Risk, time, cost and contingency

Identifying, quantifying and managing risk, time, cost and contingency

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Glossary

|  |  |  |
| --- | --- | --- |
| Term | Description | Key section |
| Actual cost | Actual cost, also called ‘actual cost of work performed,’ is the actual cost of the work that has been completed. | Section 3.5.2 |
| Accountable Officer | As per Ministerial Direction 10.1, they are required to support Portfolio Agencies to perform Public Construction Procurement and attest compliance with the Directions in the Agency’s annual report. | Section 1.2.1, 1.3 |
| Base cost estimate | A formal estimate of the future costs of undertaking a project, excluding risks and uncertainties. A base cost estimate includes direct/indirect costs and margin (if any) and excludes Risks, Uncertainty, and Escalation. | Section 2.2.3 |
| Base risk estimate | The expected probabilistic cost of all costed project risks and uncertainty in delivering the project scope, including escalation. When the base risk estimate is combined with the base cost estimate, the sum represents the cost outcome for delivery of the project scope with a 50 per cent probability that the estimate will not be exceeded. | Section 2.2.3 |
| Benefits | Benefits are the economic, social or environmental value created for Victorians as a result of the successful completion of a project | Section 2.1.2 |
| Contingency | Contingency or project risk estimate is the provision for inherent and contingent risk in the Project Budget. It is an allocation in excess of the base cost estimate to provide confidence that the total estimated investment will not be exceeded. | Section 2.2.4 |
| Contingent risk | An uncertain event having a probability of less than 100 per cent. The impact is also uncertain, ranging from a minimum to a maximum, typically through a most likely value | Section 2.2.1 |
| Cost breakdown structure | The cost breakdown structure arranges the costs within a project into cost units or cost centres and cost elements or cost types | Section 2.2.3, 3.5.2 |
| Cost estimate | A cost estimate is the total of cost elements, using established methods and valid data, to estimate the future costs of a program or project, based on what is known today | Section 2.2.3 |
| Critical path | The longest duration through the activities required to deliver the project | Section 3.4.2 |
| Discounting | A technique to compare costs and benefits that occur at different points in time on a consistent basis, with a lower value assigned to benefits and costs further in the future. | Section 2.1.2 |
| Earned value | Earned value, also called ‘budgeted cost of work performed’, is the actual value of the work that is complete | Section 3.5.2 |
| Escalation | The anticipated variation in project costs over time as a result of external factors such as market conditions, inflation, supply constraints, timeframes, etc. | Section 2.2.3 |
| Excess risk estimate | An additional risk allocation above the base risk estimate to provide further confidence that the total estimated investment will not be exceeded. | Section 2.2.3 |
| Float | Floatis a time‑based allowance for risk for a project activity or chain of activities. Total float is the period an activity can slip before the delay impacts the estimated finish date of the project. Free float is the amount by which a task can slip before it delays its successor. | Section 3.4.3 |
| Inflation | Inflation describes the general increase in prices over time as a result of monetary policy and broader economic factors but not project or industry specific factors. It is a component of escalation. | Section 2.2.3 |
| Inherent risk | An uncertain condition (i.e. not an event) which is always present and has a 100 per cent probability of existence. | Section 2.2.1 |
| Integrated cost and schedule risk analysis | A statistical technique used to predict a level of confidence in meeting a project’s completion date and cost goals. | Section 4.4.3 |
| Lag | The delay time between two activities. A time lag delays the start date of the successor activity, e.g. the time required between coats of paint to allow for drying. | Section 3.4.3 |
| Lead | Lead describes that the predecessor activity is still running, while the following activity starts. Lead is also known as ‘negative lag’. Leads are used to accelerate the start of the succeeding activity to compress the schedule. | Section 3.4.3 |
| Planned value | The budget authorised for an activity or Work Breakdown Structure component to be completed. | Section 3.5.2 |
| Process quality | The implementation and adherence to acceptable project processes, including those of project management and quality assurance. Project processes includes data gathering, execution methodology, and verification of outputs. | Section 2.1.4 |
| Project budget | The amount of money approved by the Government for the project. The project budget includes the base cost estimate, base risk estimate, and the excess risk estimate. | Section 2.2.3 |
| Project risk estimate | Estimated additional resources (cost, labour/supplies, and time) to the base cost estimate as a provision for inherent and contingent risk; it is comprised of the base risk estimate and excess risk estimate. | Section 2.2.4 |
| P50 | Confidence level which denotes a 50 per cent probability that the cost outcome will not be exceeded. | Section 2.2.3, 3.5.1 |
| Quality | Quality is the standard to which a deliverable satisfies the stated and implied needs of its various stakeholders, and thus provides value through attributes, including usability, reliability, maintainability, and performance efficiency. | Section 2.1.4 |
| Risk | The effect of uncertainty on objectives. An effect is a deviation from the expected. It can be positive, negative or both, and can address, create or result in opportunities and threats.  Risks are events or conditions that may or may not happen that influence the project. | Section 2.2.1 |
| Risk breakdown structure | A hierarchical representation of risks classified by risk category. Can be used as a tool to identify project risks. | Section 3.3.3 |
| Schedule | A schedule is a time management tool, a plan for carrying out a project considering the deliverables that need to be produced and the expected time to completion, usually measured in days, months, or years. | Section 2.2.2 |
| Schedule risk analysis | A schedule risk analysis uses statistical methods to identify the level of confidence that a project will meet the forecasted completion date and the estimated float to meet the project completion date for the desired level of confidence. | Section 4.4 |
| Scope | The scope determines the deliverables within the timeframe and resource constraints imposed on the project. | Section 2.1.3 |
| Systemic risk | Risk resulting from the system delivering the project, and the overall context in which the project is delivered. This does not include risks unique to the project. | Section 2.2.1 |
| Total estimated investment | An estimate of the total amount of expenditure required to deliver an ‘asset investment’ project, including the base cost estimate, the base risk estimate (including escalation), and the excess risk estimate | Section 2.2.3 |
| Uncertainty | Uncertainty in a risk management context is the inherent variability of an estimate and the lack of certainty in future outcomes. It reflects the inability to define unknowns. | Section 2.2.1 |
| Work Breakdown Structure (WBS) | A WBS is a hierarchical, deliverable‑oriented itemisation of the project tasks required to be executed to accomplish the project objectives grouping by like items or areas of work. | Section 3.4.2 |

# Executive summary

These Risk, Time, Cost, and Contingency technical guidelines have been developed by the Office of Projects Victoria to assist project teams plan, propose, and deliver projects through the Department of Treasury and Finance’s Investment Lifecycle. They are applicable to investments funded through the Budget process where a business case must be prepared, with additional requirements applicable to High Value High Risk (HVHR) projects.

The guidelines introduce an integrated approach to risk, time, cost, and contingency identification, quantification, and management, to promote consistency in related project management practices, estimates, terminology, and reporting. They detail the underlying concepts to improve the level of understanding of project teams, outline the steps for implementation, and prescribe minimum estimating requirements and methods and practices. Risk, Time, Cost, and Contingency reporting requirements are also summarised to provide clarity for project teams and agencies.

A maturity model is provided to support a fit‑for‑purpose approach, which defines minimum requirements for agencies delivering HVHR and non‑HVHR projects, as well as best practice for large priority or flagship projects. The maturity assessments have been developed to assist teams to identify whether their level of understanding and application of practices is appropriate given the complexity of their projects and should be applied with the aim of maximising value for money within budget and time constraints.

These guidelines should be read alongside existing government standards, guidelines, frameworks and strategies, and it is expected that organisations will develop their own estimating guidelines in support of this guidance specific to the types of projects being delivered.

* + 1. Introduction
       1. Document purpose

The Office of Projects Victoria (OPV), an administrative office within the Department of Treasury and Finance (DTF), has developed these Risk, Time, Cost and Contingency (RTCC) technical guidelines to assist project teams as they plan, propose and deliver projects through DTF’s Investment Lifecycle.

The guidelines introduce an integrated approach to risk, time, cost and contingency identification, quantification, and management. They highlight the importance of applying these concepts and the foundations of RTCC, which are benefits, quality and scope, throughout the lifecycle of an investment. Taking an integrated approach helps position projects to achieve their stated benefits and be delivered on time and to budget.

In addition to introducing these concepts, the guidelines provide a set of terms, tools and techniques which enhance Government’s ability to deliver projects that provide maximum benefit to Victoria.

The guidelines aim to:

* Support improved RTCC identification, quantification and management to:
* enable consistency in developing and managing estimates
* allow the timely identification and intervention of projects that need greater oversight
* inform the quantification of the overall whole of Victorian Government (WoVG) risk exposure and response
* assist projects in understanding their reporting obligations by clearly and consistently defining RTCC terminology
* allow project benchmarking for improved accuracy of estimating and management for departments and the WoVG portfolio.
* Provide an understanding of the interactions between RTCC, benefits, scope, and quality
* Present maturity assessments for self‑assessment.

The guidelines are presented in three key sections:

1. **Key Concepts** – RTCC and its foundations (benefits, quality and scope) are introduced alongside individual maturity assessments for each of the concepts. These assessments assist project teams to determine whether their level of understanding and application is appropriate given the complexity of their projects.
2. **Implementing RTCC** – details how RTCC concepts can be implemented across the DTF Investment Lifecycle and summarises project reporting requirements.
3. **Quantifying RTCC** – details the prescribed methods for quantifying RTCC concepts.

RTCC and its foundations (benefits, quality and scope) should not be considered in isolation of other project priorities and practices. These guidelines should be read alongside existing government standards, guidelines, frameworks and strategies, and it is expected that organisations will develop their own estimating guidelines in support of this guidance. As illustrated in Figure 1, RTCC aligns with other government and industry frameworks.

Figure 1 – How RTCC interacts with existing guidelines and frameworks



* + - 1. Requirements

These guidelines apply to all government departments, corporations, authorities and other bodies under the *Financial Management Act 1994*. The guidelines are applicable to any investment proposal (asset or output) seeking budget funding and requiring the development of a business case, which is a mandatory requirement for capital investments with a total estimated investment (TEI) of $10 million or more.

* + - * 1. External requirements and frameworks

Responsibilities and accountabilities under the *Financial Management Act 1994* are detailed in DTF’sResource Management Framework(RMF). As required by the RMF there is a mandatory requirement that the Accountable Officer must attest (see project scope statement, 2.1.3) to how the proposed asset investment is the most effective and efficient means of supporting the delivery of departmental outputs and meets government objectives, including consideration of:

* the whole of life costs of the asset, compliant with the Asset Management and Accountability Framework
* the implications on output provision performance (quantity, quality, timeliness, revenue and expense) of the investment.

Mandatory requirements exist for High Value High Risk (HVHR) projects. These requirements are detailed in the DTF HVHR Project Assurance Framework which comprises a series of project assurance checks and processes to increase the likelihood that such projects achieve their stated benefits and will be delivered successfully, on time and to budget.

To determine whether a project should be subject to the HVHR project assurance framework the DTF Project Profile Model (PPM) is used to assign a risk assessment grade based on the intrinsic characteristics and complexity of a proposed project. Projects that exceed the set risk and value thresholds are classified HVHR and are required to comply with more rigorous processes.

* + - * 1. RTCC guideline requirements

Appropriate methods and techniques for the identification, quantification and management of RTCC will vary. The principles presented in these guidelines are used to define a maturity model to define minimum requirements applicable to teams and agencies executing projects, with a higher level of sophistication necessary for agencies delivering HVHR projects. Three levels of maturity are defined for each RTCC element; ‘defined’, ‘managed’, and ‘optimising’.

Table 1 – Maturity levels

|  |  |  |
| --- | --- | --- |
| DEFINED | MANAGED | OPTIMISING |
| Requirements applicable to all projects | Requirements applicable to agencies delivering HVHR projects | Recommended for priority or flagship projects, or projects seeking to demonstrate improved efficiency or performance |

The minimum requirements of the ‘defined’ category for all maturity assessments apply to all project teams. The ‘managed’ category reflects the policy and reporting requirements applicable to teams and agencies delivering HVHR projects, while priority or flagship projects should target the ‘optimising’ category.

The guidelines provide principles, aimed at improving practices within government and challenging norms to support projects managing to an announced budget or date, rather than viewing contingency as part of the ‘available’ budget and not maximising value for money outcomes. The guidelines:

* reinforce the obligation and principle that projects are to be managed to deliver the best value within the approved project cost estimate, where value is defined as the lowest lifetime cost for the required performance
* reiterate the importance of understanding the trade‑offs associated with the design and specification of an asset and the ongoing operation of the asset over its lifetime
* identify risk and opportunities for safety and management to protect value
* appeal for strong governance and a focus on outcomes, with clear roles and responsibilities including role separation between the sponsor, funder and the project team
* encourage effective allocation and control of the project contingency and float.
  + - 1. Responsibilities

The appropriate identification, quantification and management of RTCC elements depend on the ability to use adequately experienced resources to investigate and prepare estimates. Unnecessary under or overestimation of RTCC elements constrains government and is not in the public interest. To appropriately establish and manage RTCC elements requires a culture of strong leadership, outcomes focus, value for money, cost awareness, appropriate governance and accountability. Table 2 details the different responsibilities of the users of this document across all stages of the Investment Lifecycle.

Table 2 – RTCC responsibilities

|  |  |  |
| --- | --- | --- |
| User | Responsibility | Actions |
| **Central Agency (DPC/DTF)** | Ongoing oversight and advising the Premier, Treasurer and other Ministers on budget bids or decisions  Defining requirements for oversight of elements relevant to this guide | Understand and assess RTCC interactions and considerations |
| **Accountable Officer, Asset Owner and Senior Responsible Officer (SRO)** | Ongoing accountability for the ownership and operation of the asset  Responsibility for monitoring and managing RTCC through project development and delivery  Establishing the data and information which the scope is based on verification of estimates | Understand the requirements of, and evaluate the maturity of identifying, quantifying and managing RTCC processes  Provide information to improve the quality of the scope, bases of design, estimate, and schedule |
| **Project Team** | Managing a project through its development and delivery  Managing project governance activities.  Delivering within the approved budget, time and scope constraints  Developing and implementing processes for RTCC management at the required maturity level | Identify better practice for project controls  Identify a fit‑for‑purpose methodology to be applied to a range of projects  Manage stakeholder expectations regarding project delivery and exercising options |
| **Business case writer or advisor** | Developing a business case for investments | Ensure that investment proposals are based on sound assessments of RTCC, developing appropriate trade‑offs between the fundamental elements of benefits, scope, and quality over the intended life of the project |

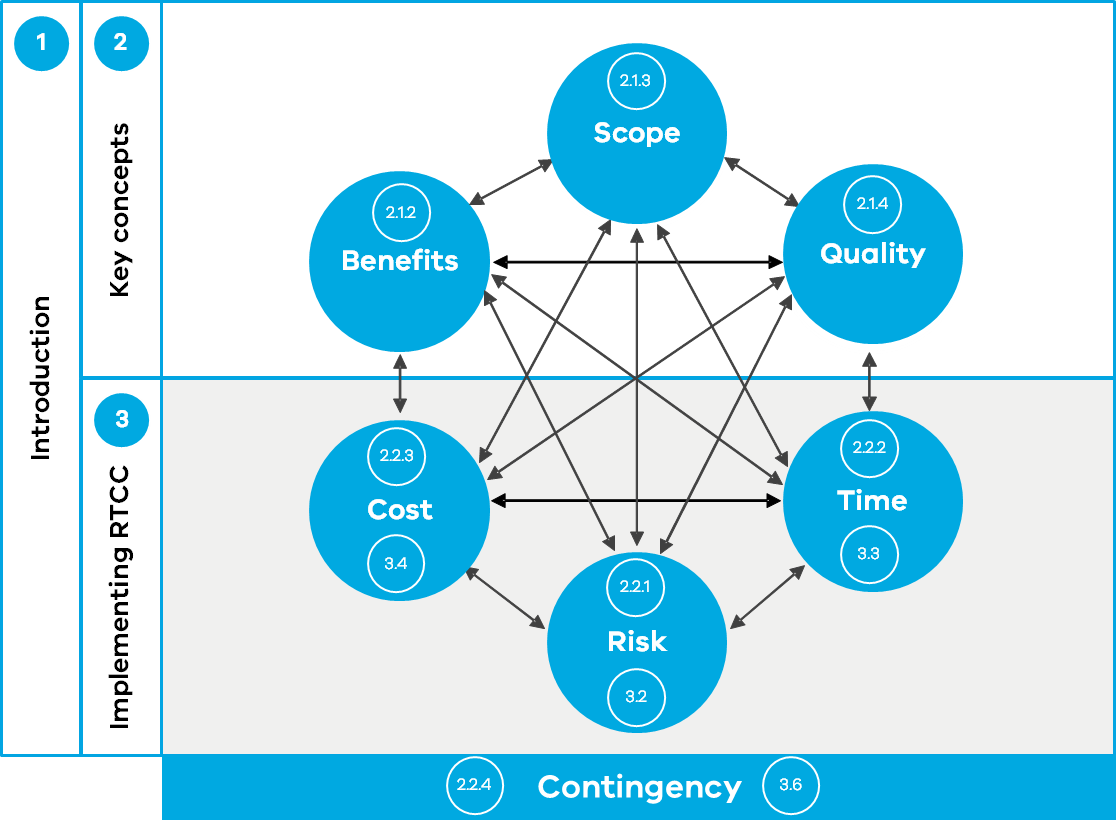
* + 1. Key concepts
       1. Foundations of RTCC
          1. General considerations

Achieving greater certainty of investment and value for money requires a firm understanding of all project elements and the concepts that underpin them. As well as the constraints or trade‑offs associated with a change to one or more elements and its impact on the outcomes of other elements.

