BS ISO 21512:2024

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Project, programme and portfolio management — Earned value management implementation guidance

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National foreword

This British Standard is the UK implementation of ISO 21512:2024.

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A list of organizations represented on this committee can be obtained on request to its committee manager.

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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

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Introduction

This document provides guidance when implementing an earned value management system based on ISO 21508. This document shows how an organization can take a systematic approach to implement and maintain an earned value management system that enables improved project and programme management. This document is not intended to be prescriptive; each organization should determine its approach for earned value management and to what extent the organization should adopt ISO 21508. Users are encouraged to use this document along with ISO 21508.

This document provides guidance to users either establishing or maintaining an earned value management system.

The text in each clause is topically arranged to assist the organization in establishing or improving its earned value management system. The topics are arranged in the following order:

a) general introduction to the material contained in the clause;

b) guidance on how an organization can approach the subject;

c) practical tools, methods, strategies and examples.

The examples and approaches presented in this document are for illustrative purposes only, and are not necessarily suitable for every organization, project or programme. In implementing, maintaining or improving an earned value management system, it is important that organizations select approaches, tools and methods appropriate to their needs and governance framework.

Earned value management tools and methods are sustainable and useful, when they are integrated within an organization's overall governance for projects and programmes.

This document is applicable to:

a) practitioners and professionals of earned value management, project management, programme management and portfolio management;

b) management, sponsors and other governing bodies overseeing projects, programmes, and portfolios;

c) project, programme and portfolio management office professionals;

d) project, programme and portfolio stakeholders;

e) academia including faculty, students and researchers;

f) developers of national standards, organizational standards and public policy.

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Project, programme and portfolio management — Earned value management implementation guidance

1 Scope

This document specifies guidance and examples for establishing, implementing and maintaining an earned value management system based on ISO 21508:2018. This document also provides practises for earned value management, as set forth in ISO 21508:2018. This document can be used by any organization.

This document is aligned with and complements the information contained in ISO 21508:2018 which is the higher tier international standard and companion document for this document.

Further guidance on project, programme and governance and other related guidance are set out in relevant standards.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO/TR 21506, *Project, programme and portfolio management — Vocabulary*

ISO 21508:2018, *Earned value management in project and programme management*

3 Terms, definitions and abbreviated terms

For the purposes of this document, the terms and definitions given in ISO/TR 21506 and ISO 21508 apply.

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

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

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

3.1 Terms and definitions

3.1.1
100 % rule
concept concerning the entire work required to be accomplished to achieve the *project* (3.1.57) or *programme* (3.1.53) scope captured in the *work breakdown structure* (3.1.89)

Note 1 to entry: The 100 % rule applies to the parent and child elements. The child-level of *decomposition* (3.1.23) of a *work breakdown structure element* (3.1.90) represents 100 % of the work applicable to the parent-level.

[SOURCE: ISO 21511:2018, 3.1]

3.1.2
activity
identified piece of work that is required to be undertaken to complete a *project* (3.1.57) or *programme* (3.1.53)

Note 1 to entry: It can also be considered a work element. It is a defined, discrete piece of work.

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[SOURCE: ISO 21508:2018, 3.1.1, modified — a second sentence has been added to the Note 1 to entry.]

3.1.3
actual cost
cost incurred for work performed

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

[SOURCE: ISO 21508:2018, 3.1.2]

3.1.4
actual time
number of time periods between the actual start date and the date on which the *project* (3.1.57) data is reported

3.1.5
agile development
agile approach
agile management
agile project management
agile programme management
iterative approach to *project* (3.1.57) and *programme* (3.1.53) planning and implementation to allow continuous adaptation for the delivery of scope and the final deliverable or outcome

3.1.6
baseline
reference basis for comparison against which performance is monitored and controlled

[SOURCE: ISO 21502:2020, 3.1]

3.1.7
baseline plan
tool to facilitate the comparison against which performance is monitored and controlled

3.1.8
basis of estimate
documentation that supports the calculation of resources required to perform activities

3.1.9
budget at completion
total forecasted cost for accomplishing the work related to a *work package* (3.1.91), *activity* (3.1.2) or *control account* (3.1.11)

[SOURCE: ISO 21508:2018, 3.1.3]

3.1.10
change order
documentation to alter the *baseline* (3.1.6) of a *project* (3.1.57) or *programme* (3.1.53)

Note 1 to entry: Documentation prior to the formal change order is often referred to as a baseline change proposal or a change request.

3.1.11
control account
management *control point* (3.1.15) where scope, budget, *actual cost* (3.1.3) and schedule of a *project* (3.1.57) or *programme* (3.1.53), *work package* (3.1.91) or *activity* (3.1.2) are integrated

[SOURCE: ISO 21508:2018, 3.1.4]

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3.1.12
control account manager
cost account manager
person with the authority and responsibility to manage a management *control point* (3.1.15) where cost and scope are integrated and compared to the designated performance metrics for *earned value* (3.1.26)

3.1.13
control account plan
cost account plan
management tool for organizing work within one or more work or *planning packages* (3.1.91)

3.1.14
control period
established time frame in which the actual *project* (3.1.57) or *programme* (3.1.53) results are compared with the *performance measurement baseline* (3.1.51) to assess performance and take management action, if needed

3.1.15
control point
point in the processes of *project* (3.1.57) or *programme management* (3.1.54) that can serve as a decision time or gate and can be further defined by one or more individual *activities* (3.1.2)

3.1.16
corrective action
direction and *activity* (3.1.2) for modifying the performance of work to bring performance in line with a plan

[SOURCE: ISO/TR 21506:2018, 3.15]

3.1.17
cost management system
set of tools for estimating, allocating and controlling costs in a *project* (3.1.57) or *programme* (3.1.53)

3.1.18
cost performance index
measure of the *actual cost* (3.1.3) efficiency of a *project* (3.1.57) or *programme* (3.1.53)

3.1.19
cost variance
measure of cost performance on a *project* (3.1.57) or *programme* (3.1.53)

Note 1 to entry: Actual cost compared to planned cost.

3.1.20
critical chain project management
scheduling method for planning and managing a *project* (3.1.57) or *programme* (3.1.53) that focusses on resource availability to complete project or programme *activities* (3.1.2)

3.1.21
critical path
sequence of *activities* (3.1.2) that determines the earliest possible completion date for a *project* (3.1.57), *programme* (3.1.53) or phase

[SOURCE: ISO 21502:2020, 3.8, modified — "programme" has been added to the definition.]

3.1.22
data tracing
activity (3.1.2) of end-to-end to performance data quality checks

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3.1.23
decomposition
iterative process to incorporate an increased level of detail as identified during the *lifecycle* (3.1.43) of a *project* (3.1.57) or *programme* (3.1.53)

Note 1 to entry: Decomposition can be accomplished through a hierarchal, functional or other method to achieve a manageable set of elements.

3.1.24
demonstration review
check for compliance with the *governance* (3.1.35) of *earned value* (3.1.26) criteria on a new or modified *earned value management system* (3.1.30)

3.1.25
earned schedule
time-based technique used to provide status and predictions regarding the schedule, using earned value data

Note 1 to entry: Earned schedule is analogous to the use of cost to determine earned value.

Note 2 to entry: Earned schedule is also a measure of the number of time periods in the *performance measurement baseline* (3.1.51) in which the earned value is greater than the *planned value* (3.1.52).

3.1.26
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.

[SOURCE: ISO 21508:2018, 3.1.5]

3.1.27
earned value management
method that integrates the *project* (3.1.57) or *programme* (3.1.53) scope, *actual cost* (3.1.3), budget, and schedule for the assessment of progress and performance

[SOURCE: ISO 21508:2018, 3.1.6]

3.1.28
earned value management methodology
approach that permits progress achieved to be objectively measured

3.1.29
earned value management planning
delineation of steps, methods and reporting necessary for the creation and tracking of the *performance measurement baseline* (3.1.51)

3.1.30
earned value management system
earned value management tool
selected toolset that integrates the *project* (3.1.57) or *programme* (3.1.53) scope, *actual cost* (3.1.3), budget, and schedule for assessment of progress and performance

3.1.31
earned value measurement
earned value metrics
metrics used to determine the *earned value* (3.1.26) of *projects* (3.1.57) or integrated *programmes* (3.1.53)

3.1.32
estimate at completion
forecasted total cost to accomplish the work on a *project* (3.1.57), *programme* (3.1.53), *work package* (3.1.91) or *activity* (3.1.2)

[SOURCE: ISO 21508:2018, 3.1.7]

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3.1.33
estimate to completion
forecasted cost of the work remaining in a *project* (3.1.57), *programme* (3.1.53), *work package* (3.1.91) or *activity* (3.1.2)

[SOURCE: ISO 21508:2018, 3.1.8]

3.1.34
feeding buffer
time cushion placed at the end of a sequence of tasks that lead into the critical chain

3.1.35
governance
principles, policies and framework by which an organization is directed and controlled

[SOURCE: ISO 21502:2020, 3.10]

3.1.36
integrated baseline review
assessment to establish a common understanding of the *performance measurement baseline* (3.1.51) for verification of the technical content of the *project* (3.1.57) or *programme* (3.1.53)

[SOURCE: ISO 21508:2018, 3.1.9]

3.1.37
integrated baseline review handbook
document that compiles guidance for the preparation, conduct and closeout of an integrated *baseline* (3.1.6) review

3.1.38
issue
event that arises during a *project* (3.1.57) or *programme* (3.1.53) needing resolution for the project or programme to proceed

[SOURCE: ISO 21502:2020, 3.11, modified — "or programme" has been added to the definition.]

