to the amount budgeted for the activity;

d) objective measures of work performance should be agreed upon prior to the commencement of each work package and should not be changed once work has started on the work package;

e) objective measures of performance should be planned in the same manner in which they are to be assessed and should be assessed in the same manner in which they are planned;

f) objective measures of performance should be established in such a manner that value is earned and actuals are accumulated in a consistent manner and in the same time frame;

g) one measure of performance only should be used per work package.

Objective measures of performance should be established to determine accomplishment of in-progress activities. This document does not specify any particular objective measure to be used. The selection of the measure should depend on activity content, size, and duration. The measuring of earned value should be calculated using the same method as stated in the approved plan. The resulting metric is referred to as the earned value. Objective measures should allow work achievement to be measured in a clear and unequivocal way. Setting the objective measures in advance should enhance accountability and objectivity.

Performance measurement should be accomplished by assigning a specific earned value technique to each activity. The technique used should be dependent on the nature and duration of the work. Where possible the objective measures of performance established in step 3 (5.4) should be used as a basis for the earned value technique assigned.

Performance can be measured in terms of currency, labour hours or other measurable units. The performance measurement indicators, such as a milestone, should be scheduled with sufficient frequency to provide a basis for accurate performance measurement. Additionally, performance measurement should occur consistently within documented time intervals.

5.7 Step 6: Set the performance measurement baseline

The performance measurement baseline should be logically constructed and correlated to the available project or programme resources. Prerequisites to establishing the performance measurement baseline may include, but not be limited to, the following:

a) project or programme deliverables have been accounted for within the scope of work;

b) integration roles and responsibilities for each major deliverable have been assigned and are clearly visible;

c) budgets for activities are validated to be as realistic as possible;

d) management commitment to the baseline costs, schedule and scope targets are acknowledged;

e) activities have been assigned resources that actually carry out the work or are needed to complete the work.

The planning parameters determined in earlier steps should be formally established as the performance measurement baseline for the project or programme using the following guidelines:

— work scope of individual work breakdown structure elements and the project in total should be identified and recorded;

— work scope of the individual work breakdown structure elements should be integrated with each other and consistent with the overall project or programme objectives;

— schedule of the individual activities and project or programme in total should be developed and recorded;

— schedule of the individual activities should be integrated with each other and consistent with the overall project or programme objectives;

— budgetary values of the individual work breakdown structure elements and the project in total should be developed and recorded and the association between an element and its budget should not be varied except through a formal baseline maintenance or baseline change control procedure, see step 11 (5.12);

— work breakdown structure, scope of work, schedule, and budget for each activity and the time-phased budget, when integrated with each other and approved by the project manager, programme manager or other designated authority, becomes the performance measurement baseline and is subject to formal change control, see step 11 (5.12).

The baseline should provide the reference points against which actual project or programme progress should be compared. The baseline should include the best estimates for activity duration, scheduling, resource allocation, costs, and the other project or programme variables deemed necessary to be monitored.

5.8 Step 7: Authorize and perform the work

In order for the project or programme manager to exercise proper control, the commencement of work should be authorized. The work authorization should identify the following:

a) what is to be done;

b) who is to do it;

c) when it is to be done;

d) amount of resources budgeted;

e) acceptance by the person responsible for work.

Work to be undertaken should be formally authorized using the following guidelines:

— source of authority for commencement of work should be identified and documented;

— work should be planned before it is authorized;

— work should be authorized to be commenced in the manner in which it was baselined;

— authorization should identify responsibility for performing the activity and the methods for accumulating the performance.

5.9 Step 8: Accumulate and report performance data

The accumulation of performance data refers to budgeted costs, earned value, actual costs and estimate to complete. It should also include the accumulation of scheduling data, identifying the status of scheduled activities with forecasted completion dates for current activities, and forecasted start and completion dates of future activities.

Additional metrics may be utilized to assist in performance analysis where the means of computation is definitively established. Examples of such performance metrics are outlined in Annexes A and B, along with conventional formulae.

The point of accumulation of actual cost should be at the level that identifies the cost elements and factors contributing to cost variances. Actual cost should be recorded consistent with the budget elements and include resource expenditures.

