Australian Government | Infrastructure Australia

July 2021

Guide to multi-criteria analysis

Technical guide of the **Assessment Framework**

The Assessment Framework comprises an overview, stages 1 to 4 and technical guides:

Overview

1 Defining problems and opportunities

2 Identifying and analysing options

3 Developing a business case

4 Post completion review

Technical guides

The Assessment Framework (including this document) and the Infrastructure Priority List are changing in line with amendments to the Infrastructure Australia Act 2008.

While this transition process is underway, IA will continue to receive and evaluate proposals according to the current process and assessment framework.

For further information
contact engagement@infrastructureaustralia.gov.au

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It leads reform on key issues including means of financing, delivering and operating infrastructure and how to better plan and utilise infrastructure networks.

Infrastructure Australia has responsibility to strategically audit Australia's nationally significant infrastructure, and develop 15-year rolling infrastructure plans that specify national and state level priorities.

Online

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Multi-criteria analysis context

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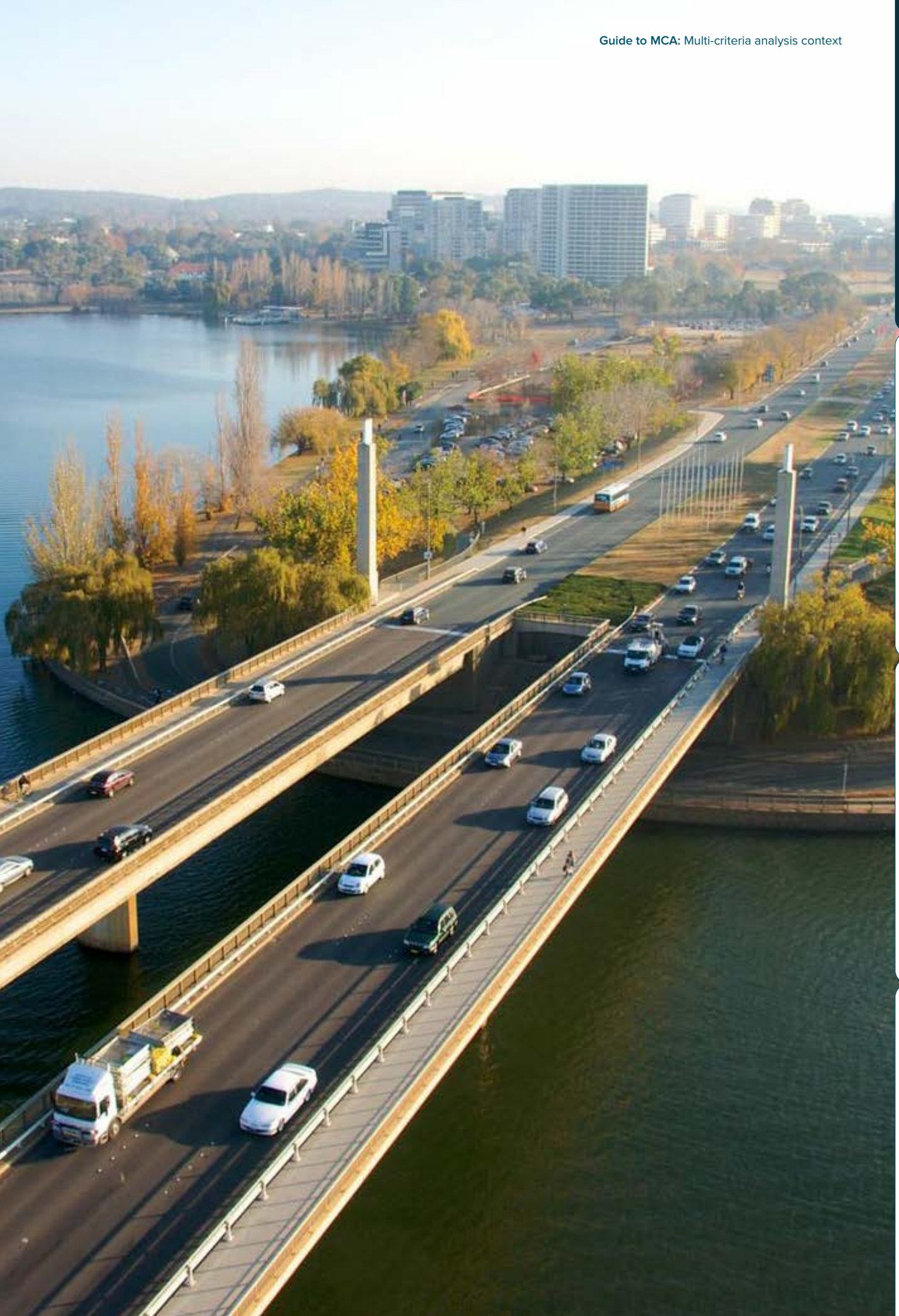


At a glance

- Multi-criteria analysis (MCA) is a tool that can be used to compare reform and investment proposals. When applied consistently and transparently, it is a suitable approach for filtering options before applying more detailed quantitative analysis, or to compare options where impacts are not easily quantifiable.
- There are a range of ways to apply MCA, but in all cases the analysis should be robust, transparent and defensible.
- MCA uses objectives, criteria, measures, weightings and scoring approaches to rank and compare options.
- It is important to test the robustness of the analysis results by understanding how options perform under different conditions. Sensitivity testing and scenario testing are relevant approaches for testing results.
- The MCA process and outputs should be appropriately documented, to clearly demonstrate the development and application of the tool, the option performance, and the rationale for selecting options.

1.1 How to navigate this document

This document is designed for proponents (you) wishing to use multi-criteria analysis (MCA) to support the options analysis for a Stage 2 submission to Infrastructure Australia (us) in accordance with the Infrastructure Australia Assessment Framework (the Assessment Framework). If you are unfamiliar with the Assessment Framework, we recommend that you review our **Overview** and **Stage 2** volumes before reviewing this document.

- **Section 1** explains the context of MCA, including how it fits within our broader assessment process. This section also identifies key benefits and challenges of MCA, and our requirements for submitting analysis to us to support an infrastructure proposal.
- **Section 2** takes you through the steps you should follow to design an MCA framework to select options for more detailed appraisal. This includes guidance on defining objectives, criteria, measures, weightings and scoring approaches.
- **Section 3** explains the step-by-step process for applying the MCA framework to compare options. This includes guidance on presenting and testing results, and documenting the outputs of the MCA process.