3.1.39
issue register
document to record *issues* (3.1.38), responses and other relevant issue information

3.1.40
lag
attribute applied to a logical relationship to delay the start or end of an *activity* (3.1.2)

[SOURCE: ISO/TR 21506:2018, 3.28]

3.1.41
lead
attribute applied to a logical relationship to advance the start or end of an *activity* (3.1.2)

[SOURCE: ISO/TR 21506:2018, 3.29]

3.1.42
lessons learned
knowledge gained throughout a *project* (3.1.57), *programme* (3.1.53) or portfolio that shows how events were addressed or should be addressed for the purpose of improving future performance

[SOURCE: ISO/TR 21506:2018, 3.30]

3.1.43
lifecycle
systematic and organized grouping or staging of necessary *activities* (3.1.2) to be completed to provide the expected deliverable or outcome of a *project* (3.1.57) or *programme* (3.1.53)

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3.1.44
management reserve
amount of budget or schedule external to the *performance measurement baseline* (3.1.51), withheld for management control in response to unforeseen events or *activities* (3.1.2) that are a part of the scope

[SOURCE: ISO 21508:2018, 3.1.10, modified — "or schedule" has been added to the definition.]

3.1.45
milestone
significant planned, or to be planned, point in a *project* (3.1.57), *programme* (3.1.53) or portfolio

[SOURCE: ISO/TR 21506:2018, 3.34]

3.1.46
organizational breakdown structure
decomposition (3.1.23) of the management team of an organization or decomposition of the management team that performs the work of a *project* (3.1.57) or *programme* (3.1.53)

Note 1 to entry: The organizational breakdown structure can include partnering or subcontracting. It is used to illustrate the relationship between project and programme activities and the organizational units that will manage or perform the work activities.

[SOURCE: ISO 21511:2018, 3.5]

3.1.47
parent element
work that is decomposed into two or more lower level elements of work

[SOURCE: ISO 21511:2018, 3.6, modified — Note 1 to entry has been deleted.]

3.1.48
performance management framework
basis for the assignment of management responsibility for *project* (3.1.57) or *programme* (3.1.53) performance to the project or *programme management* (3.1.54) team

3.1.49
performance management methodology
formalized methods governing *earned value management* (3.1.27)

3.1.50
performance measurement
quantitative units of measure that are placed to track progress

[SOURCE: ISO 21508:2018, 3.1.12]

3.1.51
performance measurement baseline
total time-phased scope of work and budget plan against which *project* (3.1.57) or *programme* (3.1.53) performance is measured, not including *management reserve* (3.1.44)

[SOURCE: ISO 21508:2018, 3.1.13]

3.1.52
planned value
time-phased budget (3.1.80) authorized for the work scheduled

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

[SOURCE: ISO 21508:2018, 3.1.14]

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3.1.53
programme
group of programme elements managed in a coordinated way to realize benefits

[SOURCE: ISO/TR 21506:2018, 3.50]

3.1.54
programme management
coordinated *activities* (3.1.2) to direct and control the realization of identified benefits and deliverables

[SOURCE: ISO 21504:2022, 3.11]

3.1.55
programme manager
person appointed with the accountability and responsibility of the *programme* (3.1.53) to realize identified benefits, outcomes and deliverables

[SOURCE: ISO/TR 21506:2018, 3.55, modified — "outcomes" has been added to the definition.]

3.1.56
progressive elaboration
progressive decomposition
iterative process to incorporate an increased level of details identified during the *lifecycle* (3.1.43) of a *project* (3.1.57) or *programme* (3.1.53)

[SOURCE: ISO/TR 21506:2018, 3.58]

3.1.57
project
temporary endeavour created to produce agreed deliverables

[SOURCE: ISO/TR 21506:2018, 3.59]

3.1.58
project management
coordinated *activities* (3.1.2) to direct and control the accomplishment of agreed objectives

[SOURCE: ISO/TR 21506:2018, 3.61, modified — "deliverables" has been changed to "objectives" in the definition.]

3.1.59
project management office
office established to provide guidance, assistance and documentation to assist in the implementation and delivery of a *project* (3.1.57)

Note 1 to entry: Such offices can also be established at the *programme* (3.1.53) level.

3.1.60
project manager
person appointed to lead the *project* (3.1.57) team and to be accountable and responsible for the project's agreed objectives

[SOURCE: ISO/TR 21506:2018, 3.63, modified — "deliverables" has been changed to "objectives" in the definition.]

3.1.61
project plan
project management plan
documented description of the technical and management *baselines* (3.1.6) to be followed for a *project* (3.1.57)

[SOURCE: ISO/TR 21506:2018, 3.64, modified — the admitted term "project management plan" has been added.]

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3.1.62
quality assurance
planned and systematic procedures necessary to provide adequate confidence that a process, measurement or service satisfies given requirements for quality

[SOURCE: ISO/TR 21506:2018, 3.67, modified — "actions" has been changed to "procedures" in the definition.]

3.1.63
quality control
monitoring specific results to determine compliance to *quality assurance* (3.1.62) and other relevant standards and to identify the steps to eliminate unsatisfactory performance

[SOURCE: ISO/TR 21506:2018, 3.68, modified — "assessment of" has been changed to "monitoring" and "conformity with" has been changed to "compliance to quality assurance and other" in the definition.]

3.1.64
residual risk
estimated level of *risk* (3.1.67) remaining after completion of approved *risk treatment actions* (3.1.72)

3.1.65
resource loading
identification of the *project* (3.1.57) resources needed to complete the work identified for the project or *programme* (3.1.53)

Note 1 to entry: Often bounded by hours available for personnel, contract terms and conditions or material availability.

3.1.66
responsibility assignment matrix
documented structure that shows the allocation of delegated work responsibilities designated for delivery of scope or benefits

[SOURCE: ISO 21511:2018, 3.10]

3.1.67
risk
uncertain event or set of events with a potential positive or negative impact

[SOURCE: ISO 21505:2017, 3.3]

3.1.68
risk assurance
processes and actions needed to provide the knowledge and confidence that the *project* (3.1.57) or *programme* (3.1.53) can deliver on the investment

3.1.69
risk contingency reserve
estimated funding for the management of identified *risks* (3.1.67)

Note 1 to entry: Risk contingency reserve can be added to the *project*'s (3.1.57) estimates for cost, schedule or both to cover identified risks, where the use of *management reserve* (3.1.44) is not allowed.

3.1.70
risk exposure
potential level of impact on cost, schedule, or both that can be incurred if *risks* (3.1.67) occur

Note 1 to entry: The estimate of risk exposure can include emergent risk, as yet unknown, but based on previous known risk criteria.

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3.1.71
risk register
risk log
documentation for recording identified *risks* (3.1.67), risk analysis, and *risk treatment actions* (3.1.72), as well as other necessary information for managing risks on a *project* (3.1.57) or *programme* (3.1.53)

3.1.72
risk treatment action
documented response to respond to an identified *risk* (3.1.67)

Note 1 to entry: Risk treatment actions include preventative, mitigation, fallback and recovery actions.

3.1.73
rolling wave planning
form of *progressive elaboration* (3.1.56) where planning is accomplished in phases or time periods

[SOURCE: ISO 21511:2018, 3.12]

3.1.74
schedule buffer
time inserted into the schedule at identified points to absorb unforeseen delays

3.1.75
schedule performance index
measure of how close the *project* (3.1.57) or *programme* (3.1.53) is to completion compared to the approved performance measurement *baseline* (3.1.6)

3.1.76
sponsor
person responsible for obtaining the resources and executive decisions to enable success

Note 1 to entry: In some organizations, the sponsor also has the responsibility to promote and protect the *project* (3.1.57) or *programme* (3.1.53).

[SOURCE: ISO 21502:2020, 3.26, modified — Note 1 to entry has been added.]

3.1.77
stakeholder
person, group or organization that has interests in, can affect, be affected by or perceive itself to be affected by any aspect of the *project* (3.1.57) or *programme* (3.1.53)

[SOURCE: ISO 21502:2020, 3.27, modified — "or portfolio" has been deleted.]

3.1.78
surveillance review
periodic check to confirm the *earned value management system* (3.1.30) is continuing to meet the *governance* (3.1.35) criteria

3.1.79
task order
documentation for specific services placed against an established contract

3.1.80
time-phased budget
planning tool that focuses on the sequence and timing of the *project* (3.1.57) or *programme* (3.1.53) implementation

3.1.81
to complete cost performance index
metric to calculate the cost efficiency and financial effectiveness of a *project* (3.1.57) or *programme* (3.1.53)

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3.1.82
to complete performance index
comparative metric to determine whether the *estimate at completion* (3.1.32) is reasonable

Note 1 to entry: Also defined as the computation of future required cost efficiency necessary to achieve the target estimate at completion.

3.1.83
uncertainty
amount of potential variation of an *activity*'s (3.1.2) cost or duration due to an estimating error

3.1.84
undistributed budget
cost for authorized work that has not been distributed to a *control account* (3.1.11)

[SOURCE: ISO 21508:2018, 3.1.17]

3.1.85
variance
difference between the *baseline* (3.1.6) and the actual performance

3.1.86
variance at completion
difference between *budget at completion* (3.1.9) and *estimate at completion* (3.1.32)

[SOURCE: ISO/TR 21506:2018, 3.86]

3.1.87
variance threshold
prior agreed upon amount of difference to be allowed before an action can be needed

Note 1 to entry: Variance threshold is generally expressed as a percentage of deviation from the *baseline* (3.1.6).