The performance data should be aggregated up through the work breakdown structure that allows for traceability of higher-level element variances to the source work breakdown structure elements at a more detailed level.

Performance data reports should be extracted from accumulated data to enable those individuals responsible for the work to analyse current project performance. The estimate at completion provided with that data should represent the current value held in the system, which should be updated following performance analysis.

The reporting period should be chosen in accordance with the overall duration of the project or programme requirements and management reporting requirements.

Schedule progress, earned value and actual cost for each activity should be recorded and accumulated to report performance, as appropriate using the following guidelines:

a) current schedule should be progressed to show achievement and to provide a forecast of completion dates and resources for scheduled work;

b) earned value for an activity should be accumulated for subsequent comparison with the planned value for the activity;

c) actual cost recorded should include the cost incurred for the work accomplished;

d) actual costs incurred in the performance of the activity should be accumulated for subsequent comparison with the earned value for the activity;

e) planned value, earned value, actual cost, schedule, budget at completion and estimate to complete should be logically summarized through the project decomposition to represent the status of the individual activities and the project in total;

f) performance data should be accumulated on a consistent and periodic basis with common date criteria;

g) performance reports, at the previously agreed summary reporting level, should be distributed to designated management levels on a consistent and periodic basis.

5.10 Step 9: Analyse performance data

Performance measurement should be used on a consistent and periodic basis. Measurement and analysis should be undertaken at the level at which responsibility has been assigned. In more complex projects or programmes, measurement and analysis may entail several layers of management or several levels of the work breakdown structure.

Project and programme performance data should be analysed and estimates at completion should be developed using the following guidelines:

a) earned value for activities and work breakdown structure elements should be compared with the corresponding planned value to determine the schedule variance;

b) schedule progress should be compared with the baseline schedule to determine slippages, forecast dates, changes to the critical path, and remaining float for network schedules;

c) earned value for activities and work breakdown structure elements should be compared with the corresponding actual cost to determine the cost variance;

d) cost variance and schedule variance should be analysed to determine the cause and impact on the project or programme:

   1) if the variance is within the accepted established tolerance for the project or programme, a decision should be made as to whether any corrective action should be required;

   2) if the variance is outside the accepted established tolerance for the project or programme, corrective action should be considered;

e) estimates at completion should be routinely developed and updated based on past trends and current knowledge and compared with the corresponding budget at completion to identify the magnitude of the variance at completion;

f) forecasts of dates at completion should be routinely developed and updated based on past trends and current knowledge, for comparison with the planned completion dates;

g) usage of management reserve should be analysed to enable forecasts of future availability and usage.

Where required, project or programme status reporting to internal stakeholders within the organization or external stakeholders should follow the analysis of the current performance data and include the results of that analysis.

5.11 Step 10: Take management action

Management action should be undertaken, as required, to compensate for current variances or rectify projected variances from baseline. Variances may arise from poor planning, unforeseen scope changes, technical problems, equipment failures or other external factors such as supplier difficulties.

Corrective actions should require either a change in the baseline plans or the development of a short-term recovery plan that should be incorporated in the forecasts. Changes to planning should only be accomplished prospectively. Baseline re-planning may include the application of management reserve to future activities for performance tracking purposes.

The following guidelines should be used to determine management actions:

a) required corrective action should be determined based upon the source and cause of the variance;

b) corrective action plans should be developed and implemented based on analysis of the identified cost, schedule and projected deviations from the baseline;

c) forecasts should be revised based on approved corrective actions and baselines should be changed, as deemed necessary and which have been approved in accordance with baseline maintenance procedures and processes;

d) retroactive changes to cost, schedule or technical plans should not be enacted, except under limited conditions (see 5.12);

e) corrective action plans should be reported during subsequent periods of the project or programme.

5.12 Step 11: Maintain the baseline

Changes to the baseline planning may originate through the identification of unforeseen scope changes, resource requirements, resource constraints or direction from other stakeholders with decision making authority.

The introduction of approved changes to the baseline should be managed and tracked using the following guidelines:

a) changes to the baseline planning are accomplished only with associated approved changes to the scope of work, schedule or budget of the project or programme components;

b) changes to the baseline should be documented and traceable;

c) retroactive changes to baseline schedule, cost or scope of work should not be made.