Figure 2 depicts the relationships of these various elements. Improved results are achieved by considering project elements holistically (RTCC as well as benefits, scope and quality) rather than considering risk, cost or time elements independently.

As benefits, quality and scope are discussed in detail in other frameworks and guidelines, the following section will provide a brief introduction to each of these concepts alongside details of where further guidance and support can be found. The numbering in the figure below indicates the related document section.

Figure – Project constraints and elements



RTCC elements may form hard or soft constraints, depending on the project. A hard constraint may be a publicly committed date or budget requiring projects to optimise the delivery of other RTCC elements within that context, whereas a soft constraint may be the lifespan (quality) of an asset or delivery of benefits. Elements should be prioritised based on set goals to allow the project to deliver the agreed scope with compromises acceptable to all stakeholders.

* + - * 1. Benefits

#### What are they?

Benefits are the economic, social or environmental value created for Victorians as a result of successful project completion and asset management.

Benefits are expressed in terms of their present economic value at the time of reporting.

#### Why are they relevant?

Benefits are an outcome of delivering scope to meet user requirements and provide the rationale by which projects are funded. Until a project is delivered, uncertainties remain around whether its benefits will be achieved to the desired level.

Tracking and reporting the cumulative value of all projected benefits and issues also demonstrates that the project is delivering on its original objectives, as articulated in the business case.

#### Key concepts

**Benefits tracking** involves a regular review of how benefits realisation is progressing, to identify variances from the plan and take corrective action. Benefits are created through delivery of the project scope of the required quality. To realise benefits, there is sometimes a need to compromise between quality, cost, and time. At each review, these compromises and their impact on benefits realisation must be carefully assessed against Key Performance Indicators (KPIs) by the delivery and client agencies, and translated into corrective actions where appropriate.

Project owners are required to track benefits to:

* ensure business or public benefits are not being compromised without proper authority
* ensure consideration of the effects on project goals should time and cost trade‑offs occur
* allow for a trade‑off between project cost and future benefits such as reduced maintenance within the project budget
* capture the effects of changes in scope
* ensure the asset can be used in its optimal form.

**Time‑to‑benefits** describes the period that passes between the point at which a need is identified and the time by which the user realises the benefit i.e. the sooner the project is delivered the sooner the benefits are realised. During delivery it is often the case that there is a focus on managing to project budget, with minimal consultation of the asset owner around the consequences of varying the project schedule. It is important that both the budget and the impact to benefits of decisions be actively managed, with changes in expenditure to deliver an asset earlier justified based on the benefits realised. Time‑to‑benefits should be contrasted against time‑to‑value as discussed in the section on time (see 2.2.2).

Projects should conduct a sensitivity analysis to check whether delays may have a disproportionate impact on benefits relative to cost outcomes. The time‑to‑benefits and causes of project delays should be actively managed, reported and monitored.

**Discounting** allows a comparison between one investment and another and by putting costs and benefits that occur at different points in time on an equivalent footing i.e. the value of a dollar today is worth less in the future. Discounting in a government context needs to consider the expected return to the economy at different points in time. This concept is described in detail in DTF’s **Economic Evaluation – Technical Guide.** Benefits reporting is discounted to quantify the impact of project delays or schedule acceleration on the project business case.

#### Key documentation

The **Benefits Management Plan** maps project objectives and benefits to project deliverables and its users. The plan is a requirement of DTF’s **Investment Management Standard** and provides guidance on how the project can define, track and measure benefits. The plan also documents the alignment to government policy and assumptions for the benefits realisation.

#### Additional resources

Departments should refer to the benefits delivery sections of the:

* **DTF Investment Management Standard (IMS)** establishes the context and value the investment may provide. The IMS outlines the difference between investment management and project management and provides tools including an investment logic map, investment concept brief, benefits management plan, and strategic options analysis.
* **Project Development and Due Diligence (PDDD) Guidelines** suggest the creation of a benefits logic map showing the relationship between project outputs and stakeholder outcomes.
* **Economic Evaluation – Technical Guide** outlines how benefits are quantified and reported in terms of their economic impact. The Economic Evaluation – Technical Guide also describes how benefits and disbenefits should be discounted.
* **Victorian Government Value Creation and Capture Framework** seeks to provide a consistent and concerted approach for the optimal creation of value from infrastructure projects.
* **Sustainable Investment Guidelines (SIG)** are a technical supplement to the DTF Investment Lifecycle and High Value High Risk guidelines with the aim of providing consistent approach to adopting sustainable practices in Victorian government infrastructure investments. SIG provides project teams with guidance to balance the needs of environmental, social and economic priorities to achieve sustainable development, including considering sustainability from a whole of life perspective, which should result in maximising sustainable investment benefits realised across the life of the asset.

#### Maturity assessment

The maturity levels for benefits apply to all project phases. Application of the maturity models should be fit‑for‑purpose and allow for efficient delivery of the project with the aim of maximising value for money within budget and time constraints (under or overperformance may unnecessarily incur additional time and/or cost).

Table 3 – Benefits maturity assessment

|  |  |  |
| --- | --- | --- |
| DEFINED All projects | MANAGED HVHR projects | OPTIMISING |
| Benefits are defined in the business case and reviewed at project gates. | Benefits management plan clearly defines benefits with times for delivery, dependencies and contingencies. | Benefits are reviewed regularly with any impact caused by scope change assessed |
| Benefits are of (high) value to the organisation and the community. | Benefits are revisited periodically to track their delivery. | Benefits are routinely examined to ensure alignment with the overall project and organisational strategy and goals. |
| Benefit delivery is considered strategic, feasible, and where possible, innovative. | Benefit delivery KPIs are meaningful, measurable and attributable to the project and are worth tracking and reporting. | Changes in business and external environment lead to business plan review and verification. Internal/external KPIs are used to assess changes to the business case and benefit plan. |
| Benefits are communicated, with limited consultation of stakeholder groups. | Stakeholder groups have been consulted and their views are accounted for in the benefits management plan. Stakeholder communication occurs regularly at defined intervals. | Stakeholder groups are fully informed throughout the project lifecycle. |

* + - * 1. Scope

#### What is it?

The scope defines a project’s boundaries. Critical fitness for purpose characteristics including deliverables, requirements, timeframe, interfaces, inclusions, exclusions, assumptions, performance, and end user requirements are all outlined in the scope. Project scope should be used to achieve the project’s benefits and government policy and priorities as defined in the business case.

Scope should be evaluated based on its effect on the benefit cost ratio (BCR), and scope that does not maximise the BCR should be considered for removal from the project.

#### Why is it relevant?

The project scope forms the basis for the time, risk, and cost estimates. The appropriate management of scope may prevent unnecessary work or ensure critical tasks are not omitted.

Accurate identification, definition, and control of project scope results in:

* improved clarity and understanding for all stakeholders
* minimised time and costs overruns
* effective management of risk, schedule, and cost (as these need a valid, well‑defined scope).

#### Key concepts

**Agreed scope** are the works and associated benefits in the business case that are approved and funded by government.

**Scope creep** describes incremental changes that usually happen slowly and without a formal change control process, often leading to budget overruns and delays. Although individual changes may appear minor, multiple occurrences of scope creep can result in significant increases in costs or delays over time.

**Change control** describes the requirements for the early and efficient notification of change, quantifying the value and impact of change, the approval process and the implementation of approved changes. Any project change, including those associated with the realisation of unforeseen risks or changes to scope, should be identified, documented and appropriately controlled. Scope changes usually have a direct impact on project risk, time, cost and contingencies.

**Scope control** requires the continuous evaluation of the agreed scope against the approved quality, budget and schedule.

**Variation control** is the contractual control of scope, cost and time between project partners. This may involve the change control process, depending on the contract and the nature of the change. Appendix 3 details how variations should be recorded and tracked.

#### Key documentation

**Project scope statement:** As described earlier, an attestation that the scope provides a cost‑effective enabling asset for delivering the identified service benefits is required. Throughout all stages of the Investment Lifecycle the actual costs should be traceable back to the project scope statement and ultimately to the service benefits of the business case. Specifically, the SRO must attest in the business case that the scope:

* describes a fit‑for‑purpose asset that enables delivery of the identified service benefit (from the statement of the service benefits)
* defines the physical scope, utility and functional requirements of the capital project in an efficient, effective and economical manner; and departures are identified, explained, and justified in terms of best‑for‑the‑State outcomes.

**Basis of Design (BoD)** details the information to be relied on to deliver the design. This may include information about the site, applicable legislation, specifications or standards and performance or client criteria to which the project is delivered. This document should also include an order of precedence defining how conflicts between different technical standards or requirements are to be managed (where not outlined in the contract).

**Principal Project Requirements (PPR)** or the **Project Scope and Delivery Requirements (PSDR)** describes the work to be performed and deliverables required. As a detailed description of project requirements and their delivery, this document will specify the entity responsible for completing each task, the project schedule, and any other necessary details to establish a baseline of rights, obligations, and exclusions.

#### Additional resources

The **DTF** **Investment Lifecycle** and **High Value High Risk Technical Guides, PDDD Guidelines** and **Self‑Assessment Tool** provide guidance on the requirements for project scope across the project lifecycle.

#### Maturity assessment

The maturity levels for scope apply to all project phases and should focus on providing definition as early as possible. Application of the maturity models should be fit‑for‑purpose and allow for efficient delivery of the project with the aim of maximising value for money within budget and time constraints (under or overperformance may unnecessarily incur additional time and/or cost).

Table – Scope maturity assessment

|  |  |  |
| --- | --- | --- |
| DEFINED All projects | MANAGED HVHR projects | OPTIMISING |
| The scope of work for the project is clearly defined in the business case; describing the significant parts, systems, phases or deliverables of the project. | A systematic process, compliant with ISO 21511, is followed to establish project requirements and identify the scope of work necessary to deliver these requirements. | A documented, integrated change control process is used to track, manage, and communicate changes to the technical baseline or requirements. |
| The full scope of work is defined as deliverable orientated work packages in a WBS, and accountability for package delivery is allocated. | Work packages in the WBS are defined to allow activities to be managed, coordinated, executed and monitored. Activity requirements are documented to ISO 21511, and associated work scope is as complete as possible. | The WBS defines all work stated in the scope of work and the total of lower‑level activities add up to describe 100 per cent of the higher‑level activity in the WBS. |
| Basic controls are in place to prevent undesirable trading‑off between scope and other elements (primarily time and cost). | The links between project objectives and WBS elements are clearly defined. | Key decision makers are included from early stages as part of integrated project teams, involving areas from government to supply chain. |
|  | A change control process exists to document, evaluate, approve and resolve project scope changes, which occur only with the consent of those charged with governance. |  |

#### Better practice: front end planning

A project’s success depends heavily on the quality of its early development and due diligence activities, which also helps inform the choice of the optimal project delivery strategy. The cost of changes increases dramatically in the later stages of a project, as illustrated in Figure 3. The later the timing of a change, the more constrained the project team is in its ability to influence change, and the higher the cost of change.

Figure 3 – Cost of change throughout the investment lifecycle

Detailed initial planning can reduce risk and significantly improve the post‑delivery operating costs of an asset. This requires close collaboration between the project owners, operators/managers or users, and the project team. Ideally, key expertise will be included in project planning from early stages, as part of integrated project teams.

An emphasis on front end planning (FEP) is suggested for technically complex and high‑value projects. FEP assists in providing more accurate risk allocation at earlier stages in the project lifecycle through establishment of clear project scope, cost estimate (including both capital and operating expenditures), project schedule and risk assessment through developing and refining the appropriate deliverables, as outlined in the **PDDD Guidelines**.

The **Victorian Digital Asset Strategy (VDAS)** supports projects by offering guidance on good information management practice. The use of a common data environment across the project lifecycle and the definition of information requirements are key concepts explained throughout the guidance. VDAS supports the concept of FEP, emphasising that most costs associated with developing assets are incurred during operations, rather than the project stages.

* + - * 1. Quality

#### What is it?

Quality of a project deliverable is defined as the degree to which the deliverable satisfies the needs of its various stakeholders, asset owners and end users over the life of the asset. Quality can include usability, reliability, maintainability, and performance efficiency. It focuses on the characteristics of the scope, and the tolerance to alter or provide flexibility around features as defined in the scope.

Process quality refers to the implementation and adherence to acceptable processes, including those of project management and quality assurance. The project processes include the gathering of data, the execution methodology and verification of outputs.

#### Why is it relevant?

Quality directly affects the overall lifecycle cost of the asset and the user benefits. A client agency may justify the increased capital cost required to deliver a higher‑quality asset on a whole of life basis through reduced operation and maintenance costs, with the appropriate level of quality determined by maximising the benefit cost ratio within budget constraints.

Although this guideline focusses on the quality of deliverables, the concept of process quality is relevant because the quality of processes and practices determines how the project delivers a product of the required quality and allows delivery within the schedule and budget.

#### Key concepts

**Specifications** describe the materials and workmanship required for a project and need to be read alongside other information in a contract such as quantities, schedules and drawings.

**Standards** serve as a common language for defining the quality of and establishing safety criteria for products. Standards establish common engineering or technical requirements for products, practices, methods or operations in compliance with local regulations that designers and contractors are expected to follow while developing and delivering the project. It should be possible to verify standards of products and workmanship by testing, inspection, mock‑ups and samples, and documentation such as manufacturer's certificates.

**Quality assurance processes** ensures that the scope is delivered to the required quality. It requires that the roles and responsibilities of project team members are defined and describes the procedures that ensure that project scope meet quality objectives and requirements, including how compliance with these procedures is monitored and demonstrated.

Quality assurance involves:

* **verification**: checking that the methodology satisfies the required specifications
* **validation**: checking that the processes and methodologies are fit‑for‑purpose.