We have provided a spreadsheet-based **MCA template** to accompany this guide that illustrates our recommended application of an MCA and includes examples of how the results can be effectively represented. It is not a requirement to use this template, although in all cases you should meet the requirements set out in this document.

1.2 Purpose of this guide

The Assessment Framework provides a structured and objective approach to making decisions about infrastructure. The Assessment Framework is designed for proponents, to help you develop high-quality infrastructure proposals for submission to us for assessment.

Multi-criteria analysis (MCA) is a tool that can be used to compare reform and investment proposals. When applied consistently and transparently, it is a suitable approach for filtering options before applying more detailed quantitative analysis, or to compare options where impacts are not easily quantifiable. MCA is commonly used but its application is often inconsistent, and the value of the outputs for informing decisions varies.

The purpose of this document is to explain how MCA fits within infrastructure assessment and provide clear and practical guidance to improve the quality of its application to inform decisions.

This guide presents good practice material that you should consider when designing and applying MCA. There is more than one way to do this, but in all cases the analysis should apply good practices to be robust, transparent and defensible. It is also important to consider relevant state or territory requirements and the scale and type of investment.

We require that any MCA submitted to support an infrastructure proposal is:

- applied appropriately, in advance of, and not as a substitute for, a cost–benefit analysis (CBA), and applied consistently with the CBA by including and appropriately assessing net costs and benefits that are likely to drive the CBA results
- robust and transparent, clearly documenting how objectives and criteria have been developed, weighted and scored, including the key linkages to the evidence and judgements shaping the MCA
- sufficient to inform our Assessment Criteria (See **Section 3.2** of the **Overview** of the Assessment Framework).

Box 1: **Key terms**

Assessment Criteria: three overarching criteria we use to assess the merit of every proposal, at every stage of the Assessment Framework – Strategic Fit, Societal Impact and Deliverability.

Business case: a document that brings together the results of all the assessments of an infrastructure proposal. It is the formal means of presenting information about a proposal to aid decision-making. It includes all information needed to support a decision to proceed, or not, with the proposal and to secure necessary approvals from the relevant government agency. Unless otherwise defined, we are referring to a final or detailed business case, rather than an early (for example, strategic or preliminary) business case, which is developed in accordance with state or territory requirements. A business case is prepared as part of Stage 3 of the Assessment Framework.

Option: a possible solution to address identified problems and opportunities. A wide range of options should be considered and analysed to determine the preferred option, which will be recommended in the business case.

Program: a proposal involving a package of projects that are clearly interlinked by a common problem or opportunity. The package presents a robust and holistic approach to prioritise and address the projects, and there is a material opportunity to collaborate and share lessons across states, territories or agencies. The projects can be delivered in a coordinated manner to obtain benefits that may not be achieved by delivering the interventions individually.

Project: an infrastructure intervention. A project will move through the stages of project initiation, planning, delivery and completion. A suite of related projects to address a common problem or opportunity will create a program.

Proponent: an organisation or individual who prepares and submits infrastructure proposals to us for assessment. To be a proponent of a business case (a Stage 3 submission), the organisation must be capable of delivering that proposal.

Proposal: the general term we use for successful submissions to the *Infrastructure Priority List*, across the key stages of project development, specifically – early-stage (Stage 1), potential investment options (Stage 2) and investment-ready proposals (Stage 3). Proposals that have been delivered would be assessed in Stage 4.

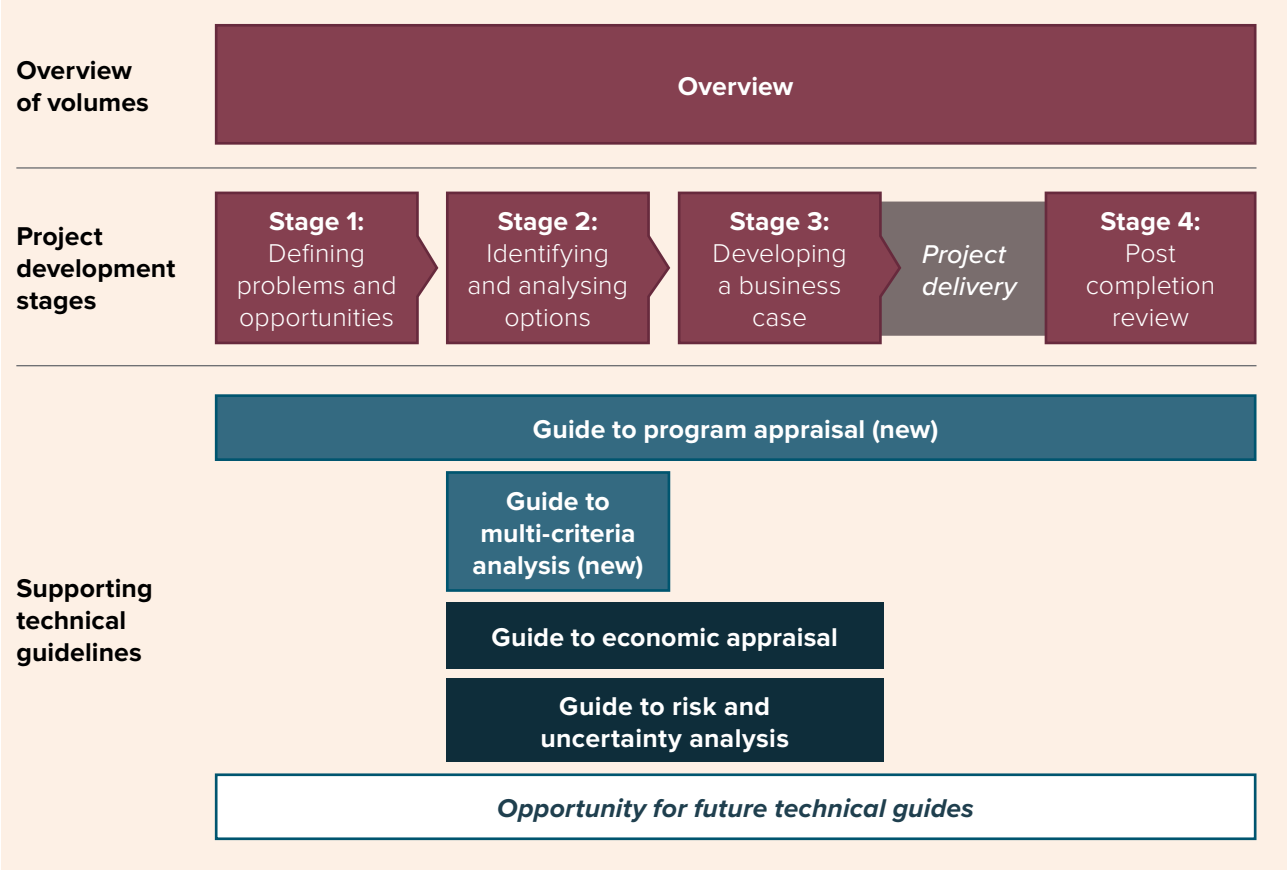
1.3 Structure of the Assessment Framework