Certain elements of the work may need to be re-planned based upon unforeseen requirements or scope changes to the project or programme components. Such changes are internal re-plans and may reflect the refinement of work through stages of undistributed budget, control accounts, work packages and activities. Such planning should follow the processes described in steps 3 to 5, which should be applied iteratively until developed and incorporated as a formal change to the baseline.

Due to the importance of maintaining a valid performance measurement baseline, re-planning should be accomplished within

— proper authority,

— systematic and timely manner,

— control, and

— adequate, appropriate and visible documentation.

Maintenance of the performance measurement baseline should be required to enable that baseline changes are correctly recorded. The maintenance of the performance baseline should also enable it to be examined to determine causes and potential impact on completion dates and costs, as well as impacts on other aspects such as risk and quality. Accordingly, changes to the baseline should be documented and approved, to maintain auditability including the use of management reserve and the distribution of undistributed budget. In order to maintain the integrity of the performance measurement baseline, the project or programme manager should not transfer scope of work or budget independently of one another.

6 Earned value management system review

6.1 General

Once an earned value management system is established, the project or programme sponsor, or their representative with knowledge of earned value management systems, should review the system to

determine that it meets organizational requirements and is compliant with an adopted standard or organizational procedure. A review may be demanded and conducted by a customer, an auditor or by the organization. Other reviews, internal or external, may be required.

The earned value management system reviews should provide confirmation that the scope of work has been accounted for, quantified in terms of cost and schedule with the necessary structures for project or programme control.

Earned value reviews should provide the following benefits, including but not limited to:

a) confirm that earned value management system is compliant to the adopted standard;

b) confirm the integration of project or programme component scope of work, time, and cost for measurement and control;

c) confirm consistency for an integrated system of the project or programme;

d) confirm a fixed cut-off point to conclude the planning phase;

e) confirm pre-planned checkpoints for reliable performance data;

f) reduce risk;

g) enable lessons learned from previous and current projects or programmes to be captured;

h) confirm a tool to use for performance measurement.

6.2 Integrated baseline review

An integrated baseline review is a process conducted to assess the content and integrity of the performance measurement baseline. The integrated baseline review should confirm the establishment of the integrated scope, cost and schedule baselines. The integrated baseline review should enable the determination of the credibility, sufficiency, and adequacy of the planning, and should verify that activities are integrated with each other.

The overall purpose of the integrated baseline review is to approve the performance measurement baseline. The review should also enable the project sponsor and customer to understand the risks to project or programme execution.

An integrated baseline review should be conducted after the project or programme has gone through at least one reporting cycle to provide project data. The review should include work performers, project or programme personnel, customer personnel and other stakeholders, as determined to be critical to the successful achievement of the project or programme objectives.

6.3 Demonstration review

A demonstration review of the earned value management system may be conducted to validate the system, as well as whether it meets the organizational earned value management governance and guidelines. A demonstration review should be a review of the total system with emphasis on the system operations. The earned value management system should be reviewed completely for conformity against the earned value management criteria adopted by the organization.

The review should also consist of a review of the data and related earned value management reports. The review should cover functional areas that play a role in operating the system, such as finance and project or programme controls and the performing project or programme management team.

In a demonstration review, the earned value management system should be assessed against the organizational earned value management guidelines.

The demonstration review report should be written based on the five guideline groups:

a) organization;

b) planning, scheduling and budgeting;

c) accounting;

d) analysis and management reports;

e) changes and data maintenance.

The demonstration review report should highlight where the system is working well and address the system deficiencies.

6.4 Surveillance

To confirm that standards are being maintained, periodic surveillance should be conducted throughout the remainder of the project or programme.

Surveillance of the earned value management system should provide, but is not limited to, the following:

a) timely and reliable cost, schedule and technical performance information;

b) conformity with adopted earned value management guidelines;

c) timely indications of actual or potential issues;

d) maintenance of the performance measurement baseline integrity;

e) information that depicts actual conditions and trends;

f) comprehensive variance analysis at the appropriate levels, including proposed corrective actions with regard to cost, schedule and technical performance, and other issues.