#### Key documentation

The **PDDD Guidelines** provides guidance on the development and maintenance of project standards and specifications across the project lifecycle.

**Quality Assurance Management Plan**: All projects are required to develop a quality plan detailing how outputs will be produced.

#### Additional resources

DTF’s **Project Assurance Review (PAR) Guidance** provides timely independent advice to Government (as the investor), departments or project teams (as the deliverer) and DTF on the progress and the objectives, governance and readiness of a project. The PAR process is designed to improve delivery confidence, provide assurance, reduce scope creep and give a more extensive stakeholder engagement than other processes may allow. While the DTF Gateway Review process involves reviews at critical points in the project lifecycle, PARs can be applied at any point and are not dependent on key milestones. Additionally, PARs involve the development of bespoke Terms of Reference (ToR) to meet the specific assurance needs of a project or program.

The **PDDD Guidelines** and **Self‑Assessment Tool** outline the requirements for a quality assurance management plan and the level of definition required. The PDDD Guidelines defines the requirements of a Quality Assurance Management Plan with the elements of quality assurance, control and improvement. AS ISO 9001 details how quality management systems should be structured and implemented to drive productivity, consistency, and continual improvement.

**Maturity assessment**

The maturity levels for quality apply to all project phases. Application of the maturity models should be fit‑for‑purpose and allow for efficient delivery of the project with the aim of maximising value for money within budget and time constraints (under or overperformance may unnecessarily incur additional time and/or cost).

Table 5 – Quality maturity assessment

| DEFINED All projects | MANAGED HVHR projects | OPTIMISING |
| --- | --- | --- |
| **Deliverable quality** | | |
| Individual work streams have detailed quality specifications. | Quality considers whole of life cost, including maintenance, management, operating and disposal costs. | Quality standards and industry methods are tailored to project‑specific requirements. |
| Contracts specify quality parameters or penalties. | Quality acceptance criteria are detailed and agreed between the management team and the contractors/sub‑contractors. Regular quality audits are conducted. | Regular independent quality assessments are conducted. |
| Specifications are reviewed in line with PDDD Guidance to ensure they align with project requirements | Project specifications are aligned with agency and industry standards | Technical quality is reviewed by an independent third party |
| Management is involved in quality oversight. | Quality pre‑review before submission for formal approval. |  |
| **Process quality** |  |  |
| Formal quality approvals are in place, in the form of quality gates or similar. | A Quality Manager is appointed, responsible for quality assurance for project frameworks, processes and use. | A dedicated Quality Manager is appointed; metrics are measured and applied to quality decisions. |
| The quality plan details how outputs will be produced. | The quality plan is signed off and regularly reviewed. All projects use quality planning standard processes. | Quality processes include the implementation of improvements. |
| Critical processes are quality assured (including, inputs, methodology and outputs), with their risks documented. | Quality requirements are reflected in financial and schedule estimations. | Quality plan improvements are made as the project progresses. |
|  | There is a single source of truth for project documents. | Each process is change managed and quality assured |

* + - 1. RTCC elements
         1. Risk

#### What is it?

Risks are events or conditions that may or may not happen and influence, positively (opportunities) or negatively (threats) a project or asset.

Risk is not the same as uncertainty. For risk management purposes, uncertainty is the range of possible future outcomes resulting in the inherent variability of estimates.

The ability to identify and quantify risk depends on the quality of the risk processes and the nature of the project. The quantification of the required contingencies, in turn, depends on the quality of the risk process, the level of risk in the project, and the level of confidence required by the project delivery organisation.

Risks should be owned by the party best placed to manage each individual risk. Over the project lifecycle, both initial and residual (after controls and treatment in place) risk and uncertainty usually decrease as the project progresses, and the future becomes more certain. The risk and uncertainty in a project also depend on the project team, the quality of project controls, the contract, and the project complexity.

Consequences of individual risks are quantified based on the resulting time (as overall schedule delay) and cost impacts, whether to the project or its resulting benefits. The quantification of risk and its effect on the total estimated investment is discussed in section [2.2.4](#_Contingency).

Risks to the successful delivery of benefits, also called performance risks, are quantified for project purposes by estimating the cost required to maintain delivery of the originally scoped benefits. Performance risks integrate into enterprise risk for the profile of projects and assets.

#### Why is it relevant?

Risk is relevant because it is a key element to project success and must be carefully managed to create and protect value. Neglecting project risks (of both losses and gains) assumes certainty about future events and is not realistic. Risk and its impacts are used as inputs to develop the project management plan and inform decision making therefore inadequate management of risks can lead to:

* time and cost under or over estimation
* inefficiencies arising from not developing treatment strategies before occurrence
* significant events from ignoring the risk profile e.g. low likelihood risks can have severe consequences (Black Swan events)
* under and overestimation or overuse of project risk allocations from poor risk identification and management as discussed in sections [2.2.4](#_Contingency) and 3.6.

Risk management is required to create and protect value and should be based on organisational and project objectives. The impacts of risks must be aligned between the broader government’s and the project organisation’s risk appetite. Where the risk appetite expresses the level of uncertainty the government, project or stakeholder is willing to accept in pursuit of the project objectives. Risk management performance is enhanced using lead indicators to make informed decisions to monitor and control projects proactively.

The **Victorian Government Risk Management Framework** (VGRMF) requires proactive risk management, including planning risk treatments and response actions. Ministerial Standing Direction 3.7.1 Risk Management Framework and Processes mandates use of the VGRMF for all departments and public bodies covered by the *Financial Management Act 1994*.

The VGRMF outlines the Victorian Government’s expectation for risk management. Additional documentation should be referenced to ensure the risk management plan addresses all risks, e.g. reputational, compliance, and environmental.

#### Key concepts

The key differences between risk and uncertainty are outlined in Table 6.

Table 6 – Risk and uncertainty

|  |  |
| --- | --- |
| **Risk** | **Uncertainty** |
| * Risk can be defined as a potential event or condition that, if it occurs, has a positive or negative effect on a project objective. ISO 31000 defines risk as being the effect of uncertainty on objectives. * Risks are quantifiable in that they can be assigned a probability of occurrence and impact by calculation, either known (such as the outcome from throwing dice) or statistical (using empirical data from similar events in the past). * Risk with a probability of occurrence of less than 100 per cent may also be known as **contingent risk.** | * Uncertainty is the inherent variability of estimates and lack of certainty to achieve future outcomes e.g. a task may take three to five days to complete * Uncertainty relates to an inability to define or determine a specific outcome in a precise way. Forecasts, assumptions, judgements, and conditional outcomes often involve uncertainty. Uncertainty can be reduced by undertaking research, evaluations, studies and finding evidence of the impact of future events. * Uncertainty that has a 100 per cent probability of existence may also be known as **inherent risk.** |
| Example: Encountering contaminated soil in an area with known nearby contamination. The project must make provision for the potential of incurring the additional expense of soil remediation, and the impact depends on the severity of contamination. | Example: Estimated variability in construction activity durations due to normal variations in productivity. |

**Risk and uncertainty** can originate from the project itself or the systems used in delivery, being:

* **Project specific**: These are significant risk events or uncertainties specific to the project. The project specific risk is usually reviewed in a workshop, captured in the risk register, and managed to minimise the likelihood of the risk occurring or its impact:
* an example of a project‑specific risk event is asbestos contamination on the site
* an example of project‑specific uncertainty might be the cost of specific materials
* **Systemic:** These are risks and uncertainties from the system delivering the project and the overall context in which it is delivered, which can include the industry, organisation, technology, culture, strategy, and policy e.g. the completeness of scope definition or the quality of project controls. Systemic risks and uncertainties are most often identified top‑down through workshops, with senior project and owner executives participating. In general, specific systemic risk events should be escalated to be managed by the State at the portfolio level, and not be included in the project budget or risk estimate unless they can be quantified and justified as specifically applicable to the project:
* an example of a systemic risk that should not normally be included in the project risk estimate is sector‑wide industrial action
* an example of a systemic risk that might be included in the project budget is disruption to a project in front of Parliament House due to protests or rallies
* an example of systemic uncertainty is changes in wages over time. This should be accounted for in the project budget
* a second example of systemic uncertainty is foreign exchange fluctuations affecting the delivered prices of imported goods and materials, which should be accounted for in the project budget. If hedging is used, the cost of hedging should be considered equivalent to the cost of insurance as discussed in section 2.2.4.

Project specific risks and systemic risks are combined during risk analysis to determine the overall risk exposure to the project objectives.

Throughout the project lifecycle there may be a need to transfer risk information between different groups, usually at the end of each phase. This is a vulnerability, as at these points, risk registers may be filed, and new ones created. Risks that have not been eliminated must be communicated and handed over in a manner that ensures the new owner is accountable and understands the residual risk. Projects must also maintain existing controls to ensure risk management is preserved across phases.

#### Major risk events

Projects with a significant likelihood of incurring very large additional costs are unlikely to be sanctioned unless there is a specific need, such as part of a disaster response effort.

Where there is a strategic need for a project that could be subject to a very large cost increase and the risk cannot be reduced through insurance, these major risk events should be identified in the business case but excluded from the project budget and managed using stand‑alone funding arrangements. Release will be managed through the change control process, with approval from the portfolio Department Minister, Treasurer or Cabinet.

The use of probability to reduce the amount of contingency held is unlikely to be satisfactory for these one‑off special cases, as holding a proportion of the funding will be insufficient to fund the realised risk event.

The use of real options to manage these scenarios may also be considered, as described in the technical supplement **Investing under uncertainty – Real options analysis**.

#### Key documentation

**Costed project risk register** showing the expected upper and lower limits of cost and schedule impacts of the project risks identified. See Appendix 1 for requirements.

**Project risk statement** is required in the business case. It explains the project risk estimate (i.e. the base and excess risk estimates) and includes the methodology used for the calculation. Certification is required from an appropriately qualified and experienced professional to ensure that:

* identification and quantification of project risks follow good practice and are predicated on capable management commensurate with the complexity of the project
* the estimates disclose all material assumptions
* departures from government guidelines are identified, explained, and justified in terms of best‑for‑the‑State outcomes.

**Risk and opportunity management plan**, a formal document that describes how to minimise threats and maximise opportunities for project success. The requirements for this document are outlined in the PDDD.

#### Additional resources

The **Victorian Government Risk Management Framework** (VGRMF) provides a minimum common risk management standard for project delivery organisations.

As the government’s insurer and risk adviser, the **Victorian Managed Insurance Agency** (VMIA), supports VGRMF implementation. VMIA advice, guidelines and tools support in the identification and management of significant strategic and financial risks including:

* breach of environmental protection or sustainability legislation
* poor understanding of stakeholder expectations
* negative/hostile/inaccurate press coverage
* unethical business practices.

#### Investing under uncertainty

The following DTF guidance documents can assist project organisations in the consideration and management of the potential effects of uncertainty on infrastructure project development and delivery.

* **Investment Management Standard** (IMS) discusses risk and uncertainty management in public investment. The IMS requires that each IMS workshop considers how investment may be impacted by uncertainty, and how the preferred response might change if assumptions do not hold or future conditions do not unfold as expected.
* Investment Lifecycle and High Value High Risk Guidelines suggest actions to address uncertainty across the project lifecycle in the technical supplement Investing under uncertainty – Real options analysis.

#### Maturity assessment

The maturity levels for risk apply to all project phases. Application of the maturity models should be fit‑for‑purpose and allow for efficient delivery of the project (under or overperformance may unnecessarily incur additional time and/or cost).

Table 7 – Risk maturity assessment

| DEFINED All projects | MANAGED HVHR projects | OPTIMISING |
| --- | --- | --- |
| Risks are identified in the risk register, linked to cost and schedule impacts, and allocated to the party best placed to manage it. | Risk processes are integral to the project management process and are implemented at the earliest stages. There is a comprehensive identification of project/program risks. | Risk processes include the identification, quantification, and management of project portfolio risk. |
| Team understands risk management processes (ISO 31000) and an effective allocation of risk roles and responsibilities. | The risk management process leads to the selection of risk‑efficient strategic choices when setting project objectives and choosing between options for project solutions or delivery (including choice of commercial model). | Effective planning for risk occurs and ensures objectives are met. It is supported by software and an updated database of lessons learned. |
| Risk response plans exist and are based on documented processes which includes strategy, contingency and treatment planning. | Sources of uncertainty that could affect the achievement of project objectives are managed systematically to optimise project outcomes. | A well‑defined documentation process exists, which includes advanced integrated risk strategy planning. |
| The risk management process is formalised and implemented systematically and with consistency. | Information requirements are planned and tailored to support risk modelling. | Processes and risk models provide for the interactions and dependencies between risks and are optimised using empirical data. |
| Value is added by implementing effective management responses to significant sources of uncertainty that could affect the achievement of project objectives. | Risk processes are applied throughout the project lifecycle. Integrated Cost and Schedule Risk analyses are conducted using appropriate methods during the delivery stage. | Cost estimates, schedules, and risk registers are jointly analysed in a single quantitative Integrated Cost Risk and Schedule analysis. |
| Primary stakeholders are involved in planning, necessary information is gathered as standard practice, and some predictive modelling exists. | The risk framework provides mechanisms to guide risk identification and allocation at each stage of the project lifecycle. | Quantitative models are used in forecasting to identify critical scenarios for schedule and cost overruns and to run sensitivity analyses to evaluate proposed mitigation approaches. |

* + - * 1. Time

#### What is it?

Time is represented in a project schedule, which captures when and what tasks are to be completed to deliver the entire project scope. The schedule shows what and how work will be executed, with a realistic sequence of activities. Activity durations should be sufficiently defined to allow for accurate progress measurement. The process and reasoning used to link, and sequence activities must be logical, capturing lead and lag times appropriately.

#### Why is it relevant?

Effective project scheduling can strongly impact project benefits realisation and costs to play a crucial role in ensuring project success. Setting realistically resourced time frames helps create a realistic cost estimate, keep projects on track, assign resources appropriately and to manage quality. The earlier schedule discipline is implemented, the more positively it impacts the likelihood that a project will achieve the committed benefits within time, cost, and quality.

Complex projects are prone to schedule overruns for reasons including insufficient scope planning or definition and unrealistic and incomplete scheduling.

Scheduling requires the integration of activity dependencies, realistic duration estimates and combined resource planning to prevent:

* schedule delays (due to inaccurate timing or sequencing of activities)
* inaccurate cost estimations (under or over estimating the time and labour required to complete an activity)
* inaccurate cost, risk and time, impacting the accuracy of the critical path (the longest duration through the sequence of activities)
* resources not being mobilised or available when needed
* cost increases (due to penalties, extra costs for time and resources to make up for lost time, or interface‑related delays).

During project implementation, the project team uses the schedule to monitor and control the project by comparing the delivery of set milestones and activities to targeted dates.

#### Key concepts

**Time‑to‑value** represents the value to a stakeholder from reducing the period that is required to deliver the scope of a project. A stakeholder may be an internal customer, where the value is realised through de‑risking the project and having greater certainty on the delivery date of a package or whole project, or the end user, where the value is realised through earlier delivery of benefits (similar to time‑to‑benefits). Optimal time‑to‑value requires a carefully considered trade‑off between early delivery and the potential use of additional resources. Projects should consider and measure time‑to‑value to support optimising trade‑offs between cost and schedule.

Considering the **value‑of‑time**, schedule delays can have a substantial impact on the costs of the projects and return on investment. Minimising schedule delay is an important objective, provided the features, functions, and specified level of quality are achieved to gain the benefits.

**Time impact analysis** is a method to assess and quantify the impact of changes during delivery, by calculating the impact of the delay (or acceleration) on the project critical path. It is used to understand the effect of changes on schedules and budgets and to assist during claim negotiations.