The Assessment Framework consists of a series of volumes and technical guides. Together, they describe the activities in a typical project development and review process, and how we assess proposals that are submitted to us.

For practicality and ease of use, each submission stage is described in a separate document and supported by the technical guides. This allows you to focus on the guidance most relevant to you and the stage you are up to in project development.

The structure of the Assessment Framework is shown in **Figure 1**. The suite of Assessment Framework volumes is available at **www.infrastructureaustralia.gov.au/publications/assessment-framework**.

Figure 1: Structure of the Assessment Framework



1.4 How MCA fits into project appraisal

We use our four-stage Assessment Framework to assess proposals, where **Stage 2** involves identifying and analysing a wide range of options that have the potential to address problems and opportunities defined in **Stage 1**. Within **Stage 2**, MCA can be appropriate for reducing a long-list of options that align with policy and stakeholder expectations to a smaller, filtered list of options for more detailed quantitative assessment.

Methods for identifying and analysing options

Figure 2 presents an overview of the methods for analysing options that you can use during **Stage 2** and how this compares to **Stage 3**. This is a general process presented as a guide only. When selecting assessment tools throughout the decision-making process, you should consider the relative cost and robustness of analysis. In some cases, it may be more cost-effective to use a more robust assessment method.

We expect that MCA, as a minimum, will be used after a longlist of potential options has been identified and fully documented and a strategic assessment has been used to filter options which are not feasible or do not meet strategic alignment requirements. The output of the MCA is a filtered list of more promising options.

The final activity you complete in **Stage 2** should involve a rapid CBA to further refine the filtered list of options to a shortlist, which would then be subject to detailed analysis, including a detailed CBA, in **Stage 3**.

Figure 2: Assessment methods recommended for Stages 2 and 3 of the Assessment Framework

MCA used to filter a longlist output from the strategic assessment to a filtered list. Rapid CBA should be used to refine this to a shortlist for detailed CBA.

Detailed and robust assessment of shortlisted options to arrive at a preferred option (using detailed CBA).

The methods shown in **Figure 2** comprise a range of processes, tools, and techniques to support this decision-making, often involving complex and competing information. The main role of these tools is to help address the limitations of human decision-making in a consistent manner.

The appraisal methods applied within **Stage 2** and **Stage 3** of the Assessment Framework include:

- **Strategic review:** a high-level qualitative assessment of feasibility and alignment to relevant goals, objectives and strategic plans:
  - This filters a longlist of options by identifying attributes that render an option infeasible because they clearly fail to meet key policy, deliverability, cost or stakeholder requirements. In effect, it is a lightweight application of MCA principles to filter against these key criteria.
  - It is quick and inexpensive to apply because it does not require extensive data and analysis. This type of qualitative assessment is appropriate for initial filtering rather than detailed option appraisal.
  - Guidance on strategic assessment is provided in **Appendix B** of **Stage 2** of the Assessment Framework.
  - The output of the strategic review is a list of feasible options.
- **MCA:** a detailed, preferably quantitative assessment using scores and ratings against multiple criteria linked to the objectives of the initiative:
  - It is flexible and scalable and can be used to address the full range of investment outcomes including those that are difficult to quantify. However, it has limitations including the potential for subjectivity and bias and not providing a value for money analysis.
  - MCA is the focus of this guide as it is a useful mid-step tool that can assist the options analysis exercise before more detailed tools are utilised.
  - The output of the MCA is a filtered list of options.
- **Rapid and detailed CBA:** analysis of the costs and benefits of the options to test their value for money:
  - The key strength of CBA is that it allows the objective comparison of disparate options by comparing the scale of the costs and economic, social and environmental benefits to society valued in a common, dollar metric. The strategic review and MCA play important roles in identifying promising options, but the critical evidence informing the choice of the preferred option is provided by the CBA.
  - CBA may not incorporate all relevant outcomes if some of these cannot be quantified and monetised and will cost more to apply than more qualitative approaches. Therefore, it is prudent to apply CBA to a smaller list of options, to focus the use of limited resources, as well as communicate non-quantified impacts alongside the CBA results.
  - The main difference between the rapid and detailed CBA is in the level of underpinning detail and rigour, and the cost of application.
  - Rapid CBA should inform the selection of a shortlist of options for detailed analysis, while detailed CBA is required to inform the selection of the preferred option documented in the business case.
  - Detailed guidance on CBA, and rapid CBA, is provided in the **Guide to economic appraisal**.

Taken together, strategic review, MCA and CBA should be viewed as a toolbox whereby each tool complements and supports one another. In practice, decisions are often made based on the outputs of several tools, building to a final, detailed analysis and the recommendation of a preferred option from a shortlist of the most promising options.

Similarly, these tools may be used for a subset decision within the preferred option. For example, CBA may identify the preferred size and location of a facility, but MCA could be used to determine the preferred layout by comparing competing priorities across multiple stakeholders.