Annex A
(informative)

Cost and schedule performance measurement analysis using earned value management data

A.1 General

Analysis of performance metrics is an important approach to measure and understand current period and overall project or programme performance. Use of performance metrics should allow corrective and preventive actions to be implemented, thereby improving the use of the earned value management system data.

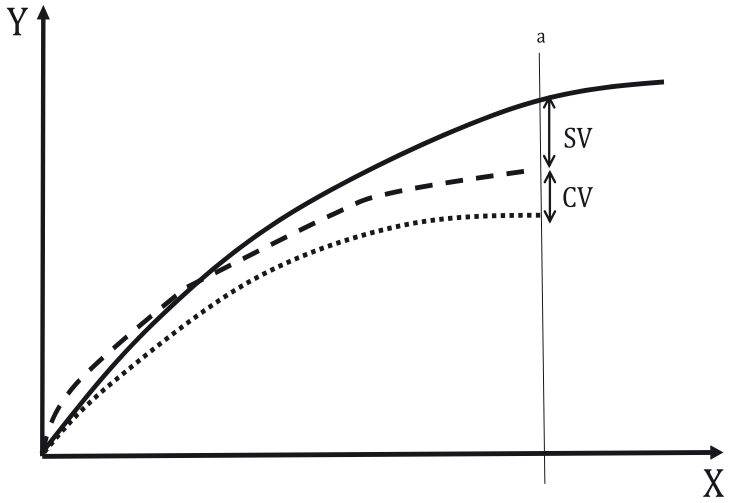
A.2 Performance measurement indicators and predictors

In order to understand performance measurement analysis, it is important to know the metrics of indicators and predictors earned value uses. Table A.1 summarizes the key earned value cost performance indicators and predictors.

Table A.1 — Key earned value indicators and predictors

Key indicators	Cost variance	CV	CV = EV − AC
	Schedule variance	SV	SV = EV − PV
	Cost performance index	CPI	CPI = EV / AC
	Schedule performance index	SPI	SPI = EV / PV
	Variance at completion	VAC	VAC = BAC − EAC
Predictors	To complete cost performance index	TCPI	TCPI = (BAC − EV) / (BAC − AC) where the future required cost performance is being compared to the budget at completion (BAC); and TCPI = (BAC − EV) / (EAC − AC), where the future required cost performance is being compared to a cost estimate at completion (EAC).
	Independent estimate at completion NOTE 1 In EVM, IEAC (independent estimate at completion) are calculated values. NOTE 2 In EVM, EAC is a project manager's estimated value.	IEAC	IEAC = BAC / CPI Or the long form formula where IEAC = AC + (BAC − EV) / PF where PF is a cost related performance factor (for example CPI, SPI or CPI and SPI used in combination, i.e. CPI x SPI)

Figure A.1 depicts cost and schedule variance indicators in relation to planned value, earned value and actual cost.



Key

———	planned value (PV)	CV	cost variance
– – –	earned value (EV)	SV	schedule variance
.....	actual cost (AC)		
X	time		
Y	currency		
a	Status date.		

Figure A.1 — Cost and schedule variance

A.3 Cost performance measurements

A negative cost variance and cost performance index of less than one indicates an unfavourable over-budget condition, as the earned value accrued is less than the costs incurred to achieve. Conversely, a positive cost variance and cost performance index greater than one indicates an under-spend condition.

Significant negative or positive cost variances should be investigated to determine the causes and should initiate discussions as to whether to implement corrective and preventive actions to prevent further deterioration and implement possible cost recovery.

The cost performance index is a ratio that provides a measure of the cost efficiency achieved by the project to date. The "to complete cost performance index" is a forward-looking predictor that calculates the future cost efficiency required to achieve specific cost objectives at project or programme completion. The usual cost objectives analysed should be the project or programme approved budget at completion, and if different, the project or programme manager's claimed cost estimate at completion.

The independent estimate at completion is a predictive measure that calculates predicted completion costs based on the historic performance of the project to date. Using the cost performance index, schedule performance index or both indices in combination as performance factors, one should produce a range of calculated completion cost outcomes. These outcomes may be used to assess the likelihood of the project or programme achieving the approved budget at completion, and the project or programme manager's claimed cost estimate at completion.

NOTE The comparison between cost performance and plan may occur at various levels from work package, to control account, or to project or programme.