#### Key documents

As described in Section 3.4 Implementing time practices, the key documents include Basis of Schedule, schedule, and work breakdown structure (WBS).

#### Key resources

**ISO 21511** **Work breakdown structures for project and programme management**.

A WBS can assist in defining scope by the discipline of subdividing the major project deliverables of the scope statement into work packages or areas. Development of a WBS to ISO 21511 is mandatory for HVHR projects during the delivery stage and is advisable for other stages.

**Maturity assessment**

The maturity levels for time apply to all project phases. Application of the maturity models should be fit‑for‑purpose and allow for efficient delivery of the project, with consideration of how decisions concerning time interact with the other RTCC elements.

Table 8 – Time maturity assessment

|  |  |  |
| --- | --- | --- |
| DEFINED All projects | MANAGED HVHR projects | OPTIMISING |
| The scheduling process is structured and focused. It uses a set of standards, documents and controlled processes to assist with the preparation and publication of a schedule | The schedule flows in a visible, logical manner with milestones clearly linked and logically related to the relevant activities. | The schedule incorporates an efficient allocation of float/resources and has stakeholder approval at all levels of the project. |
| All activity dependencies are defined during the business case, and there are no standalone activities in the schedule. | The schedule is developed top‑down, and project milestones and deliverables are validated bottom‑up. | Schedule detail can be aggregated or ‘rolled‑up’ to provide a summary for reporting purposes. |
| Appropriate interfaces between teams are identified and documented | An ISO 21511‑compliant WBS is used to capture activities. Activities are sequenced as per the critical path process. Schedules are integrated by automation into a single database, with a documented hierarchy maintained with change control. | Structured schedule data is stored in a shared common data environment between stakeholders and referenced in the schedule using digital processes. |
| The Basis of Schedule, Schedule, Critical Path Analysis and Schedule Risk assessments are available. | The schedule is risk loaded (i.e. includes float), and an integrated cost/schedule risk assessment is conducted. | Schedule modelling techniques are used and connected to other project elements (e.g. cost). |
| Reviews and audits are conducted periodically to ensure documented processes are followed | Schedule performance is monitored during the delivery stage, including using float, variance, and critical path analysis. | Schedule development is aligned to VDAS (good practice information management) to minimise risk and support effective decision making. |
|  | Earned Value Management (EVM), as per Australian Standard AS4817‑2019 is used to integrate schedule and cost for assessment of progress and performance during the delivery stage. | Machine Learning (ML) models trained on past project data are used to benchmark, stress‑test, and optimise the project schedule. |
|  | Continuous improvement systems capture lessons learned and drive refinements to scheduling models. | Time impact analysis is used to quantify the effect of change on the schedule and manage claims |

* + - * 1. Cost

#### What is it?

Costs are the expenditures incurred in the execution of a project over the investment lifecycle. Acost estimate is the summation of the individual cost elements, using established methods to estimate the future costs of a project, based on what is known today.

#### Why is it relevant?

Accurate cost estimation and reporting is essential for effective decision making and managing expenditure within a project’s budget. An inaccurate total estimated investment may lead to the selection of a project that is a less or more suitable investment as well as budget under or overruns. It can also result in the inefficient use of funds and reduce the funding available to other projects or unnecessarily increase financing costs for borrowing more money than what is required.

Scope and program changes may impact the base cost as well as the risk estimate, as changes affect the risk and resourcing profiles. Cost is generally an outcome of project performance and management of the fundamentals of RTCC.

#### Key concepts

**Cost estimation** accuracy should improve over the course of the project, illustrated in Figure 4 against the DTF Investment Lifecycle. The estimated accuracy is lowest at project initiation, as the least information is available. However, a lack of information frequently results in an overestimation of cost to increase the certainty of delivering the project within budget.

Figure 4 – Indicative estimate accuracy across the lifecycle

For successful cost estimation, the following documentation should be developed to an appropriate level as outlined by the **PDDD guidelines**:

* benefits realisation plan which is informed by IMS and PDDD requirements (see 2.1.2), such as the benefit management plan and benefits logic map
* Clearly defined and agreed on scope, including a detailed ISO 21511‑compliant WBS (see [2.1.3](#_Scope) and [3.4.3](#_Work_Breakdown_Structure))
* quality assurance management plan (see 2.1.4)
* preliminary schedule based on an ISO 21511‑compliant WBS (see [2.2.2](#_Time) and [3.4.3](#_Work_Breakdown_Structure))
* Access to historical, credible, and relevant benchmarking cost data
* comprehensive estimating methodology (see [3.5](#_Implementing_Cost_Management) and 4 – Quantifying RTCC).

**Project cash flows** represents the spread of the costs over the financial years in which the funds are expected to be spent. Cash flows should be based on the most realistic project schedule as to when the project will undertake work and the likely expenditure profile (drawdown rate) and reflect the risk profile over the lifecycle of the project. A realistic project schedule is key to the accuracy of the cash flow. In general, as the project progresses risk provisions may decrease. This should be reflected in the cash flow phasings accordingly. It is good practice to update cash flows periodically as and when cost to complete forecasts are updated.

#### Key documents

A **cost breakdown structure (CBS)** is a pre‑requisite in developing a cost estimate. A CBS is a tool to break down the costs of the necessary components of the project, including work by different project partners, contractors and sub‑contractors. The CBS allocates the costs to the lowest reasonable level of detail in the WBS (Section [3.4.2](#_Scope_1)).The CBS must ensure that cost estimates are complete and free from error and can be benchmarked or compared to similar activities or projects.

**Project budget** is the total value of resources approved for a project by the Government based on the business case. It is reset at award of project contracts at the end of the procurement stage.

The **project budget**, including assumptions used in its preparation should be explained and provided as part of the business case. Independent verification is required from an appropriately qualified and experienced professional to ensure that:

* its calculation presents a best‑in‑market cost estimate of the project
* the estimate does not include hidden allowances for escalation and risk
* indirect construction overheads are not included in the direct costs
* departures from government guidelines are identified, explained and justified in terms of best‑for‑the‑State outcomes.

The **cost management plan** describes how project costs have been defined, managed, and validated. Developing the cost management plan requires:

* data from resources requirements and WBS
* the outputs from the cost estimation methods – which should offer increasing accuracy as the project progresses through the lifecycle
* time‑phased forecast with milestones
* benchmarks, techniques and requirements for cost control and performance measurement.

The requirements for the Cost Management Plan are described further in the PDDD Guidelines.

#### Elements of the project budget prior to contract award

Figure 5 – Project budget breakdown



As illustrated in Figure 5, the project budget includes:

* **base cost estimate (BCE)** is a forecast of the future costs of undertaking a project without allowance for contingent risks (future events that may not occur) or inherent risk (uncertainty). A BCE should be accompanied by a basis of estimate document setting out all assumptions and exclusions and describing how the estimate was developed and should align with the Basis of Schedule (described in Section [3.4.2](#_Basis_of_Schedule)). A BCE may include:
* **direct costs:** costs that are directly due to cost items in the schedule, including design and construction contracts, and labour (including professional services). Direct costs also include plant and equipment, and materials. This includes the following costs:
* State project development and due diligence costs
* land acquisition
* contractor’s costs including contracted works, overheads, and profit margins (including incentives/disincentives).
* **indirect costs:** necessary costs to support project delivery, such as project management, and supervision. These costs are indirect as they are unable to be allocated exclusively to a specific WBS element. The cost of project delivery staff applied to the project should not be included in the estimate of the indirect costs if these costs are addressed within the annual operation budget. This includes:
* State project and contract management costs
* delivery agency overheads.
* **project risk** estimate is the State’s provision for inherent and contingent risk and includes:
* **base risk estimate:** the amount estimated for project risk, uncertainty, and escalation with a 50 per cent confidence level. Combined with the base cost estimate, this equals the P50, denoting a 50 per cent probability that the cost estimate will not be exceeded. It is not the sum of all identified project risks and may be higher than the most likely project outcome.
* **escalation** is included as a component of project estimates to fund future cost increases resulting from inflationary factors over the life of the project. An escalation allowance is applied to the project cash flow (the base cost estimate in the financial years in which the expenditure will occur).

The escalation rate should be calculated from actual or forecast composite index series (e.g. consumer, producer, construction or other appropriate price indices) that reflect the characteristics of the project (e.g. proportion of labour versus material costs within the estimate, widening or narrowing of profit margins due to changes in market conditions, increases or decreases in the prices of direct inputs or changes in productivity resulting in changes to the quantity of direct inputs per unit of output).

The rate should be based on established departmental escalation forecasting or as applicable through Commonwealth Government requirements (relevant to projects co‑funded by the Commonwealth such as roads projects). Under certain cases, projects may propose specific escalation rates based on their commercial strategy or contracting arrangements; these may attract further scrutiny from DTF and should not be based on nominal values.

* **excess risk estimate** is an additional risk allocation above the most likely value for all costed project risks. It is a provision for the State to manage in the event that a project exceeds its project cost estimate. This was referred to as contingency in the superseded Victorian Government guidance – Preparing project budgets for business cases.

Figure 6 – Probability of cost outcomes

#### Allocation of the project budget

The project budget developed for the business case is the total estimated investment of the project, which is the sum of the project cost estimate and the excess risk estimate. As illustrated in Figure 7, components of the project budget will be allocated to different parties. For example:

* **those charged with governance:** Excess risk estimate is allocated between parties not having direct responsibility for project delivery. Use of the excess risk estimate should be controlled through defined processes. Decisions and release of funds may need approval by the portfolio Department or Minister, Treasurer or Cabinet
* **Government project team:** The project budget will normally include cost estimates for site acquisition, contractors and professional services that will be managed and paid for directly by the project. Also, the State may retain risks which it is best placed to manage, and this will be reflected in the base risk estimate as funding available directly to the project as appropriate
* **project contractor(s):** The successful contractor(s) will be paid at the amount and at intervals as per the executed project contract. It is recommended that payments are made in line with agreed milestone or progress intervals based on the work completed. All risk, uncertainty, and escalation held by the contractor and included in the contract price becomes part of the base cost estimate when the contract is executed.

Figure 7 – Management and application of the project budget to different parties.



#### HVHR practice for cost control: Earned value management

Earned value management (EVM) integrates the WBS and CBS, allowing a project team to integrate the project cost and schedule without introducing further tasks to project management processes. Described in greater detail in Section 3.5.2 and Australian Standard 4817, EVM:

* objectively measures project performance and progress combining the elements scope, time and cost
* provides early indicators for forecasting the final cost and variances of any project (overruns, delays, or scope creep)
* highlights cost and schedule performance areas that need corrective action.

The critical advantage of EVM is its ability to monitor and report progress via a range of indicators, using data often collected by the project controls team as standard. Reporting of earned value is a new requirement for HVHR projects and requires the development of a baseline from the integrated schedule, WBS and CBS. The baseline is developed during procurement and used for control and reporting during delivery.

EVM progress measurement and reporting is required of all project partners, including monitoring of direct and indirect costs. Progress measurement should be calculated based on the completion on work e.g. quantities installed, hours worked, etc.

#### Maturity assessment

The maturity levels for cost apply to all project phases. Application of the maturity models should be fit‑for‑purpose and allow for efficient delivery of the project (under or overperformance may unnecessarily incur additional time and/or cost).

Table 9 – Cost estimation maturity assessment

| DEFINED All projects | MANAGED HVHR projects | OPTIMISING |
| --- | --- | --- |
| Estimates are based on correlations derived from actual and historical data. | All estimating assumptions are fully documented**.** A robust and insightful peer review process is followed. | Estimates are majority based on previous project norms, historical data, or parametric estimating. |
| Constraints are considered together; with time‑based costs linked to the schedule and to the estimate. | Costs are allocated to CBS elements, which should be aligned with the WBS. | Estimates show a low variability compared with the actual outcomes and are used as a guide for future estimates to improve and reduce cost outcomes. |
| All cost elements are traceable to the project scope statement. | Competent and experienced estimators using relevant benchmark cost data and who are prepared to certify their work. | All relevant stakeholders share ownership and authorisation of the estimate. |
| Cost control systems can track actual costs in multiple categories and report these against the baseline. | Estimates are rigorously analysed, including comparison against known trends and previous estimates. | Continuous improvement: on completion of projects, the actual performance data is used to inform future estimates/ update project norms. |
|  | The impact of constraints is linked to values in an EVM/Integrated cost management reporting system. | The estimation considers value rather than just costs. |
|  | Lessons learned and key decisions made are recorded at the end of an estimate and at the end of the project, documenting treatment of risks, issues and problems addressed. | The level of detail and change control is appropriate to the complexity, size and project cost. |
|  | There is a quantifiable link between the risk assessment and the contingency allocated. |  |
|  | EVM, as per AS 4817, is used to integrate project or programme schedule and cost to a single baseline for assessment of progress and performance. |  |

* + - * 1. Contingency

#### What is it?

Contingency is the allocation of funding to cover State‑retained risk and uncertainty for a project. For the purposes of government, contingency is based on the project risk estimate and is comprised of actual undiscounted dollars. Schedule float is not included, although its associated costs are included in the project risk estimate.

Risks and their funding should be owned and managed by the party with the highest capability to control each individual risk, with suitable governance and oversight to manage them. A risk may be transferred to a third party to improve effectiveness and efficiency (value for money). When this occurs, the price for risk transfer is included in the contract price and becomes part of the base cost estimate.

Note that insured project risks (i.e. project risks for which the cost impact are to be transferred to an insurer at a cost acceptable to the agency and government) are included in the base cost estimate as described above. Transferring risk under insurance contracts exchanges ownership of the liability of the risk (with the uncertainty of the actual outcome against the estimate entailed), with a fixed cost (i.e. the premium).

The project contingency therefore represents a funding provision to cover some or all of the residual risk that has not been transferred or insured and is comprised of:

* **base risk estimate:** the expected cost of risk and uncertainty incurred by the government in delivering the project. This estimate considers all the inherent and contingent risks, the likelihoods of contingent risks occurring, and range of potential impacts for a P50 confidence level, with a 50 per cent probability that the cost estimate will not be exceeded
* **excess risk estimate:** provision for risks in excess of the base risk estimate (i.e. in excess of the P50 confidence level).

Figure 8 – Breakdown of the project budget



#### Why is it relevant

Project risk estimates account for uncertainty about future events. The contingency provides funding to manage the financial impacts of project risks or uncertainties. Delivery entities are required to estimate the appropriate base and excess risk provisions (contingency), and to establish controls to manage cost and schedule impacts, so that costs can be controlled within the project cost estimate.

Inaccurate provisioning for project risk can lead to cost over or underruns or project delays. The **Resource Management Framework** requires that departments ensure that funding proposals for asset investments have included contingency amounts that are well‑developed and robust.

The project risk estimate:

* should not be a substitute for poor cost estimating, project planning, and scheduling
* should not be used to cover unidentified or unforeseen risks (‘unknown unknowns’), which should be managed by the investor at a higher level (at the program/portfolio level)
* should be based on residual risk and uncertainty, after risk treatments are implemented
* should not be included in base estimates in budgets, cost plans, and forecasts, or to the base schedule
* is not a provision for scope changes or extraordinary events (such as natural disasters).

The elements of contingency are allocated differently:

* base risk estimate should be assigned when the budget is reset at contract award and be managed as part of the target cost by the project delivery organisation
* excess risk estimate may be allocated to the delivery entity to manage (non‑HVHR projects), or split between the project, the client department, and centrally with DTF.

Contingency provisions are established in order to manage risks through the delivery of a project. Unused contingency should be returned to the investor for reallocation to other projects.