1.5 Overview of MCA process

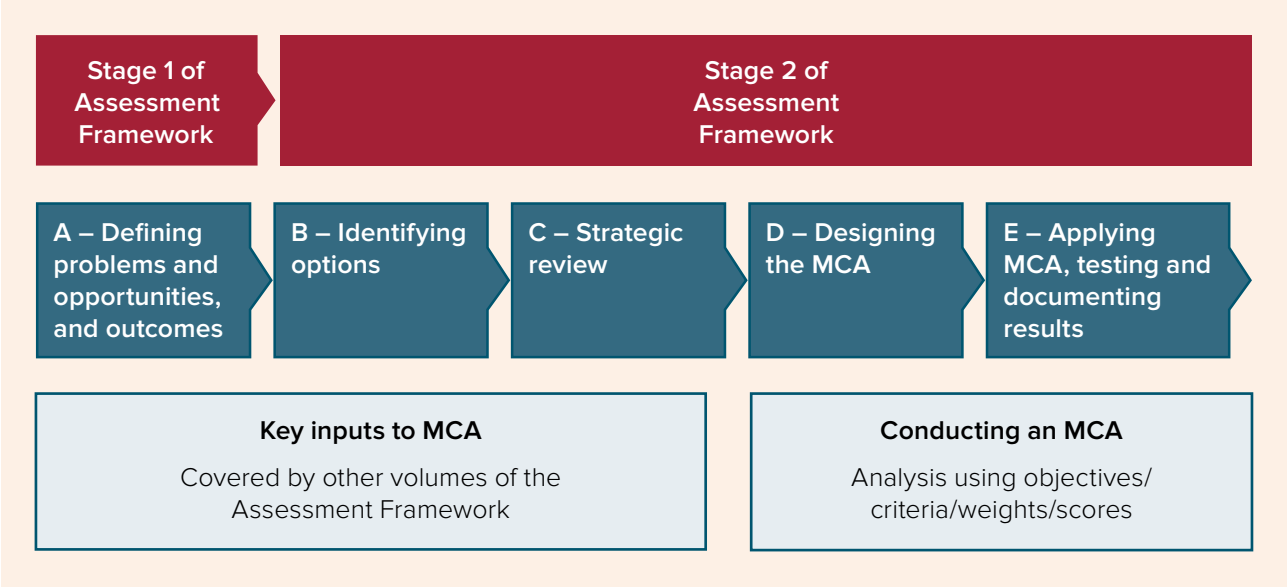
MCA within the Stage 2 options analysis

MCA is an analysis process that scores and rates options against multiple criteria that are linked to the objectives of an investment. When applied consistently and transparently, it is a suitable approach for filtering options before applying more detailed quantitative analysis.

The key role of the MCA is to reduce the list of options to a reasonable number that can be analysed using CBA. In addition, MCA provides a way of analysing options against impacts that are important to decision-makers but which cannot be readily quantified and monetised.[1]

Figure 3 shows the preceding steps that frame the MCA and the two steps for conducting the MCA.

Figure 3: Inputs and key steps for conducting a MCA



The steps preceding (A–C) and comprising (D–E) the MCA include:

A. **Defining problems and opportunities, and intended outcomes:** This step involves defining the problems and opportunities and intended outcomes driving the investment. Infrastructure Australia's Assessment Criteria and associated themes provide a good reference for identifying problems, opportunities and outcomes. It is critical that there is clarity about outcomes and priorities and sufficient evidence to comprehensively analyse the problems and opportunities that need to be addressed by the investment. **Stage 1** of the Assessment Framework provides detailed guidance on these activities and our Assessment Criteria.

B. **Identifying options** – developing a range of capital and non-capital options to help address problems and opportunities, meet objectives, and achieve desired outcomes. This usually results in a longlist of potential options. **Stage 2** of the Assessment Framework provides detailed guidance.

C. **Completing the strategic review** – filtering out unfeasible options quickly means that more rigorous analysis can focus on options that have the best potential in subsequent steps. This is intended to form an initial view of each option and can be conducted informally with less effort than is required for a quantitative analysis. See **Stage 2** of the Assessment Framework for further detailed guidance.

1. Commissioner for Better Regulation (2014), *Guidance Note: Multi-Criteria Analysis*, Department of Treasury and Finance, Melbourne.

D. **Designing the MCA** – Developing and populating the MCA framework by determining objectives/outcomes, criteria that relate to these outcomes, supporting measures underpinning the criteria, scoring scales for analysing each criterion and weights to apply to the framework. **Section 2** of this document describes how to design an MCA framework.

E. **Applying the MCA, then testing and documenting the results** – Scoring options against each of the criteria and testing the results through sensitivities and scenarios where relevant. This step also involves documenting the results and providing sufficient commentary to understand how the relative scores of options are connected to the underlying, quantitative evidence and any qualitative analysis. Providing a reasoned narrative for the MCA framework, the scoring and the options taken forward is essential for justifying the outcomes of the MCA. **Section 3** describes how to apply and document the MCA.

1.6 MCA advantages and challenges

If an MCA is well designed, consistently applied and adequately documented, it provides an appropriate and cost-effective way for reducing a large number of options to a filtered list for more detailed analysis. However, the application of MCA and its reliance on judgements and qualitative analysis result in a greater risk of a biased or misleading analysis. These risks need to be recognised and managed.

Potential advantages of using MCA

MCA techniques may be well-suited to the public policy context because governments have finite resources, and it is not always possible to analyse the merits of a wide range of feasible options on a like-for-like quantitative basis. As such, there are several significant advantages of effectively applying a well-constructed MCA as part of a suite of decision-making tools, including:

- **Structural clarity** – providing a structured way to compare options and how they achieve stated objectives. By explicitly outlining the basis for comparison, it allows stakeholders and decision-makers to see how option recommendations have been formulated. As such, MCA is a flexible decision-making framework that can be adapted to a range of circumstances.
- **Transparency** – when adequately documented, subjective considerations in decision-making can be made clear and explicit. This can make it easier to review and challenge assumptions and understand trade-offs between options. Engaging stakeholders can also enable participation in decision-making that is not possible in pure quantitative analysis.
- **Efficiency** – effort and data requirements for MCA are generally lower compared to other analysis frameworks such as CBA, which means that effective filtering can help focus limited resources on analysing those options that are likely to result in the most benefits.
- **Flexibility** – ability to handle both qualitative and quantitative evidence within the one framework, reducing disadvantage for options in the analysis process with tangible but harder to quantify benefits.
- **Risk** – a well-designed MCA should include explicit criteria that analyse the potential risks of each option and the available means to reduce them.
- **Consistency** – when applied effectively, the MCA will include consistent metrics between steps in the analysis process. That is, it will use similar criteria and metrics to filter the longlist, inform the choice of the shortlist, and underpin subsequent CBA, considered in more detail as you progress. It can also improve consistency in decision-making over time by applying a standardised framework to different projects.