A.4 Schedule performance measurements

The traditional earned value schedule performance measurements are also cost based measures that compare the volume of work performed to the volume of work planned. A negative schedule variance and schedule performance index of less than one indicates an unfavourable behind schedule condition, subject to confirmatory analysis of the network schedule, as the volume of work accomplished, earned value accrued, is less than the volume of work planned, planned value. Conversely, a positive schedule variance and schedule performance index greater than one may indicate an ahead of schedule condition, subject to confirmatory analysis of the project network schedule.

Significant schedule variances should be investigated to understand the causes and to implement corrective and preventive actions. Analysis of the earned value schedule metrics should be undertaken in conjunction with analysis of the network schedule, which remains the primary source of time-based information. The critical path impact of negative earned value schedule variances should be analysed in conjunction with the network schedule.

The predictive utility of the schedule variance will be lost in the final third of the project. As the project or programme gets closer to completion the schedule variance of the project or programme moves closer to zero, otherwise known as reversion to zero.

A.5 Additional benefits of performance measurement analysis

Performance measurement analysis contributes to trend analysis over time; to highlight trends in cost over- or under-run; and be superimposed with contracted cost outcomes, risk confidence limits and benefit realization data to provide a more comprehensive picture of overall project or programme cost performance.

Large, early, unfavourable schedule variances, irrespective of cost performance, may be a reliable warning of a project experiencing significant performance issues that should be investigated with a view to determining the causes and implementing corrective and preventive recovery actions.

Annex B
(informative)

Schedule analysis using earned value management data (earned schedule)

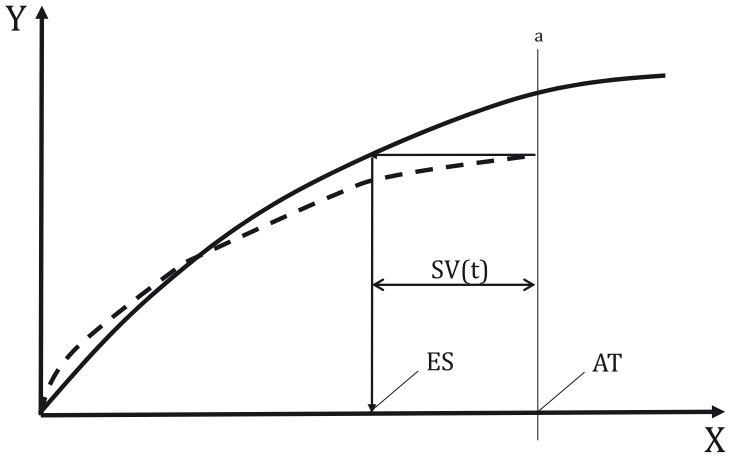
B.1 Earned schedule

Earned schedule is an extension of earned value management. Earned schedule, which calculates schedule metrics and indicators on the time axis, rather than on the cost axis traditionally utilized by the earned value management schedule metrics.

The basis of earned schedule is to identify the time increment at which the amount of earned value accrued should have been earned. The time increment can be any selected unit of accrual for the earned value, such as week or month or any other time period.

Once this value has been determined, a series of time-based metrics can be calculated as shown in Table B.1 which emulates the earned value cost based counterparts. As shown in Figure B.1, the earned schedule metric, schedule variance [time] should be calculated by reference to actual time that is the time increment at the project or programme status date.

Actual time is an unconstrained measure, in the same way as actual cost. The earned schedule metrics should be reliable for both early and late finish projects or programmes, as schedule variance only equals zero and schedule performance index only equals one at project or programme completion, if on-time completion has actually been achieved. Analysis of the earned schedule metrics should be undertaken in conjunction with analysis of the network schedule, which remains the primary source of time-based information.



Key

———	planned value (PV)	ES	earned schedule
– – –	earned value (EV)	AT	actual time
X	time	SV(t)	schedule variance [time]
Y	currency		
a	Status date.		

Figure B.1 — Earned schedule calculation

B.2 Earned schedule prerequisites

The initial prerequisite for earned schedule is an earned value management system that produces the time-phased planned value or performance measurement baseline and earned value data needed to calculate the earned schedule metrics. Since earned schedule does not require actual cost data, the method may be used in less mature organizational environments.