#### Maturity assessment

The maturity levels for contingency apply to all project phases. Maturity requirements for estimation are discussed in Section 4. Application of the maturity models should be fit‑for‑purpose and allow for efficient delivery of the project (under or overperformance may unnecessarily incur additional time and/or cost).

Table 10 – Contingency maturity assessment

|  |  |  |
| --- | --- | --- |
| DEFINED All projects | MANAGED HVHR projects | OPTIMISING |
| Project risk estimate development and assumptions are documented, including the risk inputs. | Control systems can track consumption of allocated contingency and report these against the baseline and risk register. | Continuous project risk estimate adaptation as risk inputs change. This includes returning contingencies for risks that are no longer relevant to free up capital. |
| Estimating processes are defined, consistent, and repeatable. | Rigorous measurement and analysis is used, including comparison against known trends, previous estimates, and lessons learned from past projects. | Estimates are supported by previous project norms and historical data. |
| Use of contingency is tracked and reported. | The project risk estimate model and assumptions are documented and regularly updated as the project progresses, including the risk inputs. | A continuous improvement process is in place to capture actual data at project completion to update project norms and inform future estimates. |
| Appropriate controls are in place to ensure contingency is used for managing risks and uncertainty. | Estimates for the delivery stage are developed using Integrated Cost and Schedule Risk Assessment (ICSRA). |  |

* + 1. Implementing RTCC
       1. Overall requirements

Figure 9 – Project constraints and elements across the investment lifecycle



The analysis and application of RTCC depends on the project’s progress through the investment lifecycle. in the business case stage, the following is assessed:

* what the constraints are, or should be (e.g. scope and benefits are iteratively established, risk is identified, a completion date is set, etc.)
* who defines or sets constraints (and when)
* how constraints are to be applied and analysed by the project team
* how stakeholders are managed and informed of the constraints and project status.

In the later procurement and delivery stages, the focus of RTCC shifts to:

* allocation of funding, responsibility, and ownership of risks (during the procurement process)
* determining the project status (data collection/monitoring processes)
* assessing the current status against the constraints agreed in baselines
* establishing whether any of the constraints have or will be breached. Potential constraint breaches, such as cost overrun, should be addressed as soon as they are identified to allow for more options and time to deal with the situation
* proposing solutions and ensuring adequate authority is in place to address breaches.

The DTF **Investment Lifecycle and HVHR Guidelines** require project delivery organisations demonstrate a robust project management strategy. Figure 10 provides a summary of the distinction between investment and project management.

Figure 10 – Investment vs project management (Investment Lifecycle Guidelines 2019)



To enable the efficient and practical use of an Integrated Cost and Schedule Risk Assessment (ICSRA) and EVM, all project elements and constraints need to be considered in unison and be accurately maintained. Figure 9 illustrates the considerations for the project elements and constraints (with relevant section numbers) across the investment lifecycle.

* + - 1. Business case requirements

The business case is the primary source document by which a project’s success is defined and assessed in terms of meeting the service need and whether benefits are/were delivered.

Government use the business case as the basis for:

* providing funding and investing in the right things
* ensuring projects respond to a real and priority community service need
* articulating the service need and expected benefits
* assessing whether the project can be delivered within cost and time commitments
* effective ranking against competing priorities articulated in other business cases
* approving the boundaries of the scope to be delivered
* ensuring the quality of the implementation plans
* understanding the time, quality and cost constraints for a project to deliver value‑for‑money outcomes from an investment
* determining the optimal management plan and procurement strategy
* evaluating outcomes.

The business case is therefore a critical document and its accuracy is paramount. A business case should not be submitted for a Government’s decision if there has not been a high‑quality and transparent process to determine a rigorously calculated and defensible project estimate.

Where a business case is not sufficiently developed, further development may be recommended in line with the PDDD Guidelines.

A business case furthermore needs to recommend the preferred procurement strategy (and contracting model). The recommendation should be based on the procurement strategy that delivers the best overall outcome for the State considering several factors such as:

* providing the lowest whole of life cost for the required performance standards
* managing ongoing stakeholder requirements and issues
* relative level of risk given societal expectations and technology advances
* prevailing market conditions.
  + - 1. Implementing risk practices
         1. Victorian Government Risk Management Framework

The Victorian Government Risk Management Framework (VGRMF) sets out the risk management compliance requirements of the *Financial Management Act 1994*. The VGRMF adopts the ISO 31000 *Risk Management* standard.

The Victorian Managed Insurance Agency(VMIA) provides resources and services in the form of advice, tools, guides and kits to support projects to meet the mandatory requirements, as stipulated in sections 3.1.1 and 3.1.2 of the VGRMF.

* + - * 1. Risk reporting requirements

Under Ministerial Standing Direction 5.1.4 – Financial management compliance attestation, departments and project organisations must provide an annual attestation of compliance with applicable requirements of the *Financial Management Act 1994*, the Standing Directions and the Instructions, and disclose all material compliance deficiencies. As required by government policies, projects will be required to submit costed risk registers on a quarterly basis, using a format in line with the template published by VMIA and Appendix 1.

Outlined in the VGRMF, VGRMF practice guide, and VMIA guidance, are risk reporting requirements to allow for the effective monitoring, review, communication and consultation of risk.

For certain risks, including environmental, and health and safety risks, legislation requires the project to eliminate or reduce these risks so far as is reasonably practicable to do so.

The gateway review process mandates categories for risk identification and classification, which requires consideration of a wide variety of risks. These risk categories shall be used to classify and maintain risks in the risk register:

* strategic, political and/or reputational
* legislative
* implementation and operational service risks including business, technical, financial, commercial and/or contractual
* for IT‑enabled projects, information security risks
* for e‑government, risks relating to poor take‑up
* for construction projects, risks relating to; health and safety, environmental, and the condition of the asset (including latent conditions);
* for policy projects, regulatory risks.

Table – Risk reporting requirements across the investment lifecycle

|  |  |  |  |
| --- | --- | --- | --- |
| **Project size** | **Business case** | **Procurement** | **Delivery** |
| Non‑HVHR | Costed risk register (in business case) | Costed risk register, submitted quarterly | Costed risk register, submitted quarterly |
| HVHR | Non‑HVHR requirements | Non‑HVHR requirements and a qualitative assessment | Non‑HVHR requirements and a qualitative assessment |

* + - * 1. Steps for implementing risk practices

Risk activities should not be completed in isolation to the other project elements or constraints. Risk practices as well as the resulting documents should be regularly revised and updated as the project progresses. The steps for implementing risk practices align with ISO 31000, which broadly describes a risk management framework, as illustrated in Figure 11.

Figure 11 – Risk Management Framework (based on ISO 31000)



As per the risk management framework discussed in [3.3.2](#_Risk_Management_Framework), as a minimum, the following activities should be done:

1. **Establish context:** Define the scope for the risk management process, setting objectives and expected benefits and developing risk evaluation criteria. The full risk context must consider both external elements (regulatory environment, stakeholder expectations) and internal factors (contracts, systems and control, capability, capacity).

The following principles should be considered when estimating project risk:

* clarity regarding the main objectives, materiality and deviation tolerance
* lessons learnt or benchmarks used in identification and quantification
* risk estimate is robust and well defined
* frequency for review ensures an accurate Risk Register
* value for money for the State is a critical criterion
* optimism and pessimism bias are considered and minimised.

1. Risk assessment:

**Identification** of risks that may prevent the achievement of project objectives using an appropriate method. Risk identification is often initially completed as part of a risk workshop which should include appropriate project stakeholders, a skilled facilitator, and the use of risk identification tools. The use of the risk‑related tools, resources, guides, and advisory offerings of the VMIA is strongly recommended. Other risk identification options using a previous risk register, risk prompts, use of a risk breakdown structure (RBS) to help identify gaps and risks, or expert judgment.

Table – Example of a generic risk breakdown structure for a project

|  |  |  |
| --- | --- | --- |
| **RBS Level 0** | **RBS Level 1** | **RBS Level 2** |
| All sources of project risk | * + 1. Technical risk | 1.1 Scope definition  1.2 Requirements definition  1.3 Estimates, assumptions and constraints  1.4 Technical processes  1.5 Technology  1.6 Technical interfaces  1.7 Health and safety  1.8 Environmental  1.9 Asset condition, including latent conditions  1.10 Information security (for IT‑enabled projects) |
| * + 1. Management risk | 2.1 Project/Programme management  2.2 Capacity and capability  2.3 Governance  2.4 Communication  2.5 Other |
| * + 1. Commercial and legal risk | 3.1 Procurement  3.2 Commercial  3.3 Legal  3.4 Probity |
| * + 1. Engagement and communication risk | 4.1 Strategic, political and/or reputational  4.2 Stakeholder and community engagement  4.3 Communications  4.4 Media |
|  | * + 1. External risks | 5.1 Legislative and/or regulatory  5.2 Foreign Exchange |

**Analysis** (for risk quantification – see Section 4.4 Risk estimation methods) of the sources and causes of identified risks; probabilities and consequences given the existing controls, to determine the level of risk. Both qualitative and quantitative risk analyses must be conducted:

**qualitative risk analysis**: risks are identified and evaluated usually in a workshop using a predefined subjective rating scale, such as high, medium, or low likelihood and minor, moderate, or significant consequence. A risk matrix is often used to combine these elements to both describe the probability of an event, and the severity of the consequences/the impact of the risk event should it occur of risk. Some systems also consider risk proximity, which is a time‑based technique based on when the event is most likely to occur. Qualitative risk analysis can underestimate risk until the impact becomes visible, by which time it may be too late to treat the risk effectively.

**quantitative risk analysis**: risks are quantified using quantitative data and modelling techniques, such as the suggested use of Monte Carlo methods for risk evaluation. Quantitative risk analysis involves mapping identified risks from the risk register to constraints and conducting investigations to determine the impact the event will have on the project, such as increased project cost and time (a schedule risk analysis).

**Evaluation**: There is risk in identifying, analysing and evaluating project risks in isolation. For HVHR projects, the role of a Risk Manager is necessary to ensure that risks in different project elements and disciplines, and their interactions, are adequately analysed on an ongoing basis. This function will also ensure that appropriate contingencies are determined, and risk allocation/handovers are well managed. Quantification of risk and determination of contingency is discussed in Section (c)4.4.

1. **Risk treatment** aims to reduce the magnitude and likelihood of negative consequences of project objectives to reduce the residual risk and achieve a net increase in benefit. Various risk treatment tools and techniques exist including accept and monitor, avoid, reduce likelihood of occurrence, reduce impact, transfer or terminate. Risk treatment should be planned and implemented accordingly:

**Plan risk response:** Treatment options for risks should be identified, especially for those that exceed the acceptable risk level (also known as risk profile or risk appetite). Quantifying risks assists in determining trade‑offs, such as the justification for treatment costs. To assist with the identification and creation of risk treatments, a tiered model can be adopted, e.g. Tier 1: Strategic, Tier 2: Operational and Tier 3: Compliance.

**Implement preventative treatments**: Implement preventative risk treatments prior to the risk occurring.

**Update quantitative risk analysis**: The risk register and the quantitative risk analysis should be updated based on the forecast residual risk after preventative treatments are applied.

**Implement risk response:** If the risk occurs, the planned intervention should be implemented. Following this, the risk register/repository and lessons learnt are updated with the actual consequence of the risk event on a periodic basis.

1. **Ongoing risk management:** Management of risk requires the tasks of:

**monitoring and review**, to measure performance against regularly reviewed and updated risk indicators. It involves:

updating the quantitative risk analysis based on the outcomes from risk treatment

reporting on risk, the identification of deviations from the risk management plan, and the implementation of corrective measures and controls

checking the appropriateness and effectiveness with the risk management framework, policy and strategy, and adjusting where necessary.

**communication and consultation** is required to understand stakeholder interests and concerns and to check that the risk management process is focusing on the right elements, and to present the rationale for decisions and risk treatment options.

**Reporting** ofrisk to affected stakeholders and management based on the risk register

* + - 1. Implementing time practices
         1. Time reporting requirements

Table – Time reporting requirements across the investment lifecycle

|  |  |  |  |
| --- | --- | --- | --- |
| **Project size** | **Business case** | **Procurement** | **Delivery** |
| Non‑HVHR | Milestone list  Forecast end date  Project Schedule | Milestone list  Forecast end date  Approved end date  Project schedule | Milestone list  Forecast end date  Approved end date |
| HVHR | Non HVHR requirements and a Detailed Project Schedule | Non HVHR requirements, a Detailed Project Schedule and a qualitative assessment | Non HVHR requirements, a qualitative assessment and earned value in line with Government policy |

* + - * 1. Prerequisites for time management

#### Basis of Schedule

The Basis of Schedule (BoS) is updated as the project progresses and should include:

* **Project scope:** The BoS should summarise details relevant to the schedule and link to other documents (to minimise repeating information). As the project progresses, this should be updated (for example, as per the detailed WBS as discussed below).
* **Schedule purpose and integration:** Details how schedules from various parties (e.g. subcontractors) will be integrated, who has access and how information will be disseminated and key accountabilities and responsibilities (including contact details).
* **Period of performance, key dates and constraints:** Includes key project milestones (e.g. projected start, end and others such as interface and regulatory compliance dates). Constraints should highlight risks that may impact the schedule e.g. limited availability of equipment or areas of the site.
* **Schedule duration basis:** Describes the process used to estimate activity durations.
* **Critical path:** Describes the schedule’s critical path(s) (see below).
* **Delivery plan and resource usage:** Describes the type of work (e.g. expansion project), and how the project will be delivered, including resourcing, contracting and performance strategies, and other items that may affect the schedule, e.g. working hours/overtime, calendars/holidays, planned disruptions, options to accelerate, etc.
* **Schedule risks:** Summary of schedule threats and opportunities, such as site access, labour availability, weather, and project complexity.
* **Schedule float:** Describes the basis and analysis for the schedule float as expressed either as a period, or the expected cost required to mitigate schedule risk.
* **Contributors, assumptions and exclusions:** Contributors to the schedule development and review, what assumptions/data was provided (and by whom).

The PDDD details the definition required of the BoS and Baseline Schedule at each investment stage.

#### Critical path analysis

The critical path is the most extended continuous sequence (or sequences) of activities in a schedule. Analysis of project activities is necessary to build the schedule and determine the critical path. The schedule should be examined to identify high‑priority processes and interfaces in the project, and prioritise completion of activities to optimise the critical path and the overall project completion date.

The critical path is not constant as the project progresses. Activities may be delayed, finish early, or become out of sequence, resulting in critical activities becoming noncritical and vice‑versa. Activities are classified as critical if they affect the project completion date. Accurate identification of the critical path can be assisted by considering date constraints, lags, and leads:

* **Date constraints** can be put on an activity’s start or finish date and can override these dates. They are most often used when external events influence the project schedule, such as the availability of critical resources or access to the site.
* **Lag** describes the delay time between the first and second activities. A time lag delays the start date of the successor activity.
* **Lead** refers to an activity starting when the predecessor activity is still running, resulting in an overlap between the two activities. Lead is also known as ‘negative lag’ and is used to compress the schedule. However, the use of lead times can complicate the schedule logic; simplifying such activities can be achieved by creating two simultaneous activities, with one of the activities being longer or shorter.

Figure 12 – Example of a simplified critical path



#### Work breakdown structure

The WBS is an essential foundational element for monitoring and controlling projects and should be linked to the cost breakdown structure (CBS) (ideally through a live dataset).

A WBS organises and defines the scope of the project and can be represented using a tree structure to show the work required to achieve the project objectives, as illustrated in Figure 13. The WBS is typically managed within a scheduling program, as illustrated in Figure 14. HVHR projects, at all stages of the investment lifecycle, must adhere to ISO 21511 *Work breakdown structures for project and programme management*.