Challenges in using MCA and mitigation strategies

Because MCA is a flexible decision framework, there are few set methodological rules. **Table 1** shows the key challenges and associated risks that you should be aware of, as well as suggested mitigation strategies to manage them. In addition, there is extensive literature available documenting the limitations and risks of MCA.[2] For these reasons, we recommend that MCA is only used as a filtering tool during Stage 2 of the Assessment Framework.

Table 1: Challenges, risks and mitigation strategies

Challenges	Risks	Mitigation strategies
Bias	• **Design:** The project team define the outcomes, criteria and weights that make up the MCA framework. This configuration may be subject to unconscious or advocacy bias. • **Application:** The scoring of criteria across options is likely to involve some subjectivity and the use of qualitative analysis. It is open to bias where a set of interventions is preferred by those contributing to the options analysis and this may be reflected in the scores. • **Quantitative:** Monetised costs and benefits may be given greater weight than those that cannot be easily monetised. This may downplay the significance of important outcomes.	• Provide sufficient documentation to explain: – the choice of objectives, criteria and weights – how the MCA is linked to prior analysis – how scores have been derived, including the linkages to supporting quantitative information and qualitative analysis by subject experts – how the results have been tested to understand the robustness of the model to changing assumptions. • In setting MCA outcomes, criteria and weights, consider: – our Assessment Criteria and themes (as shown in **Section 2.2** of this document and detailed in **Section 3.2** of **Stage 2**) – the specific goals and priorities set for the investment – the relative scale of the costs and benefits expected to drive the CBA results. • In scoring the MCA, adopt strategies to reduce bias and collective thinking, such as individual scoring followed by group validation or blind scoring.

2. References include: Dobes, L. and Bennett, J., 2009, *Multi-Criteria Analysis: 'Good Enough' for Government Work?*, Agenda: A Journal of Policy Analysis and Reform, pp.7–29.; Ergas, H., 2009, *In defence of cost–benefit analysis,* Agenda: A Journal of Policy Analysis and Reform, pp.31–40.

Challenges	Risks	Mitigation strategies
Limitations	• **Diverse options:** It is difficult to adequately compare diverse options where the same criteria do not apply across all of these options. • **Misleading level of accuracy:** Weighted scores have no units and no meaning beyond the MCA analysis, but weighted scores may give the impression of a robust and definitive comparison across options. • **No value for money assessment:** MCA does not consider the relative scale of benefits to costs, which is fundamental to the viability of a proposal. • **Unable to discount over time:** MCA results do not differentiate when benefits or costs occur and the relative value of this timing.	• Include criteria that apply across all the options being analysed. • Apply MCA as a tool to rank and filter options for subsequent more detailed analysis (e.g. rapid and detailed CBA). • We recommend not to apply the MCA to compare options based on a single MCA score. • Clearly link scores, weights, sensitivities and scenarios to any objective evidence that is available (e.g. forecasts, expected quantitative changes and documented community and business views e.g. those expressed in surveys, interviews or studies). • Consider indicative value for money (cost of solution relative to the indicative benefits delivered) within or alongside the MCA results. • Develop criteria on the timing of impacts if this is likely to be a differentiating feature across tested options.
Consistency with other stages of the options analysis e.g. CBA	• **Consistency with the CBA:** If the costs and benefits that are likely to drive the CBA are not adequately represented, there is a risk that the MCA filters out options that should have been subject to a CBA or retains options that should be excluded. • **Double counting:** This may occur where impacts measured by some metrics influence the scoring for multiple criteria.[3] It may be harder to identify double counting than in more quantitative methods. • **Comprehensiveness:** The CBA considers whole of society impacts for the benefits included. However, the MCA may only consider partial impacts and this will affect the results.	• Ensure that significant costs and benefits are appropriately represented in the MCA design (outcomes, criteria and weights). For example, if safety is likely to make up a significant proportion of the CBA benefits, it should have a greater weighting than other benefits. • Avoid using the same data to support multiple criteria (or ensure any necessary adjustments are made). • In designing the MCA, consider the risks posed by the omission of all key impacts.

3. Dodgson, J. S., Spackman, M., Pearman, A., Phillips, L. D. 2009, *Multi-criteria analysis: a manual*, Department for Communities and Local Government, London.

1.7 MCA requirements

To achieve the best outcomes, you must tailor your MCA to the specific circumstances of your investigation and the requirements of the relevant jurisdiction. While there are different ways to apply an MCA, we require you to follow the principles in **Table 2**.

Table 2: MCA principles

Principle 1: Match the tool to the task – MCA is a complement, rather than a substitute, for detailed quantitative analysis.
You should consider the scope, scale, and risk of the task at hand when selecting analysis tools. Nationally significant infrastructure interventions require detailed value for money assessment, so MCA is only appropriate as a filtering tool. MCA precedes and should support detailed quantitative analysis, such as CBA, but it does not replace it. As a result, all the same concepts, theories, and principles still apply – including the need to be evidence-based. You should complete the MCA in a way that is consistent with the downstream activities, for example, by giving appropriate weighting to the costs and benefits that are likely to drive the CBA results. Where available, the MCA should incorporate similar metrics to those used in the CBA to inform the MCA scores.
Principle 2: Be transparent – documentation needs to be sufficient to understand the basis for the MCA design and recommendations.
Transparency and clarity are critical when applying MCA. Because MCA accommodates broader qualitative considerations, you need to make extra effort to clearly define and agree concepts, risk, costs and benefits, and to whom those accrue. If qualitative judgements are made, these should be clearly articulated and supported with evidence and/or reasonable assumptions by those with appropriate expertise. These attributes are required to adequately explain: • the structure of the MCA, including the setting of outcomes, criteria and weights • the basis for criteria weights and the scores attributed to options for each criterion • how the robustness of the MCA framework has been tested.
Principle 3: Address relevant jurisdictional and Infrastructure Australia assessment criteria.
MCA must be structured and documented to provide the information required for jurisdictional purposes and then for Infrastructure Australia to assess the recommendations. When designing and populating MCAs for specific investments, you should take account of jurisdictional assessment criteria and processes, Australian Government objectives and our assessment criteria set out in **Section 3.2** of **Stage 2** of the Assessment Framework.