The application of earned value management at the lower levels of the work breakdown structure should facilitate the extended application of earned schedule. This application includes the capability to drill down into the specific areas allowing implementation and monitoring of corrective actions being undertaken. Management by exception for schedule analysis is also facilitated.

B.3 Using earned schedule performance measurements

Use of the earned schedule performance measurement metrics has a benefit of enabling a cross-check to the critical path to ascertain the actual schedule status.

A negative schedule variance [time] and schedule performance index [time] of less than one indicates a behind schedule condition. A positive schedule variance [time] and schedule performance index [time] greater than one indicates an ahead of schedule condition. Earned schedule metrics and indicators can be used for the entire duration of the project, including for late finishing projects and programmes.

While earned schedule at the total project or programme level does not account for the critical path, the earned schedule measures and metrics can be calculated by creating planned value and earned value S-Curves of the critical path activities, including completed activities.

Comparison and analysis of the total project and critical path earned schedule metrics can be used to assess whether the critical path activities are being properly prioritized. When the independent estimate at completion [time] for "total project" is greater than the independent estimate at completion [time] for "critical path", the comparison may be evidence of a change in the critical path. Analysis of the network schedule should be undertaken to ascertain the actual critical path.

Earned schedule can also contribute to trend analysis over time; to highlight trends in milestone slippage; and, be superimposed with contract delivery deadlines, risk confidence limits and benefit realization data to provide a more comprehensive picture of overall project or programme schedule performance.

B.4 Earned schedule terminology and formulae

Table B.1 — Earned schedule and corresponding earned value terminology

	Earned value management	**Earned schedule**
Status	Earned value (EV)	Earned schedule (ES)
	Actual costs (AC)	Actual time (AT)
	Schedule variance (SV)	Schedule variance [time] (SV(t))
	Schedule performance index (SPI)	Schedule performance index [time] (SPI(t))
Future work	Budgeted cost for work remaining (BCWR)	Planned duration for work remaining (PDWR)
	Estimate to complete (ETC)	Estimate to complete [time] (ETC(t))
Prediction	Variance at completion (VAC)	Variance at completion [time] (VAC(t))
	Independent estimate at completion (IEAC)	Independent estimate at completion [time] IEAC (t)
	To complete performance index (TCPI)	To complete performance index [time] (TSPI)

Table B.2 — Earned schedule formulae

Metrics	Earned schedule	ES cumulative	Earned schedule cumulative = C + I where C is number of time increments of the PMB where EV ≥ PV_n and I is the incremental period where (EV − PV_C) / (PV_{C+1} − PV_C)
	Actual time	AT	Actual time is the number of periods performed; i.e. the time period at which the project status date
Indicators	Schedule variance [time]	SV(t)	SV(t) = ES − AT
	Schedule performance index [time]	SPI(t)	SPI(t) = ES / AT
	To complete schedule performance index	TSPI(t)	TSPI(t) = (PD − ES) / (PD − AT) where the future required schedule performance is being compared to the planned duration (PD); and TSPI(t) = (PD − ES) / (ED − AT), where the future required schedule performance is being compared to an estimated duration (ED).
Predictors	Independent estimate at completion [time]	IEAC(t)	IEAC(t) = PD / SPI(t) Or the long form formula where IEAC(t) = AT + (PD − ES) / PF(t) where PF(t) is a time-related performance factor (for example (SPI(t))

B.5 Purpose and benefits of earned schedule

Specific benefits of earned schedule should be, but are not limited to, the following:

a) using earned value data to determine objective time-based measurement of project or programme performance for schedule;

b) forecasting of future schedule performance, based on past performance using earned value data that can be used to cross-check the measures provided by the network schedule;

c) providing objective metrics for comparison of project or programme schedule performance across an organization and between organizations;

d) developing of schedules;

e) compiling of schedule estimates;

f) focusing on comparison between actual schedule performance and plan;

NOTE The comparison between schedule performance and plan may occur at various levels from work package, to control account, to critical path, or to project or programme.

g) enabling the highlighting of inconsistencies in the measures in earned value reports;

h) providing a basis for consistency of the overall reporting and performance measurement framework by regular earned value reporting.