An increasingly detailed definition of the project work is described at each descending level of the WBS. The first tier of tasks outlines the major deliverable work areas of the project, which are then broken down into logical groupings of work. The lowest‑level WBS components are called work packages and contain the definitions of work to be performed and tracked in the schedule.

Schedule definition for the business case stage may use a top‑down methodology; however, later stages need a sub‑item or price build‑up level of detail (illustrated as level 4 of Figure 14).

Figure 13 – Sample work breakdown structure hierarchy



Figure 14 – Sample work breakdown extract (adapted from DIRD 2017)

|  |  |  |  |
| --- | --- | --- | --- |
| Level 1 | Level 2 | Level 3 | Level 4 |
| **Element** | **Heading Sub‑heading** | **Main item** | **Sub‑item or price build‑up** |
| **Project + phase** | **Earthworks** |  |  |
| **Earthworks preparation** | Clearing and grubbing | Dozer, Type x |
| **Road project x: Delivery** |  |  | Tipper |
|  |  | Loader |
|  |  | Labourers x 4 |
|  | Strip topsoil | (Rate make‑up generally as above) |
| **Bulk excavation** | Bulk excavation (other than rock), cut to fill | (Rate make‑up generally as above) |
|  | Excavate and dispose of unsuitable material |  |
| **Bulk filling** | Imported bulk filling to embankment, compacted | Supply imported filling |
|  |  | Grader, Type x |
|  |  |  | Compaction roller |

* + - * 1. Steps for implementing time practices

The following activities may have to be repeated, and the resulting documents revised as the project progresses:

1. **Identify activities**: Develop a WBS defining the individual work packages to be done.
2. **Establish duration of activities:** Duration for each activity should be based on the same rigorous rationale, historical data and assumptions used for project cost estimations.
3. **Prepare a Basis of Schedule (BoS):** As described in [3.4.2](#_Basis_of_Schedule), the BoS is a document that forms the baseline for schedule development and which records all the assumptions and exclusions that will go into the preparation of the Schedule. The BoS should be carefully compared with the basis of estimate to identify any possible areas of misalignment.
4. **Sequence activities**: The WBS activities are sorted chronologically and linked, meaning that some activities can only start when a predecessor activity has been completed. All activities should have a predecessor and successor except the first and last activity. In this section, relevant date constraints, lags, and leads are documented (defined below).
5. **Assign resources to activities**: Resources, such as staff, materials, and plant and equipment are assigned to the respective activities. In this step, a planned approach to allocating resources can increase schedule and cost efficiencies, such as adjustment of the activity start or the allocation of resources to consider resource availability. As resources are limited, demand for the resources at a given point in time must be balanced with the available supply. To resolve under or over allocation, project managers can either reallocate resources or change the activity start when enough resources are available. Balancing resource demand can benefit from using resource levelling tools and techniques. This activity assists project managers in identifying interactions and highlight dependencies and sensitivities, between cost and schedule.
6. **Verify schedule traceability**: (horizontally and vertically):

Horizontal traceability requires the overall schedule to be logically planned, accounting for interdependences of activities and work packages and areas.

Vertical traceability requires that all levels of activities and sub‑activities can be traced and are thus consistent in dates, status, scope requirements, and milestones. Lower‑level schedules are consistent with upper‑level schedules, allowing for a schedule integration with which different teams can work to the same schedule expectations.

1. **Critical path analysis**: As discussed at [3.4.2](#_Basis_of_Schedule), the critical path is the longest duration through the sequence of activities; this analysis assesses how delays along the critical path impact the project completion date.
2. **Quantify and ensure reasonable total float:** Total float is the amount of time that an activity can slip before the delay impacts the estimated finish date of the project. Free float is the amount by which a task can slip before it delays its successor. The total float should be managed proactively as activities with low total float indicate schedule risk and can affect the critical path. The amount of schedule float should always be known and managed carefully.
3. **Update the schedule using actual progress and logic:** Updating the schedule with actual dates and progress to recalculate forecasts. This is a critical step to ensure the reliability and accuracy of the schedule and forecasts.
4. **Maintain a baseline schedule:** A baseline schedule of a project is the original configuration of the project scope, the time for completing the associated activities, and the resources required for the activities to complete the project. The actual or current schedule should be continuously monitored against the baseline schedule to track variances, identify and mitigate the effects of undesirable performance. Identifying schedule variations can help management with their future risk management. Establishing a baseline is extremely important to track variations from the original plan and identify scope change and creep.
   * + 1. Implementing cost practices
          1. Cost reporting requirements

Table – Cost reporting requirements across the lifecycle

|  |  |  |  |
| --- | --- | --- | --- |
| **Project size** | **Business case** | **Procurement** | **Delivery** |
| Non‑HVHR | Base cost estimate (time phased) | Actual expenditure  Forecast expenditure  Variance (Budget – Actual) | Actual expenditure  Forecast expenditure  Variance (Budget – Actual) |
| HVHR | Non HVHR requirements | Non HVHR requirements and a qualitative assessment | Non HVHR requirements and a qualitative assessment, planned value in line with Government policy and earned value in line with Government policy |

* + - * 1. Pre‑requisites to cost management

#### Cost breakdown structure

The CBS is used to compare the actual costs with the forecast. The PDDD Guidelines note that a CBS aligned with a well‑developed WBS can be provided as an example of evidence of a robust and comprehensive cost estimation process. The CBS should include:

* should be based on and linked to the WBS (as illustrated in Figure 14), but can be categorised into a pre‑defined hierarchical structure that deviates from the WBS
* includes indirect cost items
* is a derivative of the WBS, the main difference being that the CBS is composed of project factors related to accounting costs, whereas the WBS is composed of work tasks
* sorts costs into categories, e.g. work disciplines, process phases, and locations
* allows cost tracking, and comparison of forecast against actual costs
* includes the cost for the respective item, and can further include the booking number, reference for the accounting system, invoice number and the cost area.

Figure 15 – Sample CBS



#### Earned value management

Earned value management(EVM) integrates cost and schedule data to provide a single baseline project performance status (as per Figure 15). The use of EVM improves the ability of the project or program to accurately track and receive early warning of deviations, so corrective action can be taken. The calculation of earned value is typically the role of the project scheduler with insights from the technique used by the SRO.

Table 16 provides an example of the benefit a simple calculation provides in highlighting how much it cost to perform the work against the actual cost.

Figure – EVM performance chart

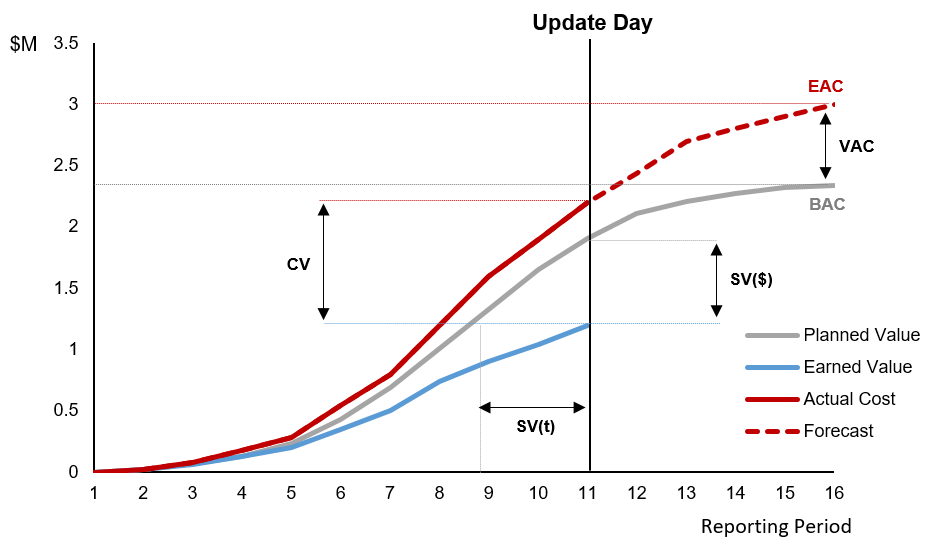


Table – EVM analysis

|  |  |
| --- | --- |
| **SV = schedule variance** describes how much the project is ahead or behind schedule. | SV = EV – PV, a negative value means behind schedule, SV% = (SV/PV) X 100 |
| **CV = cost variance** describes how much under or over budget the project is. | CV = EV – AC, a negative value means above costs, CV% = (CV/EV) X 100 |
| **VAC = variance at completion,** compares the budget at completion (BAC) with the current estimate at completion (EAC) | VAC = BAC – EAC; VAC% = (VAC/BAC) x 100, EAC = Actuals to Date + [(Remaining Work)/(Efficiency Factor)] |
| **SPI = schedule performance index** indicates how far behind or ahead of the planned work the project is. | SPI = EV/PV, Ahead (> 1) or behind (< 1) schedule |
| **CPI = cost performance index** describes the index of earned value to actual costs. | CPI = EV/AC, Over (< 1) or under (> 1) budget |

Table – Example EV and AC calculation

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Work package (WP)** | **WP status** | **Budget  (PV)** | **Earned  value (EV)** | **Actual  cost (AC)** |
| WP 1.3.1 | Complete | $16 000 | $16 000 | $20 000 |
| WP 1.3.1.1 | In progress | $32 000 | $16 000 | $19 000 |
| WP 1.3.1.2 | In progress | $5 000 | $1 250 | $1 250 |
| WP 1.3.2 | Not started | $12 000 | $‑0 | ‑0 |
|  |  |  | **$ 33 250** | **$ 40 250** |

* + - * 1. Steps for implementing cost practices

The following steps are recommended for project cost management:

1. **Cost management plan**: provides cost estimates, time‑phased budget and allocations, control thresholds, and how cost performance will be measured (see 3.4.2).
2. **Estimate costs**: determine forecasted costs (see Section 4.3). This is significantly assisted by creating a cost breakdown structure (see [3.5.2](#_Cost_Breakdown_Structure)).
3. **Estimate forecast:** establish a time‑phased cost baseline showing when costs are incurred and how the budget is apportioned between the involved parties. This baseline may be created against a reference project.
4. **Business case approval**: government approval of the project and budget.
5. **Updating costs**: update estimated costs with actuals throughout the project lifecycle, especially as bids are received, contracts are agreed, or the project definition improves. When risks are realised or incorporated into a contracted price, the allowances for those risks should be transferred into the base cost estimate. Invoices should be allocated to the respective activities and incorporated into the earned value management system on an accrual basis.
6. **Establishing a baseline:** EVM requires the following (as per AS 4817):

define the scope (as described in 2.1.3)

develop the WBS (as described in 3.4.2)

schedule the work (as described in 3.4.3)

assign the budget to the work (current section)

determine the budgeted cost of work

establish the baseline used to measure work achieved.

1. **Monitor costs:** Monitoring and controlling costs requires keeping track of planned and earned value, in addition to accruals and cash flow. Tracking delivery performance allows future cost and schedule pressures to be identified, and for the necessary corrective measures to be implemented.

EVM allows costs to be controlled using a time‑phased baseline during the deliverystage(see 3.5.2).

Change control of identified time and cost changes:

Identify changes in excess of an agreed minimum

Classify changes depending on approval requirement and source of change such as estimate rate, design change, contingency or client requirement

Approval or noting of changes as appropriate

Approval of estimate forecast in a periodic project review

Rebaselining of cost and time based on reviewed current forecasts. Where required due to complexity of changes approved, noted and forecast.

See Appendix 2 for a change control procedure. Actual requirements depend on the project specifics and contractual relationships.

* + - 1. Implementing contingency management

This section discusses contingency allocated against the risk estimate, which includes the base risk estimate and any excess risk estimate.

* + - * 1. Contingency reporting requirements

As a project progresses, and risk and uncertainty decreases, it is important that the use of contingency is monitored and reported at regular intervals. Regular monitoring and reporting provide for transparency and consistency and a more accurate understanding of overall exposure.

Table – Contingency reporting requirements across the investment lifecycle

|  |  |  |  |
| --- | --- | --- | --- |
| **Project size** | **Business case** | **Procurement** | **Delivery** |
| Non‑HVHR | Risk estimate identifies contingency recommended for the project | Total contingency provision  Forecast expenditure including contingency | Total contingency provision  Forecast expenditure including contingency |
| HVHR | Non HVHR requirements | Non HVHR requirements, remaining contingency held by project and remaining contingency held by central agencies | Non HVHR requirements, remaining contingency held by project and remaining contingency held by central agencies |

* + - * 1. Steps for implementing contingency management

The following steps are recommended as an approach for the effective management of the contingency and its allocations (both base risk estimate and excess risk estimate). Steps 3‑6 should be done iteratively as the project progresses through the lifecycle:

1. **Planning, identification, and calculation**: See Section 3.3 Steps for implementing risk practices.
2. **Allocation**: Allocation of contingency should be appropriately distributed across central agencies, client/investor, and delivery agency/project levels in line with government policy so that the risk is managed by the parties with the highest capability to control the risk with suitable governance and oversight.
3. **Spending**: Project contingency should be used in a transparent and traceable way to fund uncertainty and realised risks from the Risk Register. Release of centrally held contingency should be justified against realised risks, changes, and contract variations.
4. **Monitoring**: Use, and eventual return should be monitored, and updated over the project lifecycle. This includes recalculating the project risk estimate and updating the risk register as the scope is refined, new risks are identified, or risks eventuate or are closed.
5. **Returning**: Where project risks have been successfully managed during project delivery, contingency funds should be returned to the investor at regular frequencies to allow for optimal investment.
6. **Reporting**: Continued reporting to provide visibility of overall use.
   * 1. Quantifying RTCC
        1. Prescribed estimation approach

The following tables outline the minimum estimation approaches required to be used when in the business case, procure and delivery stages for Non‑HVHR and HVHR projects and programs.

#### Project schedule

Table – Schedule estimation methods across the investment lifecycle

|  |  |  |  |
| --- | --- | --- | --- |
| **Project size** | **Business case** | **Procurement** | **Delivery** |
| Non‑HVHR | Analogous where comparable data exists. | Analogous where comparable data exists.  For new design: detailed build‑up; composite level of detail | Detailed build‑up from WBS; moving to actual productivity and lessons learnt. |
| HVHR | Detailed build‑up where feasible, otherwise parametric | Detailed build‑up from WBS; first principles based on reference design. | Detailed build‑up from WBS based on detailed design; moving to actual costs, lessons learnt. |

#### Project cost

Table – Cost estimation methods across the investment lifecycle

|  |  |  |  |
| --- | --- | --- | --- |
| **Project size** | **Business case** | **Procurement** | **Delivery** |
| Non‑HVHR | Analogous or parametric where highly comparable data exists.  For new design: Detailed build‑up; composite level of detail or higher | Detailed build‑up, ideally from CBS; unit rate level of detail or higher | Detailed build‑up from CBS; moving to actual costs, lessons learnt. |
| HVHR | Detailed build‑up from CBS where feasible, otherwise parametric | Detailed build‑up from CBS; first principles based on reference design. | Detailed build‑up from CBS; first principles based on detailed design; moving to actual costs, lessons learnt. |

#### Project contingency

Table – Contingency estimation methods across the investment lifecycle

|  |  |  |  |
| --- | --- | --- | --- |
| **Project size** | **Business case** | **Procurement** | **Delivery** |
| Non‑HVHR | **Deterministic**: parametric modelling/predetermined guidelines | **Deterministic**: parametric modelling/predetermined guidelines | **Deterministic**: parametric modelling/predetermined guidelines |
| HVHR | Parametric with probabilistic simulation of risk events | Probabilistic simulation | **Probabilistic**: integrated cost and schedule risk assessment |

* + - 1. Level of confidence (P‑values)

Project cost and schedule estimates are expressed as a likely range of cost and schedule outcomes, often as a *level of confidence*. The level of confidence describes the likelihood that the actual duration and cost comes in at or before the estimated completion date and investment.