2

Designing a multi-criteria analysis framework

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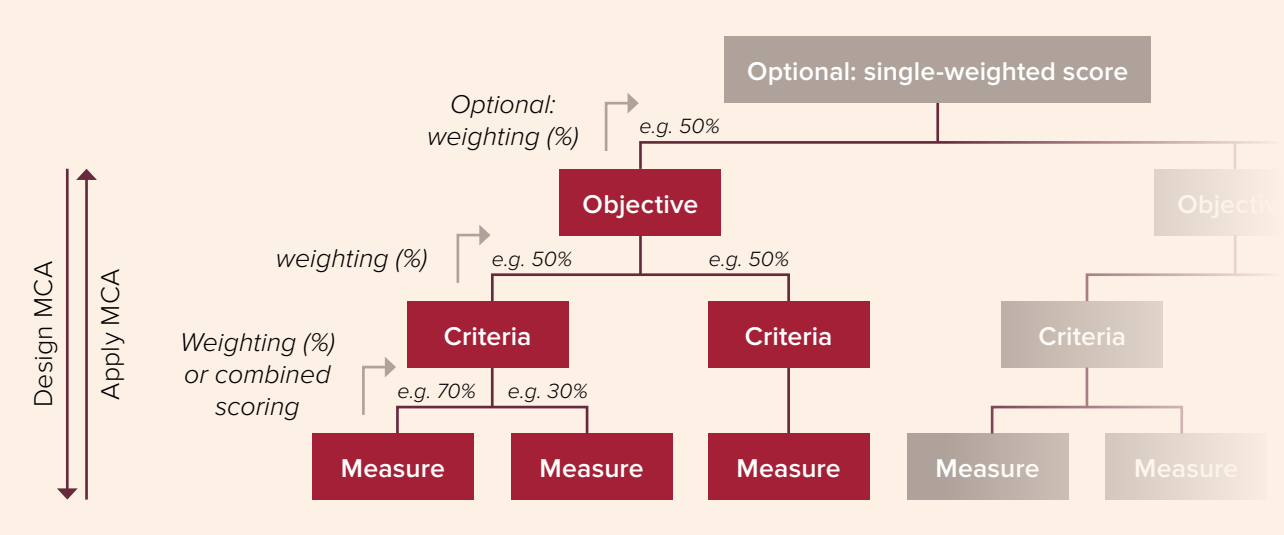
2.1 Design overview

MCA process and components

Figure 4 shows how an MCA may be applied to score an investment option.

Figure 4: MCA process and components for scoring a single option



The MCA consists of the following components, each of which are described in further detail in subsequent sections:

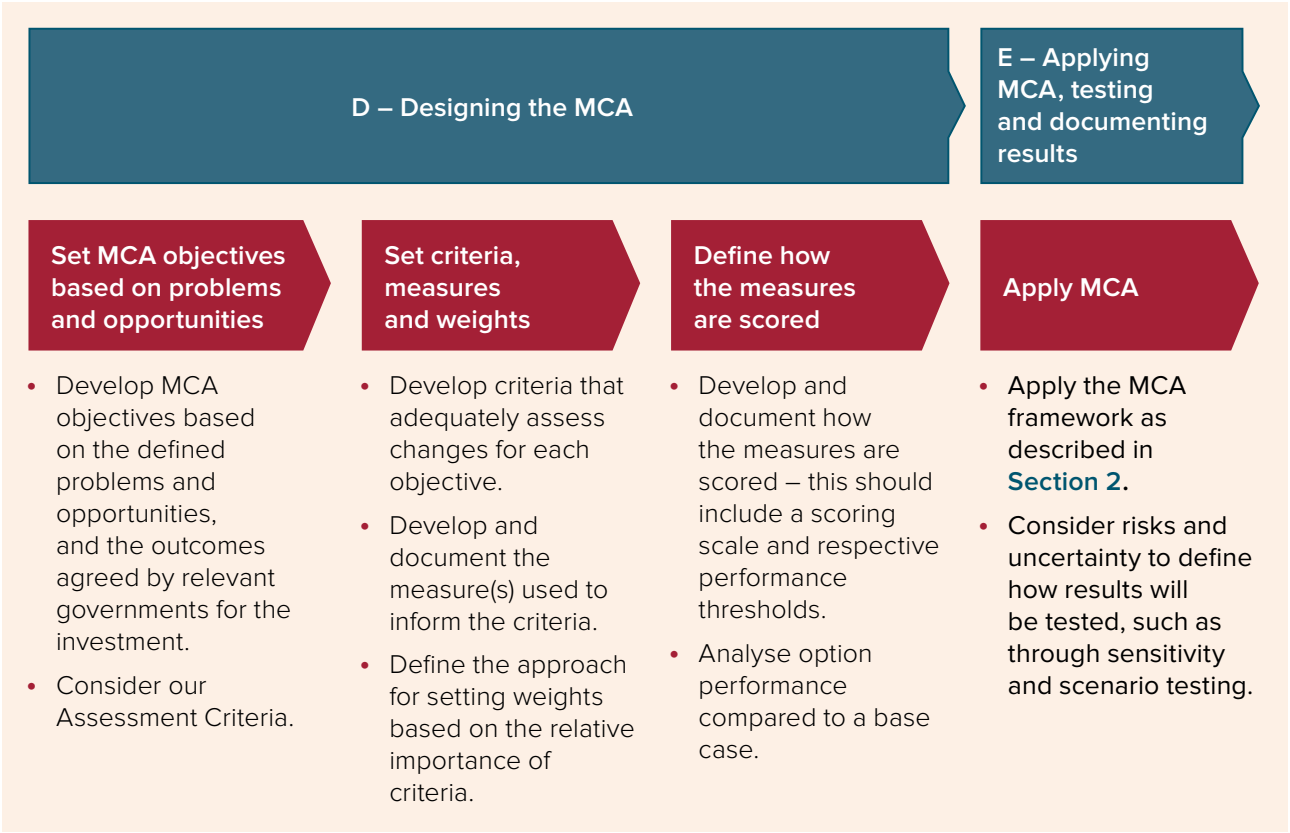
1. **Objectives:** These translate and describe the higher-level government priorities and objectives in a way that is appropriate for a specific investigation, as identified in **Stage 1** of the Assessment Framework.
2. **Criteria:** Outcomes or indicators by which an option is assessed against the stated objectives. Together, criteria address the question 'What distinguishes a good choice and a bad one?'[4] Criteria are typically scored and weighted to give a single score for each objective.
3. **Measures:** These link the underlying quantitative evidence or qualitative judgements to the criteria scoring. Where there are multiple measures, these are scored (and potentially weighted) in a similar way to the criteria.
4. **Weighting:** The relative importance of a given criterion within the scope of the decision context. Weights are used to develop a weighted score for each of the defined objectives. Weights can also be applied to define the relative importance of the measures that inform the criteria and to combine scores for objectives into a single score for each option.
5. **Scores:** An assessment of how the option performs against the established criteria. This should be based on a qualitative rating underpinned by either quantitative score ranges (where available) or, attribute descriptions for qualitative measures, so a reader can understand how scores have been determined.