3.1.88
work authorisation document
part of a system to facilitate approval of work throughout the *project* (3.1.57) or *programme* (3.1.53)

3.1.89
work breakdown structure
decomposition (3.1.23) of the defined scope of the *project* (3.1.57) or *programme* (3.1.53) into progressively lower-levels consisting of elements of work

[SOURCE: ISO 21502:2020, 3.29]

Note 1 to entry: Conceptual work breakdown structure is one that precedes the project or programme authorization.

3.1.90
work breakdown structure element
work at a designated level that is either a *parent element* (3.1.47) or a child

[SOURCE: ISO 21511:2018, 3.15]

3.1.91
work package
one or more groups of related activities that are within the *control account* (3.1.11)

[SOURCE: ISO 21508:2018, 3.1.19]

3.2 Abbreviated terms

The following abbreviated terms are used in this document.

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AT	actual time
AC	actual cost
BAC	budget at completion
CA	control account
CAD	computer-aided design
CAM	control account manager
CPI	cost performance index
CV	cost variance
CPLI	critical path length index
ES	earned schedule
EV	earned value
EVM	earned value management
EVMS	earned value management system
EAC	estimate at completion
ETC	estimate to completion
IEAC(t)	independent estimate at completion (time)
IECD	independent estimate of completion date
IBR	integrated baseline review
PCSD	project control system description
PD	planned duration
PF	planned finished date
PMB	performance measurement baseline
PV	planned value
PM	project manager
SPI	schedule performance index
SPI(t)	schedule performance index (time)
SV(t)	schedule variance (time)
TCPI	to complete performance index
TSPI	to complete schedule performance index
VAC(t)	variance at completion (time)
WBS	work breakdown structure
WP	work package

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4 Overview of earned value management

4.1 Overview

Clause 4 describes earned value management within the context of an organization conducting project and programme management. Clause 4 offers an explanation of the overall method of earned value management and what the method is intended to produce to enable better performance and performance measurement.

4.2 Earned value management

The earned value management methods should allow the comparison of the work completed in the project or programme with a baseline budget, as a measurement of how the project or programme is performing. In other words, what work was planned, at a specific control point, to have been done, the planned value; what work has been done, the earned value; and, what resources were used to do that work, the actual cost. Further, it should include an analysis of metrics using earned value management indices and variances, and an estimate or forecast of the cumulative cost and schedule and that can include management reserve at the end of the project. Earned value management is a methodology that uses a designated approach to integrate the project's or programme's scope of work with schedule and cost elements for planning and control.

NOTE Methodology is the overall study of how the methods or actions are done. Methods are the tools and processes to be applied within the methodology.

The objectives of earned value management can vary depending on the context. One common objective should be to provide objective quantification of progress and productivity. This progress and productivity can be monitored at a variety of levels, including work package, control account, project and programme levels.

4.3 Purpose and benefits of earned value management

4.3.1 The purpose of earned value management should be to provide control and analysis of the project or programme[6]. The analysis improves the situational awareness of project or programme status and the assessment of the cost, schedule and technical performance. Corrective actions can then be designed and implemented, as needed.

Once designed and implemented, an earned value management system should provide internal controls, including documentation and project and programme processes. The system can include communication of the status from pre-established metrics, corrective action development, and a common framework and vocabulary[6].

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

a) objective performance measurement techniques;

b) data for project or programme management decisions;

c) system to monitor the project or programme[6].

4.3.3 The specific benefits of earned value management can include:

a) forecasts of future performance and estimates at completion based on past performance;

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

c) development of budgets and baselines;

d) compilation of estimates;

e) consistent objective measurement of completion for work packages;

f) comparison of work performed against planned performance and budget;

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g) objective measurement of risk contingency reserve;

h) identification of inconsistencies in the metrics in earned value reports;

i) consistent reporting and performance measurement framework;

j) documented analysis that enables timely and reliable estimate at completion[6].

4.4 Initiation considerations for an earned value management system

4.4.1 The organization should select a tool for its earned value management system that meets the needs of its projects and programmes. Other considerations can include:

a) the need to meet contract or customer specifications for the system;

b) the ease of use by the project or programme management teams;

c) the need for access by stakeholders;

d) the need for the data to be easily imported from or exported to other systems.

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[6]. The procedures and policies that govern the earned value management system should be documented, accessible, kept up-to-date and reviewed on a periodic and need basis.

To implement an earned value management system, the project's or programme's control metrics should be accessible and understood by the persons within the organization or organizations performing 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 can be tailored to accommodate different project or programme process area integration, more than one organization reporting, and other tailoring.

The essential data contained in an earned value management system should be the earned value, the actual cost, the planned value, the estimate to completion and the budget at completion. The earned value management system should be able to show the planned status, as well as the actual status[6].

To implement an earned value management system, the performing organization or organizations, as well as the customers and other stakeholders as determined to need the information, should have a common agreement on the assignment of value and performance. The common agreement on the assignment of value and performance can be tailored for the project or programme based on organizational or contract considerations.

The review of metrics of performance should be accomplished on a regular, scheduled basis to allow for comparison and analysis of performance[6].

4.4.2 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;

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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[6].

4.5 Earned value management planning

4.5.1 Earned value management planning should enable:

a) establishing of individual project or programme objectives;

b) establishing the integrated view of the planning of the set of projects or programmes;

c) monitoring of progress to measure deviations from the plan;

d) planning by the users of the performance management system for objective assessment of progress and use of resources[6].

Earned value management planning should begin with planning of the project or programme to support earned value management analysis and reporting. Items that can be considered during the planning of projects and programmes include modifying report formats and allowing for the use of agile development approaches.

Establishing an earned value management system to meet customer needs or establishing the initial earned value management system for an organization not currently using a system can be considered during planning. To enable the planning, preparation of the earned value management system should begin, as soon as possible, following the approval of the business case or similar business objective documentation. This preparation should involve an iterative process to provide for the needs of the various stakeholders of the system and reporting.

Planning the use of an earned value management system for a specific project or programme should begin with the preliminary work breakdown structure. Once the preliminary work breakdown structure is in place, it should provide the framework for integrating management systems, developing schedules and accumulating performance information.

4.5.2 Depending upon the specific project or programme governance of the organization or contract terms, the management systems and elements of the project or programme should include:

a) plan of the project or programme, including the statement of work;

b) organizational breakdown structure;

c) responsibility assignment matrix;

d) earned value management system selected tool;

e) organizational governance procedures and processes;

f) financial system;

g) cost models;

h) earned value management system analysis and reporting procedures and processes;

i) risk analysis, including any risk analysis found in the business case or similar documentation.

During earned value management planning, disconnects and mismatches among various systems for project and programme management, such as financial systems, should be eliminated or minimized. Eliminating such inconsistencies should result in estimates, budgets, schedules, costs and other measures to align with the approved work breakdown structure. This earned value management planning action should reduce workarounds and reconciliations that can be necessitated to obtain reliable data for decision-making.

For programme management, the work breakdown structures for each project should be the same structure through the lowest level of breakdown required under the organization's project and programme

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management governance documentation[7]. Further, common coding of the work breakdown elements will facilitate reporting and communication among the stakeholders. Subcontractor, partners, and other contributing organizations should use this approach for earned value management. This approach is necessary during the planning of earned value management to facilitate the development of the preliminary information management system and the selection and initialisation of the earned value management tools.

4.6 Using earned value measurements and performance metrics

4.6.1 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 can be used to compare actual cost and schedule performance with the approved 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[6].

4.6.2 The two major elements for variance analysis are whether the project or programme is:

a) ahead of schedule versus behind schedule;

b) over budget versus under budget.

4.6.3 These two project or programme performance factors have a direct impact on the total cost. The initial questions to be asked should be:

a) What will be the total cost if the project or programme is ahead of schedule, but costs are higher than expected?

b) What will be the total cost if the project or programme is behind schedule, but costs are lower than expected?

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

a) progress of a project or programme;

b) progress towards work accomplished;

c) completion of the deliverables;

d) progress towards delivery of a project or programme[6];

e) work accomplished as earned value compared with work planned;

f) work accomplished as earned value compared with actual costs;

g) root causes of performance variances, corrective actions needed and impacts to the performance of remaining work.

4.6.5 The information should also be used to forecast future performance. The data to establish a performance forecast for a project or programme based on historical performance should include:

a) estimate to completion;

b) estimate at completion;

c) variance at completion;

d) to complete performance index[6].