The level of confidence is usually expressed as a P‑value, such as P25, P50, and P75

* **P25** means that there is a likelihood of 25 per cent that the schedule duration or costs will be lower than, or equal to the P25 value.
* **P50** describes that there is a probability of 50 per cent that the forecasted duration/costs will be lower than or equal to the duration/costs of the P50 value. It also means that there is a 50 per cent chance that the schedule duration/costs will exceed the P50 value.
* **P60** means that there is a likelihood of 60 per cent that the schedule duration/costs will be lower than, or equal to the P60 value.

At the start of the business case stage of the project, the scope and risks are being defined so the estimate accuracy is low with a wide range of possible cost outcomes. As the project progresses through the project lifecycle, the range of likely cost outcomes converges as illustrated in Figure 17, allowing the project budget to be reset based on actual contract pricing at the end of procurement, and converging on the final outturn cost when the operational asset is delivered to its final owner.

The budget breakdown illustrated in Figure 17 is applicable for most traditionally developed projects but does not necessarily represent best practice. Improving project definition at the business case through front end planning can reduce the P60 and project risk estimate as risks are better quantified, despite increasing the base cost estimate.

Figure 17 – Budget allocations across the investment lifecycle

* + - 1. Cost and time estimation methods

The accuracy and reliability of cost and schedule estimates are dependent on the level of detail and the quality of the project definition. Estimates need frequent updating, as project definition improves and actual costs become known.

It is important to consider the following to ensure the quality of the cost and schedule estimates:

* methods are appropriate for project size, complexity and risk profile, and become increasingly detailed and advanced, achieving higher accuracy, across the project lifecycle
* accuracy requirements i.e. top‑down is quicker to develop but can be less accurate than a well‑developed bottom‑up estimate
* qualified and experienced resources should be used
* benchmarks and databases should be used (where available) to validate estimates
* assumptions, qualifications and exclusions should be documented and communicated across the investment lifecycle.
  + - * 1. Top‑down or analogous method

A **top‑down** estimate sets a forecasted cost/duration for a project, usually without undertaking a detailed cost analysis. This implies the overall project estimate is made first, and then the estimated project duration or budget value is allocated to the sub‑tasks required to complete the project. This type of estimate is not accurate and is typically only employed:

* early in the project lifecycle for option selection (before the business case) or for preliminary business cases
* where there is a fixed budget or duration, and scope is made to fit a budget or timeframe
* where there is enough data available on an analogous project to know that the funds/time allocated top‑down to the lower levels are realistic.

The estimate is derived from similarities between the current project (resource cost and time requirement) and (as the name implies) equivalent data from past comparable projects, adjusting for differences. Any deviations and differences between the historical and present project must be identified and documented. Where highly relevant analogies exist, this method requires the least amount of time to develop an approximation of time and cost estimates.

* + - * 1. Parametric method

Parametric estimating uses correlations developed from historical data to predict cost and schedule outcomes. This technique is valid where a mathematical relationship exists and can be identified between the costs or schedule of a project and its key parameters or characteristics.

The accuracy of parametric modelling is dependent on access to relevant historical data, with better outcomes achieved where the project scope falls within the range of existing data.

* + - * 1. Detailed build‑up (aka bottom‑up) method

The detailed build‑up is developed from the bottom up. To be accurate, this kind of calculation requires detailed design specifications and a good understanding of the project and its interactions. Bottom‑up estimating is characterised by determining the individual activity costs and time durations and rolling it up from the ‘bottom’ to an overall total estimate. The methods below describe increasing levels of build‑up estimating accuracy:

1. **Composite estimating**: includes rates that combine several work items. For example, in the early stages of a project the details around the installation of a connecting pipeline would be limited e.g. requirements of length, fittings, valves. Depending on the quality of statistical data gathered from historical projects, a composite can be used which sees the pipe as standard lengths of an assembly consisting of the sum of pipe material cost, components (such elbows and valves) and can further include insulation, painting and testing in such a composite cost per unit. Similarly, the estimated time required for such a fitted, insulated and tested pipe can be based on a composite estimate.
2. **Unit rate estimating**: requires the project to be broken down further to practicable individual units. For each item, the quantity of work is multiplied by unit rates for cost and time. The unit rates are determined based on historical data, considering possible risk and other margins when using contractor costs. Depending on the required accuracy, this involves using historical data but additionally adjusting them for several factors, such as inflation or deflation, historical escalation, site condition and location e.g. flat vs. mountainous, and specific risk profile.
3. **First principles estimating**: Project‑specific costs are based on a detailed study of individual resources (plant and equipment, labour, material, subcontracts) for each element of the WBS. A high level of input and detail is required as the time requirements, and cost implications of an activity are considered as the sum of all its parts, including the resources needed to perform the activity. An accurate knowledge of the resourcing costs, productivity and activity duration is required. The sample estimate below illustrates the resource estimate and budget estimate for the preparation and tiling of 10m2.

|  |  |  |
| --- | --- | --- |
| **Resource requirements** | **Cost/budget** | |
| * + 1. General labour = 10m² \*3[workers]/25[m²/day] = 1.2 worker days     2. Tiler = 10m²\* 1[workers]/25[m²/day] = 0.4 tiler days     3. Mortar = 10m²\* 0.025[m³/m²]\*1.15[%waste] = 0.288 mortar m³ | | * + 1. General labour = 1.2days \*100[$/Day] = $120.00     2. Tiler = 0.4days \*100[$/Day] = $40.00     3. Mortar = 0.288m³ \*130[$/m³] = $37.38 |

First‑principles resource estimating for materials intensive projects can be supported by:

* **Take‑off**: Also known as a material take‑off, derives its name from the estimator ‘taking off’ the materials from the engineering drawings. It is commonly used in construction and is focused on accurately estimating the materials required to complete a project.
* **Hybrid**: The hybrid estimate is less detailed than pure first principles estimating as it combines the unit rate estimating and the first principles estimating methodology, e.g. 40 per cent unit rate estimates, or 60 per cent cost estimates based on first principles.
  + - 1. Risk estimation methods

Risk is quantified through either applying deterministic (considers the impact of a single risk scenario) or probabilistic (considers all possible scenarios, their likelihood and associated impacts) methods, based on the risks listed in the risk register. Probabilistic assessments are characterised by inherent uncertainties, partly related to the natural randomness of risks, but also related to the level of project definition and identification and measurement of the risks, exposure and vulnerability.

Hybrid methods may also be used to improve a deterministic estimate by considering additional contingent risks. These contingent risks are priced by multiplying the probability of occurrence by the estimated time or cost impact of the risk eventuating.

* + - * 1. Deterministic (including parametric modelling) methods

Deterministic methods are used to assess the impact of specific risk events on the project cost and time. They can include the following methods, which are listed in order of increasing accuracy:

* **Expert judgement**: Cost and schedule impact of risks are estimated based on prior experience. This is considered the least accurate method, as judgment can be biased or inconsistent
* **Predetermined guidelines**: Risk impacts are estimated using varying degrees of judgment and empiricism; whether through standard values or a scoring mechanism to estimate cost and schedule impacts. This method is understandable and consistent but does not effectively capture project‑specific risk
* **Parametric modelling**: Correlation derived from a regression analysis of outcomes for historical projects. This empirical approach is consistent, providing statistical information about ranges, but requires statistical skills and historical data. Due to its reliance on historical data it may not effectively capture project specific risks, especially for unique or novel projects.

Deterministic methods are permitted for non-HVHR projects where enough historical data is available to predict the likely range of cost and schedule outcomes, with tools available from the website of the Commonwealth Department of Infrastructure, Transport, Regional Development and Communications. Supporting information, basis and details of assumptions will be required as evidence during the business case stage.

* + - * 1. Probabilistic methods

Probabilistic methods represent a more sophisticated approach to risk estimation and management. These approaches use statistical techniques (e.g. Monte Carlo simulation) to identify the level of confidence that a project will meet the forecast completion date and budget. It considers the variability (uncertainty and risks) or distribution of the estimate and provides a level of confidence that a project will meet the forecasted completion date or budget. The float and project risk estimate are quantified for the level of confidence.

At the most basic level, contingent risk is priced by multiplying the expected increase in time or cost by the probability of the risk occurring, to determine the expected cost and schedule outcome. In practice, the likelihood of occurrence and the best case, expected, and worst‑case impact on cost and schedule must be nominated for each risk, and correlations used to capture interactions between different risks in a Monte Carlo analysis.

Monte Carlo simulation techniques should also be used capture inherent risk factors that affect many cost or cost components, such as labour cost per hour or productivity. Ranges or distributions are entered for each risk factor, and the level of confidence for a given outcome is then determined as an outcome of a Monte Carlo simulation. The outcomes should be scrutinised to ensure that costs of risks are not duplicated.

The more advanced techniques such as integrated cost and schedule risk assessment combine the analysis of cost and schedule risk to assess the effects of risk events on the critical path and measure the subsequent effects on resourcing and project budgets.

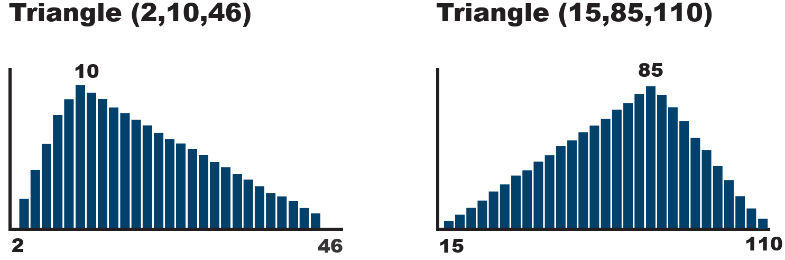
Probabilistic methods that do not include simulation, such as range‑based estimating, are permitted for non‑HVHR projects to quantify contingent risk events (risks that may or may not occur). However, capturing correlation between risks is not practical without simulation and so deterministic methods such as parametric modelling are preferred for inherent risk.

Probability distributions

Probability distributions are used to evaluate the probability of occurrence of possible cost and schedule outcomes. Typical probability distributions used in estimating are:

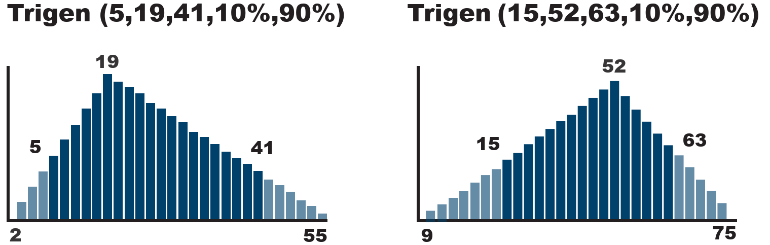
1. **Triangular distribution**: The triangular distribution is the most used probability distribution, defining the minimum, most likely (median), and maximum value. It can be positively and negatively skewed.

Figure 18 – Sample triangle distribution



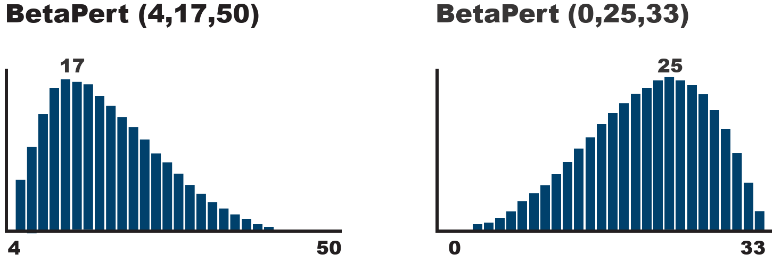
1. **Trigen (10 per cent‑90 per cent)**: is like the triangular distribution, except the corners are cut off. The optimistic and pessimistic values are set at specific probability boundaries, not at 0 per cent, meaning that there is a defined likelihood that the distribution limit will be exceeded.

Figure 19 – Sample trigen distribution



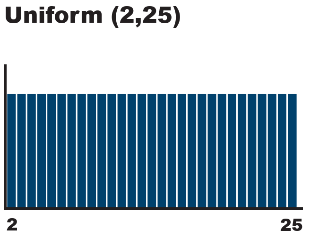
1. **BetaPert or normal distribution**: The so‑called PERT (Program Evaluation and Review Technique) is based on the beta distribution and is often just called BetaPert. The BetaPert distribution is a positively or negatively skewed normal distribution. A normal distribution is symmetrical, with the most likely value being the mean. The BetaPert distribution places the final estimate closer to the most likely value or least likely value.

Figure 20 – Sample BetaPert distribution



1. **Uniform**: only two values (the minimum and maximum) are required as all the values in between have an equal likelihood of occurring.

Figure 21 – Sample uniform distribution



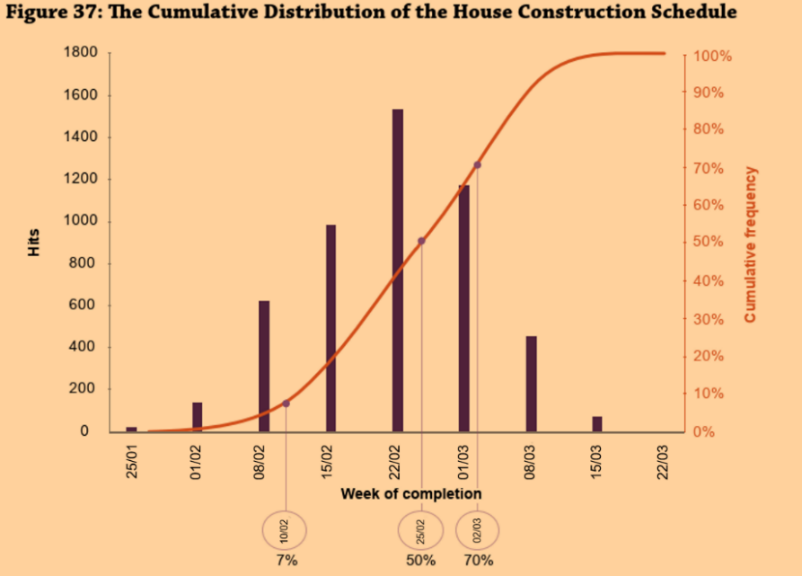
* + - * 1. Monte Carlo simulation

Once risks are allocated probability distributions and correlations, simulation software can determine the effect of uncertainty on the overall project using the Monte Carlo simulation technique. It does this by using repeated random sampling to determine the probability of defined outcomes, to represent the overall project risk profile.

Depending on the number of risks, and the specified distributions for them, a Monte Carlo simulation may involve tens of thousands of iterations. This produces a frequency distribution that shows the range and probability of project outcomes (total cost or completion dates). The simulation randomly selects new durations from the point estimates for each activity in the schedule or costs based on the probability distribution. It then recalculates different outcomes through performing multiple forward and backward passes through the schedule or cost estimate. By repeatedly assigning random numbers to the distribution, the Monte Carlo simulation produces distributions of possible outcome values. The Monte Carlo simulation predicts the likelihood of an outcome, which can be represented graphically, with confidence levels.

For example, the output data shown in Figure 22 indicates that there is a 50 per cent probability that the work will be completed by 25 February and a 70 per cent probability that it will be completed by 2 March.

Figure 22 – Cumulative distribution of a construction schedule (GAO 2015)



A key issue when undertaking simulations is an understanding of correlation and its significance on results. Correlation takes a wider view of interdependencies and refers to any of a broad class of statistical relationships involving dependence. For example, costs associated with resources with time‑based rates that incur additional costs as a result of delays can be a significant source of cost risk in many projects. Therefore, it is essential that the assumptions underlying a project cost and schedule risk estimate align.