4. Dodgson, J. S. et al 2009, *Multi-criteria analysis: a manual.* Department for Communities Local Government, London.

Infrastructure Australia's preferred MCA approach

Our recommended approach to MCA design and application is shown in **Figure 5**.

Figure 5: Overview of MCA design process



Our **MCA template** is a spreadsheet-based MCA tool that complements this guide. The tool illustrates our recommended application of an MCA and includes examples of how the results can be effectively represented to provide further context to this guide.

Within the context of infrastructure policy and the Assessment Framework, the MCA helps to filter options for further detailed analysis. While a single weighted score is intuitively appealing, the results can often imply a misleading level of accuracy and cause results to be treated like a definitive benefit-cost ratio (BCR). **As a result, we prefer a multi-score MCA approach**. However, this is not a requirement and a single score MCA can be equally effective in communicating option priorities provided that the basis for the results is adequately explained. This is further explained in **Section 3.2**.

Box 2: **Our guidelines for MCA**

States and territories may apply different MCA approaches in accordance with their own guidance. However, if you include an MCA in support of your Stage 2 submission to Infrastructure Australia, it should meet the **requirements** described in this document.

Our guidelines advise you on what is **required** (advice that must be followed), **recommended** (advice that must be considered and explained if not followed) and **good practice** (advice that should be considered but with some discretion).

We recognise that there are other ways of completing an MCA. For example, the Queensland Department of Transport and Main Roads (TMR) has developed an MCA guide and tool[5] that:

- defines a single, standard set of criteria across a range of impact categories (e.g. economic data, traffic performance and constructability)
- associates with each criterion a single measure and advises how scores should be set
- provides alternative methods for weighting these criteria before an overall score is calculated for each investment option based on the criteria scores and assigned weights
- tests the sensitivity of the results by automatically increasing or reducing the weights applied to each criterion.

Documenting the MCA design

It is important to adequately document every stage of the analysis. This especially applies to the design and application of the MCA, where the structure and application are not as rigid as for CBA, and where you use quantitative and qualitative information to inform decisions.

Box 3 describes our requirements for documenting the MCA design.

Box 3: **Requirements for documenting the MCA design**

When assessing your submission, we require you to provide sufficient information for us to understand:

- how the criteria have been designed to adequately analyse a longlist of options against each of the objectives that reflect governments' intended outcomes for the investment
- the proposed scoring system for rating criteria
- the measures that inform the analysis of each criterion and how they are likely to be applied to generate criteria scores
- the rationale and supporting evidence underpinning the selection of criteria weightings
- the participants who provided input and their relevant expertise
- the connection between the MCA design and the major impacts measured in the CBA.

5. Department of Transport and Main Roads, *Smarter Solutions: Multi-Criteria Analysis Tool*, Queensland Government; Department of Transport and Main Roads 2019, *Smarter Solutions: Multi-Criteria Analysis User Guide*, Queensland Government. Both available at: www.tmr.qld.gov.au/business-industry/Business-with-us/Getting-the-most-out-of-existing-infrastructure

2.2 MCA objectives

The MCA objectives should be framed to comprehensively describe the key outcomes that the investment is meant to achieve. These objectives will be drawn from the state and territory government policy objectives and priorities that have helped identify the need for the investment.

They should also be informed by how Infrastructure Australia is likely to assess the performance of the proposal. Shown in **Figure 6** and described in detail in **Section 3.2** of the **Overview** volume, the Assessment Framework defines:

- three Assessment Criteria
- 15 'themes' – which may be appropriate to consider at the level of MCA objectives
- further 'guiding outcomes' – which may be appropriate to consider at the level of MCA criteria.

Figure 6: Assessment Criteria and themes

Strategic Fit *'Is there a clear rationale for the proposal?'*	• Case for change • Alignment • Network and system integration • Solution justification • Stakeholder endorsement
Societal Impact *'What is the value of the proposal to society and the economy?'*	• Quality of life • Productivity • Environment • Sustainability • Resilience
Deliverability *'Can the proposal be delivered successfully?'*	• Ease of implementation • Capability and capacity • Project governance • Risk • Lessons learnt

The guiding outcomes under each theme provide an idea of the criteria that inform our assessments. For example, there are five dimensions described under the 'quality of life' theme – culture, living standards, learning and development, health and safety, and economic and social participation.

The extent to which you address these themes and guiding outcomes in your submission will depend on the nature of the investment.

- Strategic Fit and Deliverability are likely to apply across most investments.
- Societal Impact themes, such as quality of life, are likely to vary by investment.
  - For example, a transport infrastructure investment is likely to frame an objective(s) covering economic and social participation, and health and safety, and these may be represented through a single or multiple objectives.
  - An all-encompassing quality-of-life objective might be 'To improve the efficiency, reliability and safety of travel for those living, working and transiting the study area'.
  - Alternatively, you might create two (or more) objectives covering different aspects of performance. For example, one for economic and social participation, and another for health and safety.