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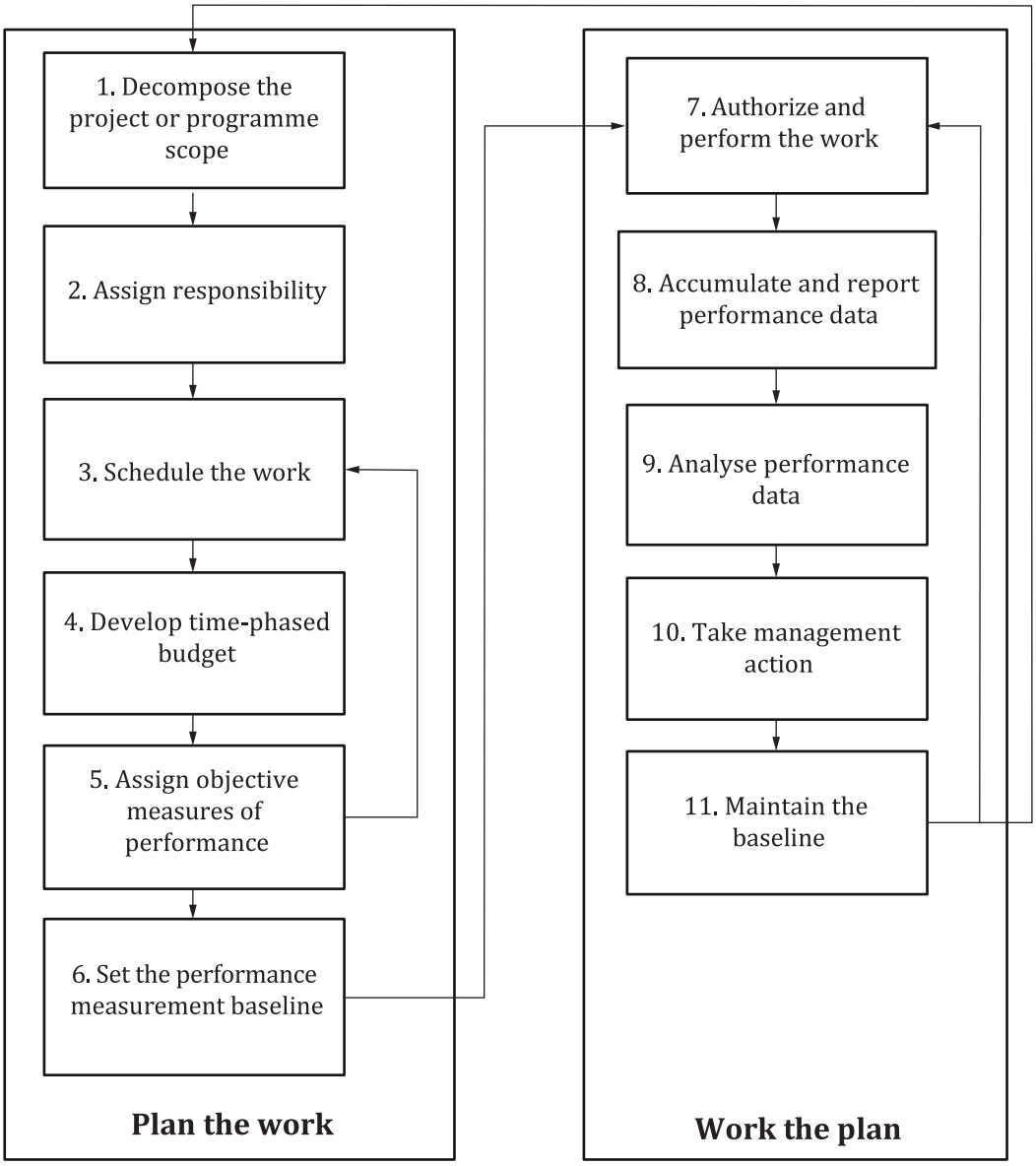
5 Implementation of the earned value management process steps

5.1 Overview

The earned value management process steps are shown in Figure 1 to illustrate one view of the process steps for earned value management. Each process step is defined and the guidance for each step is set forth in the clause or subclause related to the process step in Figure 1.



NOTE 1 Steps 3, 4 and 5 are performed iteratively.

NOTE 2 Not all relationships are shown in this figure.

Figure 1 — Example of the earned value management process steps[6]

The earned value management process steps can be used to establish a performance management methodology.

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5.2 Step 1: Decompose the project or programme scope

5.2.1 Introduction

The work breakdown structure developed from the decomposition of a project or programme can be represented by several different approaches. The work breakdown structure can be decomposed as deliverable-oriented, result-oriented, product-oriented, location-oriented, functional-oriented, process-oriented, phase-oriented, capability-oriented, or a combination. In addition, depending on the lifecycle, the work breakdown structure should be defined by the requirements that define the project or programme and its delivery[7].

5.2.2 Context

The work breakdown structure should be tailored to the objectives and the approved and documented needs of the project or programme. The work breakdown structure should take into account the industry sector, type of project or programme, and other factors. Other factors can include project phases, major deliverables, scope, organization performing the work and location of resources. The work breakdown structure should be flexible enough to accommodate alternative ways of organizing and representing the work.

NOTE The work breakdown structure represents not only the way work is planned and managed, but also how it will be delivered, in other words, incremental or progressive elaboration, iterative, agile, or any other method or modified method.

The work breakdown structure should be used throughout the project or programme to establish the framework for the management of the work. The structure should provide a logical framework for decomposing 100 % of the work defined by the scope or of the work elements at any given point, such as phases, stages or other pre-determined interval in time during the lifecycle[7]. Depending on the scope, the work can be accomplished by a single organization or multiple organizations, such as a subcontractor, partnership or other limited agreement to achieve the scope.

5.2.3 Work breakdown structure creation

The work breakdown structure should be based on approved and documented requirements of the expected deliverables, outcomes or benefits and the governance of the project or programme. Certain work breakdown structure elements can be defined to a lower level than others under conditions such as: high-cost, high-risk, high-visibility or when involving multiple stakeholders.

The creation of a work breakdown structure can be accomplished by using one of three approaches in conjunction with the appropriate organization, project or programme governance, procedures, policies and processes governing work breakdown structures and the integration with the other management processes, including earned value management:

a) top-down identification of the end deliverable, followed by successive subdivision of the work breakdown structure elements into detailed and manageable units;

b) bottom-up identification of elements of scope and merging, categorizing and ordering those elements in a hierarchy;

c) a combination of top-down and bottom-up approach[7].

The level of detail provided by the initial work breakdown structure can vary.

EXAMPLE Using progressive elaboration, a review of the work breakdown structure can be conducted by checking that each element represents the appropriate level of detail per the governance for the project or programme.

A prior work breakdown structure can be helpful in identifying the breakdown of the scope of work for a new project or programme, where similar work and activities have been done in the past or where the format of the work breakdown structure is similar.

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5.2.4 Decomposition

A conceptual work breakdown structure can be created during the business case or similar documentation process and can be re-evaluated or further decomposed once the project or programme is authorized. The conceptual work breakdown structure should be updated as soon as the project or programme is authorized. If a conceptual work breakdown structure was not created, one should be created as soon as the work scope elements are understood for the phase, stage, other interval designated or for the complete project or programme. Once developed, the work breakdown structure should:

a) provide a basis for gathering cost data across projects and programmes and be correlated with the cost management system;

b) serve to maintain the breakdown of the scope;

c) allow for status to be continuously visible and integrated;

d) serve to facilitate communication among project or programme team members, as well as with both internal and external stakeholders, such as customers and suppliers;

e) provide for the allocation of resources according to the work breakdown structure elements identified;

f) provide for maintaining and updating, as needed, until the final deliverables have been completed, delivered, or transitioned to the customer.

5.2.5 100 % rule

Whether the effort and resources can be associated with the element to be supported is important to work breakdown structure development. If the association can be made, the effort and resources should be included within that element. Under the 100 % rule of the work breakdown structure, the sum of work at the child-level should be the total work at the parent-level.

The various options to create parent-child relationships depend on the type of project or programme and the work breakdown structure developed.

Each parent element can have zero child elements or at a minimum two child elements. The work breakdown structure should represent the collective inputs of the project or programme team and relevant stakeholders.

The work breakdown structure should be the agreed upon decomposition of the work to be performed by the project or programme team. Each change made to the work breakdown structure should also be reviewed with the management team, the identified performing organization and performers within that organization, as well as other stakeholders identified as necessary to the work breakdown process.

These parent-child relationships can be combined to create a comprehensive decomposition of the scope of a project or programme into the work breakdown structure.

The benefits of lower-level parent-child relationships are:

a) facilitating communication among primary project or programme team members, both internal and external;

b) assigning stakeholders, such as customers and suppliers; allowing for organizational alignment.

5.2.6 Description of the project or programme work breakdown structure elements

Work breakdown structure elements can become the control points and can be further defined by one or more individual activities. The development of control points at an appropriate level of detail should enable the following:

a) definition of activities in the schedule;

b) elimination of overlaps by providing that a deliverable is represented in only one work breakdown structure element;

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c) identification of the person responsible, their direct manager and matrix organization, sub-contractor, or partner organizational unit;

d) identification of the person to facilitate or initiate communication about the work breakdown structure element such as changes in:

   1) deliverable;

   2) approved baselines;

   3) personnel;

   4) communication chains, including reporting;

e) allocation of work to the project or programme team by dividing work breakdown structure elements to provide for accountability and control.

5.2.7 Hierarchical decomposition

Work breakdown structures are usually hierarchical in design. Each descending level of the work breakdown structure should provide a more detailed definition of the work[7]. Additionally, the work can be focused on project or programme phases, disciplines or locations. The entire scope of work should include work to be done by the project or programme management team, team members, subcontractors and other stakeholders.

The work breakdown structure should provide a decomposition of elements to the level necessary to plan, manage and communicate the work to meet the objectives, outcomes, deliverables and benefits.

Some of the work breakdown structure process actions are given below.

a) Extending the work breakdown structure to lower levels: The reporting level of the work breakdown structure depends on the level of interest where work is accomplished. Reporting at levels below the levels of interest should be considered, if the work breakdown elements are high cost, high risk, or special interest or any combination of those considerations[7]. For those elements, extension of the work breakdown structure to lower levels can be necessary to get needed visibility, but only for those elements. Not all work breakdown structure elements should be extended to the lowest level.

b) Identifying the parent-child relationship: In some cases, items cannot be specifically associated with the element supported.

Software is a critical element that is part of a major electronic system and can be the child-level to the parent system, in other words, a transmitter. However, depending on how software is developed, it can include more functionality than just the identified transmitter. It can, for instance, also include functionality for a parent subsystem. In this case, the software cannot be associated with the specific elements supported due to how the functionality of the software was built. Without the ability to separate each subsystem's software functionality, it should become appropriate to associate that total software deliverable to the parent-level electronic system work breakdown structure. This action should eliminate allocation of the effort across multiple work breakdown structure elements, where it can be difficult to determine what level of support each piece of work should receive.