Other benefits that come from using earned schedule may include the following:

— providing an independent estimate of duration and milestone completion dates that can be especially useful for late-running activities and projects;

— providing project and programme managers another schedule analysis tool that may improve confidence in statistically forecasting delivery dates, which can be especially useful for projects and programmes that are behind schedule;

— integrating and supporting risk management activities, especially for analysing and justifying the need for applying schedule reserve;

— facilitating drill-down into areas of the schedule that may need management attention.

Engineering or technical performance issues usually first manifest as a schedule slippage that will lead to a cost issue. For this reason, as well as assisting in schedule analysis and control, earned schedule metrics provide leading indicators of both schedule and cost performance issues, whereas the earned value management cost metrics are lagging indicators of performance issues.

Annex C
(informative)

Integrating other project or programme management processes with earned value management

Earned value should have flexibility in its implementation. The key elements of planning, implementing and controlling can be scaled to fit varying situations. Earned value management can be tailored to fit any project or programme. As uncertainty, size, complexity and duration increase, so should the degree of earned value rigour. The frequency and granularity used may enable performance to be measured and controlled at the appropriate level.

The application of risk management, critical path, critical chain, earned schedule, and agile development methodology need the elements of planning, implementing and controlling, and the setting of a reference level to measure progress. Figure C.1 shows potential areas where earned value has a direct relationship.

Earned value should be used by project and programme management offices, where such offices are established, or the functional equivalents. Project and programme management offices or the functional equivalents should provide standards and processes to be used by project and programme practitioners that are auditable, transparent and repeatable, as well as scalable. Earned value management should also have a role in the process of continuous improvement to provide a reference level against which to measure improvement.

Earned value management should be in conformity with project and programme governance.

As an example, Figure C.1 provides an outline of the project management disciplines and processes that can be integrated with earned value.

NOTE The diagram shows high-level processes, subject areas or disciplines that could be integrated, namely: project or programme management office, governance, earned schedule, risk management, agile development methodology, critical path and critical chain. A lack of space on the diagram has meant that some processes or disciplines have been omitted. These processes include cost engineering, planning, scope of work, and dependencies, assumption management and stakeholder communications.

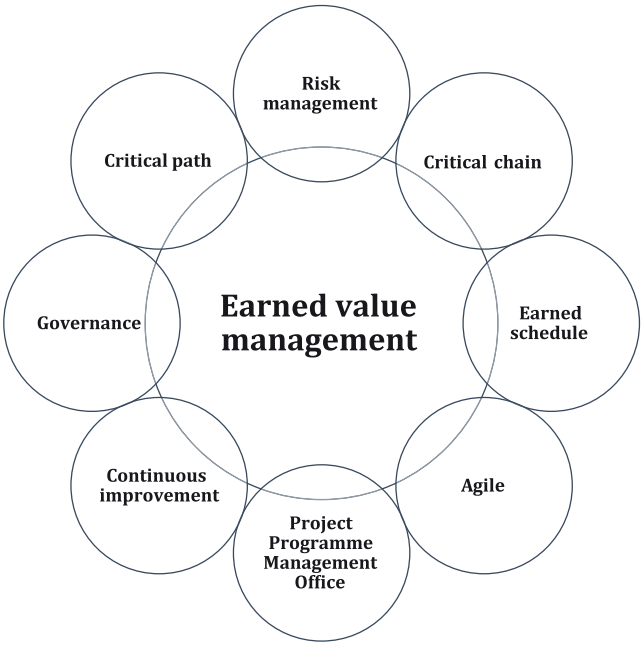


Figure C.1 — An example of integration of project management disciplines with earned value management

Bibliography

[1] ISO 21500, *Guidance on project management*

[2] ISO 21503, *Project, programme and portfolio management — Guidance on programme management*

[3] AS 4817-2006, *Project performance measurement using Earned Value*, January 2006, Standards Australia

[4] Association for Project Management. *Earned Value Management Handbook*, March 2013

[5] Association for Project Management. *APM Guidelines*. *Earned Value Management*, 2008

[6] Association for Project Management. *APM Guidelines, Earned Schedule, An Emerging Earned Value Technique*, January 2010

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