Specifying correlations between related activities in the schedule ensures that durations are considered consistently, as correlated durations tend to reinforce one another. To determine which risk events are the main drivers behind cost in schedule variance, Monte Carlo risk analysis simulations for HVHR projects during the delivery stage must be run using resource‑loaded schedules along with risk events and uncertainties.

* + - * 1. Integrated cost and schedule risk analysis

For accurate forecasting and project control, understanding the impact that risks will have on the schedule and budget is essential. The integration of cost and schedule risk into one analysis allows for higher accuracy in cost estimates.

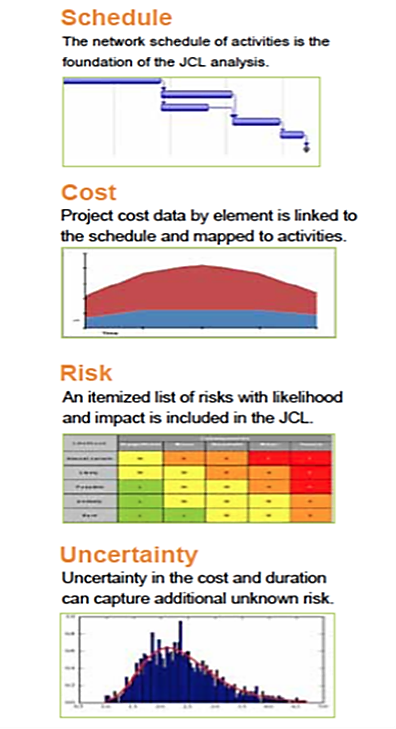
Integrated cost and schedule risk analysis (ICSRA) considers time‑dependent resource costs such as labour costs, equipment, or management costs, which increase relative to project duration. By associating the costs with schedule activities, the cost of risks associated with schedule changes can then be measured.

ICSRA uses statistical techniques to predict a level of confidence in meeting a project’s completion date and budget. The integrated analysis can show how much cost and schedule contingency is required to provide the required level of confidence, and which risk events are critical to the cost and schedule.

The main inputs for a quantitative cost and schedule risk analysis are shown in Figure 23, and requires the following:

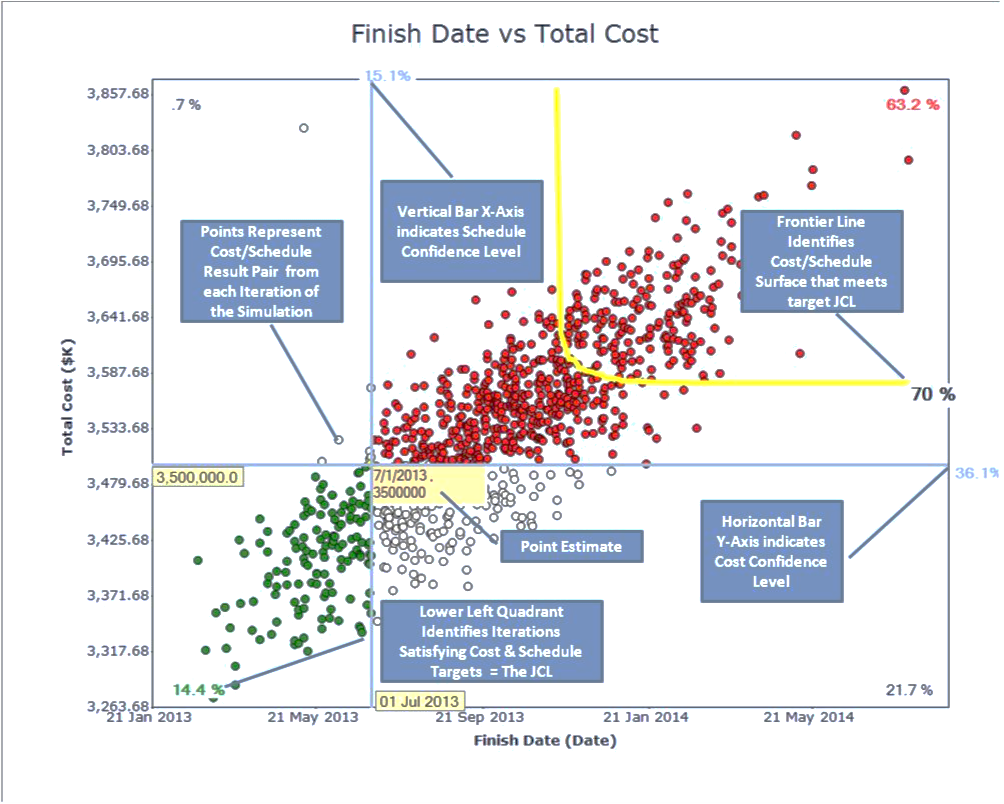
1. Development of the schedule
2. Inputting costs within schedule activities
3. Quantification of risk and allocation to activities
4. Application of uncertainty to cost and schedule
5. Analysing results
6. Updating analysis as the project progresses

Figure 23 – Key inputs to ICSRA (NASA 2012)



An output of ICSRA is the Joint Confidence Level (JCL), which incorporates cost, schedule and risk in an analytical framework. The project will specify both cost and schedule outcomes to be above a specified JCL percentage. The result of this analysis can be shown on a scatterplot to determine the probability of a project meeting time and cost targets. Figure 24 shows a scatterplot with a JCL of 70, indicating the frontier line where iterations of the statistical model (which considers risk and uncertainty) predicts linked cost and schedule certainty of 70 per cent.

Figure 24 – ICSRA scatterplot diagram (NASA 2012)



# List of references

**Resource Management Framework (RMF)**

Source: [https://www.dtf.vic.gov.au/planning‑budgeting‑and‑financial‑reporting‑frameworks/resource‑management‑framework](https://www.dtf.vic.gov.au/planning-budgeting-and-financial-reporting-frameworks/resource-management-framework)

**Investment Lifecycle and High Value High Risk (HVHR) Guidelines**

Source: https://www.dtf.vic.gov.au/infrastructure‑investment/investment‑lifecycle‑and‑high‑value‑and‑high‑risk‑guidelines

**Other DTF references**

* **Project Profile Model**Source: [http://www.dtf.vic.gov.au/Publications/Investment‑planning‑and‑evaluation‑publications/Gateway/Gatewayproject‑profile‑model‑form](http://www.dtf.vic.gov.au/Publications/Investment-planning-and-evaluation-publications/Gateway/Gatewayproject-profile-model-form)
* **Investing under uncertainty – Real options analysis technical supplement**Source: https://www.dtf.vic.gov.au/investment‑lifecycle‑and‑high‑value‑high‑risk‑guidelines/stage‑1‑business‑case
* **Project Assurance Reviews Guidance**Source: [https://www.dtf.vic.gov.au/gateway‑review‑process/project‑assurance‑reviews](https://www.dtf.vic.gov.au/gateway-review-process/project-assurance-reviews)
* **Victorian Digital Asset Strategy**Source: http://www.opv.vic.gov.au/Victorian‑Chief‑Engineer/Victorian‑Digital‑Asset‑Strategy
* **Victorian Government Risk Management Framework**   
  Source: [https://www.dtf.vic.gov.au/planning‑budgeting‑and‑financial‑reporting‑frameworks/victorian‑risk‑management‑framework‑and‑insurance‑management‑policy](https://www.dtf.vic.gov.au/planning-budgeting-and-financial-reporting-frameworks/victorian-risk-management-framework-and-insurance-management-policy)

**Victorian Managed Insurance Authority risk management tools**

Source: https://www.vmia.vic.gov.au/tools‑and‑insights/tools‑guides‑and‑kits/risk‑management‑tools

**Victorian Government Value Creation and Capture Framework**

Source: [https://www.vic.gov.au/value‑creation‑and‑capture‑framework](https://www.vic.gov.au/value-creation-and-capture-framework)

**Commonwealth Department of Infrastructure, Transport, Regional Development and Communications (DITRDC)**

Source: https://investment.infrastructure.gov.au/about/funding\_and\_finance/cost\_estimation\_guidance.aspx

* **Guidance Note 2, Base Cost Estimation (2017)**
* **Guidance Note 3A, Probabilistic Contingency Estimation (2018)**
* **Guidance Note 3B, Deterministic Contingency Estimation (2018)**
* **Range based model**
* **Guidance Note 4, Escalation (2020)**

**Other references**

AACE International (2015, 2nd edition). Total Cost Management Framework, An Integrated Approach to Portfolio, Program, and Project Management.

National Aeronautics and Space Administration (2012). Understanding Joint Confidence Level (JCL) at NASA.

Risk Engineering Society (2019, 2nd edition). *Contingency Guideline*

U.S. Government Accountability Office (2015). Schedule Assessment Guide, Best Practices for Project Schedules.

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* Geoff Hurst
* Ian Gray
* Jane Northey
* Level Crossing Removal Project
* Major Road Projects Victoria
* Nolan Bear
* North East Link Project
* Pedram Danesh-Mand
* Rail Projects Victoria
* Susan Jacques
* Victorian Health Building Authority
* Victorian Managed Insurance Authority
* VicTrack
* West Gate Tunnel Project

# Appendix 1 – RTCC document requirements

## Costed risk register

The Senior Responsible Officer must produce a costed risk register, outlining their requested provision amount based on their evidence‑based risk analysis. The costed risk register must be updated and submitted quarterly in line with government policy and as part of the Project Assurance Review process.

In addition to standard cost and schedule risk considerations, attention must also be given to the costing of performance risks, e.g. costs required to maintain the existing scope (and resulting benefits) with respect to the risk identified. The costed risk register must, at a minimum, contain the following fields.

1. Risk identified (unique number, keywords)
2. Risk Status (Open/Closed)
3. Date of the latest review of particular risk
4. Existing Risk Control Measure(s)
5. Estimated Cost/Schedule impact (with existing controls but without treatment)
6. Planned Risk Treatment(s)
7. Risk Likelihood/Probability of occurrence
8. Minimum Cost/Schedule impact
9. Maximum Cost/Schedule impact
10. Most likely Cost/Schedule impact
11. Actual Cost/Schedule impact (for risks that have been closed)
12. Reference to estimate justification and assumptions
13. Any risk ratings from risk assessments (likelihood/impact/overall)
14. Expected timing/most likely occurrence in project delivery
15. Risk Owner
16. Comments/Notes

**Project schedule**

The Senior Responsible Officer must produce a project schedule to be updated and submitted at each gateway stage. The schedule should not deviate from the basis of schedule (e.g. defined calendar, resource/capacity planning). The schedule must be generated using professional scheduling software to ensure realistic resource allocation and assist in the identification of linkages and conflicts.

The schedule must at a minimum contain:

1. All key milestones clearly identified
2. Clear critical path
3. Contingency clearly identified, including an indication where an activity is risk‑adjusted and reference to the risk identifier
4. Project baseline reflects the latest scope, showing all activities and milestones – ideally linked to the relevant part of the WBS
5. Sufficient level of detail (aligned with the cost estimate)
6. All activities have a predecessor or successor (except for the first or last activity)
7. Resources are clearly identified and allocated
8. Details of where capacity planning and appropriate calendar baselines can be found
9. A breakdown, showing how activities are linked and logically sequenced
10. An indication where it is risk‑adjusted and reference to the risk identifier
11. An indication where leads, lags, floats and constraints were used, and notes or link to where the document which describes supporting assumptions can be found
12. Current date
13. Version/change controls

# Appendix 2 – Change control requirements

## Change control process

Change control is a formal process to manage alterations to project scope or baselines. A change control process allows the early identification and transparent management of necessary changes, whether originating internally or from external parties such as contractors.

Project organisations should use a formal change control process during project delivery by documenting the procedures to be adopted which include:

* the change control request form
* the change control log or register, which should record all requested changes and estimated impact on cost, schedule, and other project elements.

This process is used to manage any change from the project baseline, including scope, cost, schedule or benefits. Risks identified within the project risk register should also be managed through this process where the risk materialising causes a change to the project baseline, for instance a change in scope. The change control process should describe:

* responsibility and accountability via an assignment matrix (RACI matrix)
* inclusion/exclusion requirements for triggering the change control process, e.g. schedule may be adjusted without triggering change control process provided there is a) no impact on a milestone, or b) drawing on the float to the completion date
* how changes will be monitored, and how and where the relevant data is captured
* the process of, and responsibility for maintaining the change control log and tracking expected impacts against the actual outcome.

Classification of the change according to the following matrix:

|  |  |  |
| --- | --- | --- |
| Description | Code | Explanation |
| Delivery model shift | A | Shift of scope in cost types and/or project accounts (e.g. shift of in‑house services to subcontracted services) |
| Incomplete costing | B | Supplies/services required but not considered during budget preparation (e.g. soil conditions not considered) |
| Incorrect costing | C | Supplies/services which cost more or less than estimated as insufficient account was taken of the correct design/rating and/or quantities during budget preparation (e.g. equipment too small, more bulk material needed) |
| Acceleration | D | Costs involved in increasing expense to meet a scheduled date (e.g. air freight costs, additional supervisory personnel, bonus for sub‑contractors ) |
| Customer influence | E | Additional costs due to the client through a change order compensated by release of additional funds |
| Engineering / design errors | F | Extra expense of design or engineering hours, additional supplies, higher construction costs incurred as a result of design or engineering errors or poor estimation of circumstances |
| Concept change | G | Costs which arise due to necessary technical concept changes during project execution (e.g. findings from other projects, safety requirements, saving potentials in procurement) |
| Inefficiency | H | Costs for services and supplies incurred by the project or by allied companies, suppliers, or sub‑contractors, where the project is liable to fund these changes (e.g. due to rework, insufficient training, interface problems, inefficient work tools, additional charges due to a high turnover of temporary staff and suchlike) |

## Authorising change

The process must:

* designate approvers, and define approvals and escalation steps
* ensure all change requests are logged
* allow information to flow from both the bottom‑up and top‑down transparently
* define the frequency and required attendance of change control meetings
* set approvals requirements, e.g. by authorised financial authority limit
* capture agreement of acceptance by parties at the level which it originated
* record approval/rejection
* generate new baselines (budget, schedule) from approved changes
* produce a reconciliation statement, summarising project impacts (budget, schedule, and benefits if applicable) linked to approved changes; an audit trail must exist for cost changes.

## Reporting change

Reporting of change should at a minimum contain:

* description of the type of changes requested
* the number and value/impact of approved and unapproved changes in the period, and cumulative to date.

# Appendix 3 – Contract variation requirements

The contract variation process is a defined process to manage and record changes to the contractual control of scope, risk, cost, and time between project partners. Contract variations may need approval through the change control process, if the variation results in a change to the scope, budget, or schedule baselines.

A contract variation may be initiated at the request of the project organisation where design development highlights a misalignment between the contract and desired project outcomes, or due to a claim by the contractor. The contract variation process should also be used to manage minor administrative changes requiring changes to the contract such as a change of contractor address.

Contractor claims typically arise due to unforeseen events that occur during the delivery stage, as a result of evolving scope definition or deviations from contract provisions. They may also arise due to non‑fulfilment of reasonable expectations, such as where the contracting party fails to provide required information in a timely manner, or changes in external conditions where the State has chosen to retain the risk. Claims typically affect the schedule or cost of the contracted service.

Contract variations should be formally controlled through documented procedures and recorded on a contract variation register, which records all requested variations and estimated impact on risk allocations, cost, and schedule. The Contract Variation Register should record:

* the originating party of the variation
* references of the clauses or attachments that are changed
* a brief summary of the variation
* a description of the impact of the variation
* the budget impact of the variation
* the time impact of the variation
* approval details of the variation (dates and approver details)
* reference to supporting documents (e.g. claims documentation).