5.2.8 Project and programme relationship

Within a programme, the projects, other programmes and other related work should be decomposed in a similar manner throughout the programme. The programme should become the highest level of the work breakdown structure. The same parent-child convention should apply to the logical relationships in the hierarchy. Each project, programme or other related work element under a programme can be developed into a standalone work breakdown structure that can be represented as a separate work breakdown structure or part of the combined programme work breakdown structure. This work can come from the organization, such as operations or through subcontractor agreements.

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Some projects or programmes possibly do not have a fixed scope based on their lifecycle development approach; therefore, any unknown or undefined scope can be left blank or can be an empty set on the work breakdown structure diagram. These projects can use agile, progressive elaboration or rolling wave planning techniques, where the scope is defined as incremental as the project progresses through its lifecycle. As scope is identified during the life of the project or programme, the identified scope should be considered within the work breakdown structure, while maintaining the logic flow of the levels of the work breakdown structure and the parent-child relationship.

5.2.9 Progressive elaboration

Progressive elaboration can entail one, concurrent or successive modifications to the work breakdown structure. The addition of detail to the work breakdown structure through progressive elaboration should produce a more accurate work breakdown structure and enhance the use of the structure to manage the project or programme. Progressive elaboration can entail one, concurrent or successive modifications to the work breakdown structure[7].

NOTE Rolling wave planning is a form of progressive elaboration that is time-based.

5.2.10 Characteristics of a work breakdown structure

The characteristics of a work breakdown structure should be related to the scope of the project or programme. The following are typical characteristics of a work breakdown structure.

NOTE In the following bullets stands for structure (S) and stands for element (E).

a) S: can be represented by a variety of formats including graphical, outline and tabular;

b) E: need not be decomposed to the same work breakdown structure level but to the level where the element is managed;

c) E: can be assigned to one person, entity, or function to be responsible;

d) S: should reflect the technical complexity, size, and other information, as deemed necessary for the scope;

e) S: defines the structure of the work and not the processes involved in accomplishing the work;

f) S or E: provides a hierarchical decomposition of elements, applying the 100 % rule, to the level necessary to plan and manage the work to satisfy the objectives;

g) S or E: can be related to scope, but not limited to, considerations such as industry standards, organizational procedures, or contract terms and conditions; and

h) E: assigned a unique identifier to distinguish one element from another.

5.3 Step 2: Assign responsibility

5.3.1 General

The assignment of responsibility should be the basis of aligning the work breakdown structure with the roles and responsibilities associated with the organizational, functional, product, capability or other breakdown structure (see 5.2). This alignment is based on the decomposition of scope into manageable, measurable work efforts that are assigned a manager to enable work to be accomplished by those persons, groups or organizations responsible for completing the work assignments, as documented in the organizational breakdown structure. The organizational breakdown structure should be integrated to form a responsibility assignment matrix (see Figure 2). The responsibility assignment matrix can be used to establish a performance management framework for the project or programme management team.

The assignment of responsibility can depend on numerous factors. Depending on how the performing organization is structured, the assignment can be to a group lead or organizational lead, individual team member or whatever organization level is dictated by project or programme. These assignments can be dependent on the industry sector, the country performing the work efforts or the governance documents within the organization. These roles can also be assigned by discipline or function, in other words,

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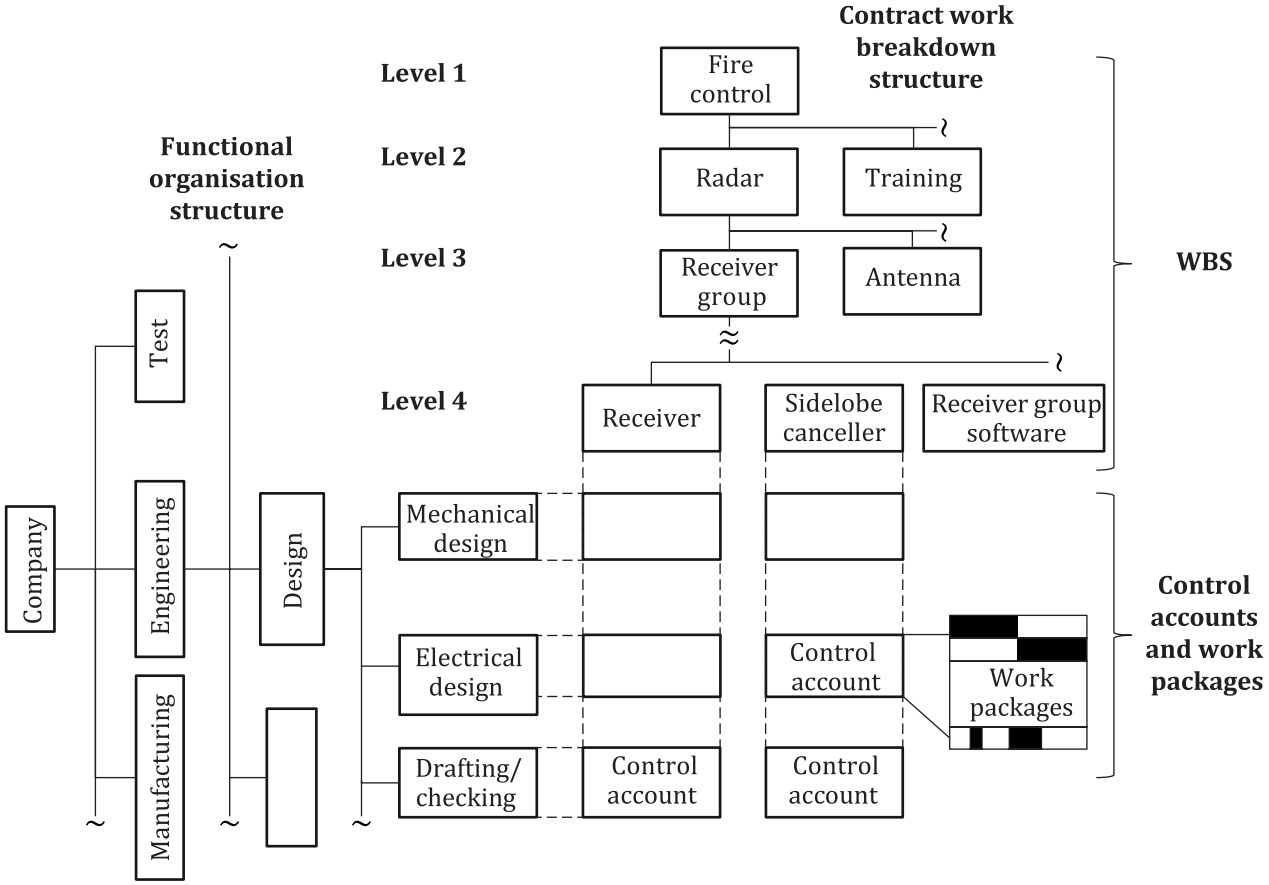
engineering, procurement, construction or other organizationally recognized assignment categorization, including type of project or programme, phase, major deliverables, organization or location of resources. Responsibility can start within the design phase and carry over into the development, production and even the sustainment phase, if these efforts are the objectives and needs of the project or programme.

EXAMPLE Responsibility is assigned to mechanical design, electrical design, drafting and checking. The responsibility is to complete the items assigned through the work breakdown structure within those organizations, as shown in Figure 2.

The use of the work breakdown structure should allow organizations performing the work scope to be accountable for their efforts. These organizations can be influenced by departmental, functional, matrix or external variables or regulatory interfaces, which can affect the work structure and deliverables.



NOTE This figure depicts a functional organization but it can easily be adapted to any other type of organizational structure.

Figure 2 — Example of a responsibility assignment matrix: Integration of a work breakdown structure and an organizational structure[18]

5.3.2 Work assignment

Assignment of responsibility should be directly traceable to the decomposition of the work breakdown structure into work elements and the organizational breakdown structure. Through this process, continuity of the work breakdown structure and the assignment of responsibility should be aligned to a person or set of persons within an organization. This assignment of responsibility allows for accountability with approval and reporting requirements being driven by governance, contract or another managerial stakeholder[7]. In addition, the assignment of responsibility for scope can serve to facilitate communication among project or programme team members, as well as with both internal and external stakeholders.

The assignments should also be aligned so that the work elements can be adjusted for conditions such as: high-cost, high-risk or high-visibility concerns. By providing clear designation within the responsibility

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assignment matrix, inside or outside the project or programme, these interactions can be facilitated. The assignment of responsibilities should be manageable and proportionate with responsibility of authority needed to achieve the activity and align with the breakdown of the parent-child relationship[7].

5.3.3 Assigning responsibility during work breakdown structure decomposition

The work breakdown structure should be one of the first items created. Its decomposition can be created during the business case or similar document process or early in the project or programme identification phase. This decomposition should allow for the assignment of responsibility by the organization, project or programme management team, which addresses lower-levels of detail, specifically the parent-child relationships. Since the work breakdown structure is a living document or part of a living document, assignments can be planned or accomplished during progressive elaboration for each phase or stage of the project or programme or when other conditions create the need to update the document.

Assigning the responsibilities for budget in summary, planning or control accounts for acceptance and approval of responsibility should be assigned at the project or programme level.

5.3.4 Description of the project or programme assignment of responsibility

The project or programme manager, with either internal organizational control or external control, such as contractual control, should have the responsibility to assign work efforts to an organization of persons identified, such as control account managers.

The control account manager has the responsibility to review the scope of work and confirm it is in alignment with the work breakdown structure decomposition of work through the associated parent-child relationships. The control account manager can then accept the responsibility through an informal acceptance or through formally approved work documents, whether internal or contractual. Once the approved control account manager is assigned resources, coordination with the integrated plan and budget should include the assignment of responsibilities based on risk, scope, schedule or performance, with the objective of enabling integration of budget and schedule. This assignment and review process should support the project or programme manager in the management of the project budget, cost, schedule and performance.

5.3.5 Work packages

Work packages should be identified as one of three types:

a) discrete activities: work that has a specific end product or result that can be directly planned and measured;

b) apportioned effort: work that cannot be readily measured or divided into discrete work packages but can be directly related to the planning and performance on other identified discrete tasks; examples include quality control and inspection;

c) level of effort: support or management work that does not result in a specified product or output; neither performance nor achievement can be measured as there is no tangible output.

NOTE Level of effort work packages can include supervision and administration.

5.4 Step 3: Schedule the work

5.4.1 General

The schedule for work that identifies activities, durations, milestones and interdependencies at an appropriate level should be the basis for earned value determination[6]. This basis means the activities should be identified at or below the level of the work breakdown structure. This identification of activities needs accurate time phasing of planned work that should be integrated with the scope, schedule and cost of the programme.

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Work scope should align to the earned value management structure through the decomposition of scope into work breakdown structure elements with assigned activities and milestones. These milestones should reflect the interdependencies and constraints, with planning for potential risk and risk treatment actions. Through the assignment of activity durations, resource loading of control accounts can be completed to allow for resource levelling and validation of the expected value.

NOTE The same process can be done using planning packages.

The final step of scheduling should be to validate the critical path in alignment to the integrated baseline, so that the project or programme manager and control account managers can approve a time-phased budget baseline. This scheduling of work should assist with the actual cost and performance to be measured.

The scheduling of the work should include supporting the development of the performance measurement baseline. The schedule should be structured in a manner that will enable progress to be:

a) calculated using the schedule;

b) compared with the performance measurement baseline.

Comparison of the progress with actual costs can occur within the schedule or outside the schedule model depending on the methodology being used.

5.4.2 Planning the work

Planning the work should be accomplished through the review of the scope of work or contract scope and terms, including the authorized milestones. The milestones should be reviewed against the governance, policies and procedures for dividing the work scope into control accounts for productivity and management. This planning output should be utilized with specific organizational governance for delegation of the authority from the project manager to the control account managers.

The identified milestones and activities should then be reviewed for their dependencies and logical relationships that allow for the objectives, outcomes, deliverables and benefits to be met with assigned resources and budget.

5.4.3 Identification activities

The work breakdown structure should be documented in further detail as described by parent-child relationships[7]. This work breakdown structure detail should provide the development of a sequence of activities and logically rolled up to the levels that achieve the activities that can be aligned to the control account level.

Identifying the activities to schedule the work scope should be done using the responsibility assignment matrix. The activities should be developed to provide sequence tied to establishing a network logic with the assignment of activities and durations that should establish the critical path.

The identification of activities should be aligned at the control account level to allow for resource loading. Utilization of summary level activities or control accounts to support the lower work activities should be defined in the initial planning of the project or programme and align to the work breakdown structure and the organizational breakdown structure. This alignment should be accomplished to allow the activities for resource loading to support control accounts to be validated.

5.4.4 Durations

Durations are identified through vertical traceability to horizontal traceability based upon the sequence of work[6].

Work should be traceable throughout the project or programme to each level of the schedule consistent with the level of planning[6].

The assignment of activities should establish the basis for the assignment of activity durations. The duration review should be done to verify activities are logically tied and the critical path can be established.

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As developed and approved, the schedule should be used by the management team to plan and monitor the work performed. The schedule or schedules should provide a way for evaluating actual progress against pre-defined objectives.

Durations of the activities should be estimated considering available data, resource demand and availability, as well as risks and uncertainties. The basis for determining activity durations should be documented in the basis of schedule documentation. The basis of schedule documentation defines the reasoning or logic for the schedule development, including assumptions and exclusions. Durations can be used in the detail work scopes or packages to align and support the control accounts. Durations can also be summarized into summary level or planning packages using a rolling wave concept.

Work package durations should roll up to the control account activities. These work packages should be integrated into the scope of work and have the earned value technique assigned to them.

5.4.5 Milestones

Major milestones should be determined based on significance, constraints and interfaces[7]. Significance in this context can be the importance of the effect of the milestones to the outcomes, deliverables and benefits. Milestones can be assigned as contractual, programme or value milestones. Milestones have zero duration and cannot be resource loaded but are logically tied into the relationships to validate scope, logic and critical path.

Programme or project milestones should reflect key areas or control points that allow for the measurement and progress of significant elements of the work.

Value milestones should be used to measure points of work within longer duration control accounts or work packages.

5.4.6 Interdependencies

Activities sequenced for interdependencies should be placed in a network that has a single point of entry and concludes with one point of exit (see 5.4.2 and 5.4.3). Each activity identified should have a predecessor and successor, so that activities are logically tied with no open ends.

The interdependencies, which are logically tied with no open ends, should allow for the forward and backward pass to establish the critical path. The forward pass is the method of moving forward through a diagram to calculate total activity duration, and the backward pass is the other direction view. The critical path should be complete once resources are validated and loaded. The project can be baselined to establish the earned value management system's performance measurement baseline.

5.4.7 Schedule validity

5.4.7.1 For a schedule to be valid, it should be:

a) complete – representing authorised effort for the entire contract, with essential subcontracted or other external work for milestones integrated, yet distinguished from internal work;

b) traceable – reflecting realistic and meaningful network logic that horizontally and vertically integrates the likely sequence for project or programme implementation (see ISO 21508:2018, Figure 2);

c) transparent – providing full disclosure of project or programme status and forecasts, and including documented ground rules, assumptions and methods for building and maintaining schedules;

d) updated – reflecting a consistent and regular update of completed work, interim progress, achievable remaining durations relative to the status date and accurately maintained logic relationships;

e) predictive – accurately forecasting the most likely completion dates and impacts to the project or programme baseline plan through valid network logic and achievable task durations from the status date through project or program completion[13].

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5.4.7.2 A schedule should also be:

a) usable – producing meaningful metrics for timely and effective communication and tracing and improving performance, treating issues and risks;

b) resourced – with labour, materiel and facilities aligned with the schedule baseline and forecast to enable stakeholders to view and assess the time-phased labour and other direct cost to achieve the project baseline and forecast targets;

c) controlled – with the schedule baselined and maintained using a rigorous, stable, repeatable and documented process. Schedule additions, deletions and updates should conform to this process and result in valued and accurate results for sound schedule configuration control and maintenance.

5.5 Step 4: Develop a time-phased budget

5.5.1 Overview

The purpose of this step is to distribute cumulatively the project or programme budget over the period of time for which the work implementation has been planned. This cumulative distribution of the budget should be the basis to establish the performance measurement baseline.

This step should directly influence the calculations and values of earned value management metrics and indices.

To develop the time-phased budget, one should use the schedule, where budget should be allocated to the schedule activities. This allocation should schedule activities according to the budget value of the resources contained in the approved baseline to be used during implementation.

Substantiated cost and schedule estimation, approved and documented risk treatment actions and progressive elaboration are factors that should be considered in the production of the time-phased budget and of the performance measurement baseline.

The cumulative time-phased distribution budget should mirror, as close as possible, the planned cumulative implementation of the scope over the duration. The cumulative time-phased distribution should not be confused with the financial or accounting cash flow needed for the funding of the project or programme over time.

5.5.2 Concepts and considerations

5.5.2.1 General

The following items should be considered in the preparation of the time-phased budget:

a) resource use;

b) economic valuation of the project work;

c) progressive elaboration;

d) approved risk treatment actions;

e) subcontracted work;

f) cost estimating and budgeting.

5.5.2.2 Resource use

Resource use allocated to a work activity should equate to accountability for a cost to be incurred due to the use and depreciation of a resource.

EXAMPLE Table 1 provides an example of the budget.

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Table 1 — Example of a project budget

Resource	Unit cost	Quantity	Observations
Trainer	$ 100/h	80 h	20 h per activity
Video-projector	$ 1 000	1 unit	Acquired by the project at the beginning Used only in activities A (40 h) and C (20 h) Book value at the project end is $ 400
The total budget of the project is: $ 8 000 + ($ 1 000 – $ 400) = $ 8 600. While the project is accountable for the upfront acquisition of the video-projector, the correct budget valuation of the cost caused by the project with the video-projector is not $ 1 000 because at the end of the project the video-projector is estimated to have a book value of $ 400 by accounting for depreciation. The video-projector, depending upon organizational governance or contract terms, can either be sold or considered as an organizational asset. Therefore, the real cost incurred by the organization is: $ 1 000 – $ 400 = $ 600.			

Based on this information, the budget value of the activities A, B, C and D is calculated as follows:

— Activity A:

  — 20 h of a trainer's time at $ 100/h totals to $ 2 000;

  — use of a video-projector:

    — 40 h out of 60 h; in other words, $\frac{40}{60}$ or 67 %;

    — cost of a video projector to the project equals the purchase cost minus book value: $ 1 000 – $ 400 = $ 600;

    — cost for which activity A is accountable in the budget: $\$600 \times \frac{40}{60} = \$400$;

  — the total budget allocated to activity A is: $ 2 000 + $ 400 = $ 2 400.

— Activity B:

  — 20 h of a trainer's time at $ 100/h totals $ 2 000;

  — the total budget allocated to activity B is $ 2 000.

— Activity C:

  — 20 h of a trainer's time at $ 100/h totals $ 2 000;

  — use of a video-projector:

    — 20 h out of 60 h; in other words, $\frac{20}{60}$ or 33 %;

    — cost of a video projector to the project equals purchase cost minus book value: $ 1 000 – $ 400 = $ 600;

    — cost for which activity C is accountable in the budget:

      — $\$600 \times \frac{20}{60} = \$200$;

      — the total budget allocated to activity C is: $ 2 000 + $ 200 = $ 2 200.

— Activity D:

  — 20 h of a trainer's time at $ 100/h totals $ 2 000;

  — the total budget allocated to activity D is $ 2 000.

Table 2 shows the total allocation of the project budget to the activities and schedule.

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Table 2 — Example of a project budget allocation

Week no.	Activity	Budget value	Cumulative time-phased
Start	—	—	$ 0
1	A	$ 2 400	$ 2 400
2	B	$ 2 000	$ 4 400
3	C	$ 2 200	$ 6 600
4	D	$ 2 000	$ 8 600

The adequate allocation of resources, in kind and quantity, of the budget to the schedule activities should be at the core of the development of the time-phased budget: what resources will be consumed in the implementation of which activity and in what quantity.

Resource use by work activity should be accounted by cost to be incurred by resources for an activity. These calculations can range from depreciation (such as for equipment), physical use (such as for concrete), direct allocation (such as for effort of human resources) to indirect allocation (such as for overheads).

5.5.2.3 Economic valuation of the project or programme work

The budget and actual schedule should be bound to the scope via the work breakdown structure. This integration should be maintained throughout the life of the project or programme.

The cost items of the budget, such as the resources planned to be consumed, are allocated in quantity to the scope elements. These cost items at the more detailed level will be the schedule activities. The economic value can be calculated based on the budget value of the resource units.

The economic perspective of the budget valuation of the work of the project or programme is distinctive from the financial perspective used in cash-flow management: the cost should not be allocated based on a time perspective of when invoicing and payments of the resources consumed will occur, but rather based on a scope perspective of accountability for resource use.

In the example of 5.5.2.1, a financial perspective would allocate the full cost of $ 1 000 with the video projector to activity A, because the activity is the first activity that needs acquisition and payment of this resource. However, such over-evaluation of activity A can lead to an incorrect time-phased distribution of the project budget. The over-evaluation results in skewed performance measures with false variances that can lead to a lack of trust in the earned value management system and possibly poor decision-making.

5.5.2.4 Progressive elaboration

The progressive detailing of the scope and schedule should be integrated with the progressive adjusting and granularity of the time-phased distribution of the budget of the project or programme, which should lead to greater accuracy and detail.

Unsubstantiated estimates can lead to under- or over-performance measures.

Scope elements that are not yet detailed should be mirrored by high-level planning elements in the schedule, and high-level budget allocation or undistributed budget.

As the project or programme progresses, scope and schedule elements should be detailed along with sufficient granularity to sustain, as much as possible, the objective allocation of the planned resource use to the work scope elements and ultimately to the schedule activities.

The criteria used to allocate resource use in this planning step should be documented and consistently followed during implementation and control, in order to record the actual use of the resources. Therefore, practical considerations in terms of feasibility, data availability, and effort needed should be considered during progressive elaboration.

The progressive detailing of the scope definition and schedule should also sustain the adequate and accurate assignment of objective measures of performance (see 5.6).

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5.5.2.5 Establishment of a residual risk position

Any risk treatment actions needed to achieve the residual risk position should be approved in the risk management system and transferred into the performance measurement baseline. There should be a mechanism for tracing these actions to the risk management system in order to monitor their progress during project or programme implementation.

Any adverse effects caused by the introduction of these actions into the baseline should be assessed to re-evaluate the overall net benefit to the project or programme. Progressive evaluations can be carried out to achieve an optimal position.

Risk contingency reserves and schedule buffers can be established in the baseline for the implementation of contingency plans or additional treatment actions for known risks. These actions should only be necessary if management reserve cannot be held at the project or programme level (see 9.1.4.5).

5.5.2.6 Subcontract work

Subcontracted work, assigned in total or in part to suppliers, should be part of the scope. The subcontracted work time and budget values are integral to the overall project or programme to be controlled by the earned value management system.

The contracted services or materials should be valued from the perspective of the project or programme owner, who is responsible for the budget, therefore under a pricing, as opposed to the actual cost to the supplier. This approach should apply to any type of contract.

Contractual terms and conditions should be established with the suppliers for the necessary information to be available in a timely manner and with the necessary detail to sustain the development of the time-phased budget.

While different approaches and alternatives can be used to document the subcontracted work and resources in an earned value management system, during the invitation for bid and when requests for proposal are issued, the organization interested in implementing earned value management should set forth the mandatory terms and conditions regarding planning and controlling information and data that should be transmitted in specified time periods. Such mandatory terms and conditions should also be communicated during a sole source contracting option, if there is only one source available for the work or resources needed.

5.5.2.7 Cost estimating and budgeting

Cost estimates should be:

a) realistic;

b) objectively assignable to the detailed project or programme scope;

c) auditable.

The breakdown of the cost elements should be organized and classified making it easier and more accurate for the allocation to the work. The project or programme manager and team benefit from the traceability that results from the objective apportionment criteria applied to the use of the cost for work.

The basis of the estimates and assumptions should be documented to enable auditability, which is essential to analyse and communicate performance variances and accountability. The documentation should also be used in the identification of risk development of preventive and corrective actions.

NOTE Point estimating can be used where there is significant uncertainty relating to cost or schedule elements.

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5.6 Step 5: Assign objective measures of performance

5.6.1 General

5.6.1.1 The purpose of assigning objective measures of performance should be an agreed upon selection of the method of measuring performance.

An objective measure should be one that is not only agreed upon but understood by the stakeholders. An objective measure can be seen as impartial, unbiased and fair, as long as the stakeholders agree. Measures of objective performance should be agreed upon to accurately assess progress. Without this agreement on objective performance, the performance reported can fail to accurately reflect the amount of progress achieved in any given reporting period.

NOTE Objective measures of performance are also known as earned value techniques or rules of credit.

The objective measures of performance should be the primary method of measuring achievement or physical progress.

The objective measure of performance chosen should be the most representative of the effort needed to achieve the work within a specific work package (see 5.3.4) or activity. It should also be the most appropriate method for planning, scheduling and evaluating performance.

5.6.1.2 Work packages should be identified as one of three types:

a) discrete activities: work that has a specific end product or result that can be directly planned and measured;

b) apportioned effort: work that cannot be readily measured or divided into discrete work packages but can be directly related to the planning and performance on other identified discrete tasks; examples include quality control and inspection;

c) level of effort: support or management work that does not result in a specified product or output; neither performance nor achievement can be measured, as there is no tangible output (see 5.3.4).

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

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 to quantify the degree of completion of activities;

c) earned value of a completed activity equating to the amount budgeted for the activity, planned value or budgeted cost of work scheduled;

d) objective measures of performance agreed upon before the start of each work package and not changed once work has started;

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

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

g) one objective measure of performance or earned value technique only used per work package[6].

Objective measures of performance should be established to determine accomplishment of in-progress activities. 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 earned value management system documentation or plans. The resulting metric is referred to as the earned value.

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

5.6.2 Earned value techniques — Description, advantages and disadvantages

5.6.2.1 General

Table 3 summarises the suggested earned value techniques.

Table 3 — Summary of the earned value techniques and their applicability

<table>
<tr><th rowspan="2">Output</th><th colspan="3">Earned value techniques for</th></tr>
<tr><th>one reporting period or less</th><th>two reporting periods</th><th>three reporting periods or longer</th></tr>
<tr><td>Measurable units</td><td rowspan="3">0/100</td><td colspan="2">Units complete (equivalent units)
Production (earned standards)
Formula method</td></tr>
<tr><td>Direct interim outputs or milestone</td><td colspan="2">Milestones</td></tr>
<tr><td>Product or achievement but no discrete units or interim milestones identified</td><td>Start/finish
50/50, 60/40, 20/80</td><td>Estimate
(% complete)</td></tr>
<tr><td>No product or achievement</td><td colspan="3">Level of effort</td></tr>
<tr><td>Proportional to progress on related work packages/discrete tasks</td><td colspan="3">Apportioned effort</td></tr>
</table>

5.6.2.2 0/100 method

5.6.2.2.1 General

No value or progress should be earned until the activity or work package is complete. This technique can be seen as another variation on the use of milestones as a progress measure.

5.6.2.2.2 Advantages

This technique can be easy to use and no additional work is required to the schedule to accommodate it.

5.6.2.2.3 Disadvantages

This technique can be suitable for short duration activities of less than one reporting period. The technique can provide distorted performance indices by not taking work in progress into account.

5.6.2.3 Units complete or equivalent units

5.6.2.3.1 General

This method should be based on measuring the number of units or items that have been completed and comparing the result with the total number of units or items that are to be completed in the approved baseline. This technique should normally be used in manufacturing sectors, where earned value is measured as the number of units produced. An equal amount should be earned for each unit completed.

5.6.2.3.2 Advantages

This technique can be easy to achieve and implement. It can help with the production of other productivity graphs, such as line of balance. This technique can be useful when a large number of repetitive items are being made, such as mass production of components: cabling or pipelines.

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5.6.2.3.3 Disadvantages

This technique should only be applied to the activities that have a repetitive element. If applied to a more complicated activity, this technique can be inaccurate. Care should also be taken to allocate the time phasing of production at the start and end of a specific production run.

If 1 000 m of pipe are to be laid over a four-month period, one should be careful in using the average of 250 metres each month for measuring progress. Given the issues and challenges around production mobilisation, equipment, hiring, procurement and labour allocation, it is prudent to allocate less progress in months 1 and 4 200 m can be a better estimate for month 1. This technique also assumes that higher production rates are achievable in months 2 and 3.

5.6.2.4 Earned standards

5.6.2.4.1 General

This technique is a variation on units complete. The technique uses a number of known activity-cycle times, analysed from previous similar activities to set the standard work time for an operation. When the operation is complete, the standard value should be earned.

5.6.2.4.2 Advantages

This technique should be used for production processes that are well-defined and can be easily analysed to produce the production standards. This technique can help to identify areas for continuous improvement and aligns well with approaches for manufacturing.

5.6.2.4.3 Disadvantages

Unless development activities can be measured and assigned standard times and costs, the technique should not be used. The technique can have the potential to be inaccurate, if applied to more complicated activities.

5.6.2.5 Formula method

5.6.2.5.1 General

The formula method, should be used where performance for low-value, non-critical material and other direct cost categories can be earned on the basis of actual cost, multiplied by the relationship of the budget at completion to the estimate at completion:

$$EV = AC \times \frac{BAC}{EAC}$$

where

EV is the earned value;

AC is the actual cost;

BAC is the budget at completion;

EAC is the estimate at completion.

Table 4 provides a view of earned value after applying the formula method based on a budget at completion value of 1 000 units.

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Table 4 — Earned value calculations based on the formula method

	Month				
	1	2	3	4	5
AC	200	400	700	1 000	1 400
BAC	1 000	1 000	1 000	1 000	1 000
EAC	1 000	1 000	1 200	1 300	1 400
EV	200	400	583	769	1 000

5.6.2.5.2 Advantages

This technique should rely on monthly updates of the estimate at completion to be accurate. It can be useful in situations where progress can be directly related to spend, such as, consumables and direct line feed.

5.6.2.5.3 Disadvantages

This technique should be avoided for complex activities and high-value items being either procured or manufactured.

5.6.2.6 Milestones complete

5.6.2.6.1 General

Achievement of the work package should be measured by the achievement of milestones. Each milestone should be assigned a proportion of the budget, and when the milestone is achieved, that proportion of the budget should have been earned. Earned value should only be taken on milestone completion.

5.6.2.6.2 Advantages

This technique of calculating earned value should be applied when there are a large number of frequent milestones.

5.6.2.6.3 Disadvantages

The method should not reflect the schedule and the work scope. Achievement should not be directly related to a specific milestone. Milestones chosen should not be directly on the critical path. If work in progress is considered, it can make the schedule performance index and cost performance index worse than the actual. If the number of milestones is low, then the measuring process should become coarse and can prove to be no longer useful.

5.6.2.7 Start/finish method

5.6.2.7.1 General

A set percentage of the value should be earned at the start of the activity or work package. The rest of the value should be earned upon completion. The starting percentage should be 20 % or higher depending upon the governance or plan for the use of this technique. The method should be used when the activity or work package has duration between one and two reporting periods.

5.6.2.7.2 Advantages

When used for a specific activity or work package type, stakeholders can agree to the set percentages for the reporting periods.

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5.6.2.7.3 Disadvantages

Care should be taken where the duration is more than two accounting periods. No value can be earned at either the start or the finish. This accounting can bias the schedule performance index, cost performance index calculations and the estimate to completion. The method can represent work in progress over or under what is claimed, thus affecting the schedule performance index and cost performance index values.

5.6.2.8 Estimate or percentage complete

5.6.2.8.1 General

In using the estimate or percentage complete technique, earned value should be determined by a subjective assessment of the total work completed. Granularity in the schedule, activity details should provide the objectivity.

5.6.2.8.2 Advantages

No additional schedule changes or preparation should be needed. This technique can be applied to activities with duration spanning three or more reporting periods and where an objective basis exists for determining percentage complete for the work package.

5.6.2.8.3 Disadvantages

The method can be misapplied, if the schedule granularity is not achieved or maintained as planning packages are turned into work defined. Clarity of the activity or work package entry and exit criteria can help packages. The method application can also be seen as subjective if the output or deliverable is not visible or clearly stated.

5.6.2.9 Level of effort

5.6.2.9.1 General

Technique is easily used to draw value for work activities that do not produce deliverables, are not on the critical path and cannot be late. Level of effort should be kept to a minimum to avoid masking performance variances. Other uses for level of effort can be quality assurance and configuration management, which should use the apportioned effort, earned value technique.

Level of effort work packages are those work packages that should be used for necessary work efforts for the project to be successful, but that do not have a specific end deliverable or outcome represented by them in whole or in part.

NOTE Activities can include some aspects of project or programme management and contract administration or other consultations related to the management of the project or programme, where such activities are not covered by overhead costs.

5.6.2.9.2 Disadvantages

This method should only be used for this type of activity. Since level of effort earned value is measured by the passage of time, it is important to provide that the time-phased budget distribution is representative of the baseline schedule. As a result, earned value should be set equal to the budgeted schedule of work planned, even if the work package has not started. This technique should mean schedule variances never occur; thus, level of effort tasks does not allow meaningful earned value schedule analysis to be done.

However, level of effort work packages can generate a cost variance and recorded actual cost can still be compared to the earned value. Level of effort work packages should be separately defined from other work packages to avoid issues with any earned value analysis. The level of effort technique should be used only for those activities where no recovery action would be taken if the work were not undertaken.

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5.6.2.10 Apportioned effort

Apportioned effort should be work that is not readily divisible into discrete work packages, but the work should be directly related and dependent upon measurable progress within another work package or another deliverable or outcome.

Apportioned effort should normally be used for tasks, such as inspection, configuration management, and quality control and assurance.

The link between an apportioned account and a base account should be a schedule link. This linkage should mean that the schedule in the apportioned account is derived by analogy to the work schedule of the base account and the earnings in the apportioned account are derived by analogy to the work accomplished in the base account.

Earned value should be determined by an apportioned factor calculated from the budget at completion for the apportioned and reference work package.

$$apportioned\ EV = EV_{\text{reference work package}} \times AF$$

where

EV is the earned value;

$EV_{\text{reference work package}}$ is the earned value of the reference work package;

AF is the apportioned factor.

There should be no similar apportionment of actual cost of work-performed values for apportioned effort work packages. Actual costs should be directly recorded and reported against the work package, resulting in the generation of cost variances where variances exist.

The control account manager of the apportioned account should still control the assignment of budget to the account, but the time phasing of that budget and the percentage of earnings should be directed by the base account. See Table 5 for an example of calculations of an apportioned work package based on an apportioned factor of 0,333.

Table 5 — Example of an apportioned work package calculations based on AF of 0,333

		Month				
		0	**1**	**2**	**3**	**4**
Reference work package	PV	0	60	120	210	
	EV	0	0	60	120	210
	AC	0	30	70	120	250
Apportioned work package AF, 0,333	PV	0	20	40	70	
	EV	0	0	20	40	70
	AC	0	10	40	50	65

5.6.2.11 Earned value types for material items

Earned value measurement for material should be measured like any other element of cost. It is intended to permit assessment of events that reflect progress in performance, not measurement of administrative or financial events, such as booking of actual costs or invoice payment. Therefore, planned value should normally be scheduled according to an event, such as material or equipment delivery or receipt, and earned value should be earned when the event occurs. Administrative or financial events can be used as indicators for contract events when such indicators occur in the same reporting period as the contract events.

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5.7 Step 6: Set the performance measurement baseline

5.7.1 Overview

The performance measurement baseline should provide the reference against which the actual outcome should be compared in order to measure, assess and diagnose performance, and devise management action, as appropriate to direct the project or programme towards its objectives.

Setting the performance measurement baseline should necessitate that each previous planning step has been developed by addressing the following elements:

a) scope definition and baselining based on the work breakdown structure;

b) responsibility assignment based on control accounts and responsibility assignment matrix;

c) development of the project schedule;

d) development of the time-phased budget, incorporating resource planning, and the undistributed budget;

e) establishment of objective measures of performance for work packages (see 9.1.4.4).

The development of the schedule and the time-phased budget should incorporate risk treatment actions and can include schedule buffers.

The performance measurement baseline should integrate each of these elements into a single integrated project baseline. The performance measurement baseline should not include the management reserve, over which the project or programme management team should have no authority (see 9.1.4.8).

5.7.2 Management responsibility

The performance measurement baseline should be the basis for the assignment of management responsibility for performance to the project or programme management team.

Management responsibility should include measuring and reporting performance, diagnosing and explaining the causes of performance, and devising appropriate management actions to direct performance towards the planning targets.

Besides the project or programme manager's responsibility for the overall performance, the primary level at which responsibility should be delegated is at the control account level, where control accounts should be assigned a control account manager. If progressive elaboration and change control take place, some control account managers should be assigned at the beginning of the project or programme, while other control account managers should be assigned as progressive elaboration and change control take place. Further delegation of management responsibility can be established at the lower work package level within each cost account, as agreed by the control account manager and the project or programme management team members involved in the scope assigned to each cost account.

Negotiation and review of the previous project or programme planning elements should take place, as part of setting the final performance measurement baseline, which should be subjected to a formal acceptance process. This formal approval process can lead to the need to renegotiate contractual agreements resulting in changes to arrangements between and among the project or programme organization and the suppliers, client and sponsors. These changes should reflect how responsibility was negotiated and agreed-upon among the relevant stakeholders.

Another important aspect of management responsibility should be the feasibility of the performance targets because unrealistic and poorly documented estimates can lead to the loss of the initial commitment. The performance measurement baseline, therefore, should include a complete documented basis of estimate and schedule basis, as the foundation for the following:

a) feasible performance targets;

b) estimates and actual results being traceable and auditable;

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