You should try and limit objectives to capture only the most important problems and potential outcomes for your proposal. You should usually keep them to less than 10, and use fewer when there are several criteria per objective.

2.3 Criteria

Criteria are the standards by which options are compared, analysed and filtered. You should clearly define your criteria so you can understand how an option is expected to perform against the MCA objectives.

Criteria setting occurs within the context of broader policy or strategic planning, so you should align MCA criteria back to key government policies, objectives or strategic plans. You should keep criteria consistent for comparable projects to improve the consistency of decision-making over time by applying a standardised framework.

Table 3 provides examples of criteria that could be used to analyse the achievement of the example objectives stated in **Section 2.2**. There is considerable discretion in how objectives and criteria are constructed to best compare the performance of alternative options.

For example, the 'quality of life' theme could have been represented by a single, highly aggregated objective and similar criteria. However, if you judge that it is important to distinguish between, and separately weight, the economic and social participation, and health and safety impacts, then defining separate objectives would be important.

The criteria should:

- Capture the attributes of the objective that you want to use to compare options (for example, in **Table 3** the criteria reflect impacts on different traveller types).
- Link the objectives to the evidence and judgements (measures) used to analyse the options.
- Encompass and align with the more detailed, downstream CBA analysis (see **Box 4**).

Table 3: Examples of MCA objectives and criteria

Assessment Criterion	Theme	MCA objective(s)	MCA criteria
Societal Impact	Quality of Life	**Objective 1:** To improve the efficiency and reliability of travel for those living, working within and transiting the study area	**Criterion 1:** Reduce delays to motorised traffic, improving journey times and travel reliability
			Criterion 2: Make public transport more appealing by expanding the temporal coverage and frequencies of services
			Criterion 3: Make it easier for pedestrians to walk within the study area by reducing the time waiting at road intersections
		Objective 2: To improve the health and safety of those living, working within and transiting the study area	**Criterion 4:** Improve the safety of motorists and public and active transport users within the study area
			Criterion 5: Reduce the level of air pollution currently affecting active transport users in the study area

Box 4: **Aligning MCA to more detailed analysis**

Before the CBA, you should plan ahead to make sure you are setting consistent MCA criteria and weights where possible. By doing this, you will collect consistent data and assess consistent attributes of the options, but in progressively more detail.

This is particularly important for developing a subsequent business case, which will need to logically flow and tell a single cohesive story.

For a transport infrastructure investment, the key drivers of the CBA results will be whole-of-life costs and benefits covering travel time, vehicle operating cost, crashes and environmental emissions.

In this instance, if the Stage 1 analysis identified that road crashes make up 80% of the problem cost, the MCA should apply a weighting that acknowledges the level of importance. Similarly, recent CBA reports for similar studies could be used to inform the relative scale of the benefits expected.

We encourage you to develop and test criteria with a range of stakeholders. This can be a good sounding board to not only analyse acceptability, but to test whether the words, phrases, and concepts you are using are understood and interpreted consistently.

There is no set rule for the number of criteria as this will vary depending on the investigation. Generally, you should limit the number of criteria to as few as possible.[6] As a rule of thumb, many typical decision contexts might have from five to 30 criteria in total. While very complex decision contexts may have more, this should align to the more detailed analysis (for example, CBA) that will follow.

There can be a tendency to develop too many criteria that differ only slightly on a few minor points (that is, the perspective that 'more is better'). The risk is that the number of criteria can become unworkable, provide little additional analytical value and dilute the ability to differentiate options.

Other factors that you may want to consider include:

- **Materiality:** Which impacts are dominant in the problem or opportunity? Which are expected to be the key benefits in the CBA? Could a single criterion sway a decision one way or the other? If so, does it require considerable effort or resources to gather the required information?
- **Benchmarks:** Can the criteria be supported with independent benchmarks? Are there potential proxies that could provide the same evidence or insights?[7] Is existing research relevant to the local decision, or do bespoke studies need to be conducted?
- **Surveys or stakeholder input:** Can the criteria be supported with input from stakeholders or the community? Are criteria overly complex? If so, should they be tested to ensure they are understood as intended? Should some, or all, of the criteria be open to input?

6. Dodgson, J. S. et al, 2009, *Multi-criteria analysis: a manual,* Department for Communities Local Government, London.
7. A rapid CBA (to derive the shortlist for a detailed CBA) should only focus on the most material benefits, so it may be helpful to develop MCA criteria with this requirement in mind.

2.4 Measures

Each criterion should be underpinned by one or more measures that provide the evidence base for scoring the criterion. **It is preferable that these are quantifiable metrics**. However, the nature of the MCA means some will involve qualitative analysis of how well options address aspects of the criteria and objectives. **Table 4** shows potential quantitative and qualitative MCA measures.

Project appraisal methods, including MCA, should analyse options against a base case. See **Section 2.6** for further detail on the role of the base case.

Table 4: Examples of measures

MCA Objective(s)	MCA Criteria	MCA Measures
Objective 1: To improve the efficiency and reliability of travel for those living, working within and transiting the study area	**Criterion 1:** Reduce delays to private, motorised traffic improving journey times and travel reliability	Change in average peak, modelled (2031) journey times through study area compared to the base case
		Change in peak period travel time reliability compared to the base case
	Criterion 2: Make public transport more appealing by expanding the temporal coverage and frequencies of services	Change in public transport wait times compared to the base case in 2031 (assume only rail affected)
		Additional service kms by time period compared to the base case in 2031
	Criterion 3: Make it easier for pedestrians to walk within the study area by reducing the time waiting at road intersections	Change in expected walk times for key routes compared to the base case in 2031
		Expected change in Pedestrian Environment Review System (PERS) scores in 2031 compared to the base case
Objective 2: To improve the health and safety of those living, working within and transiting the study area	**Criterion 4:** Improve the safety of motorists and public and active transport users within the study area	Forecast change in crashes by severity, injuries and fatalities (distinguish motorised travellers, active transport users and public transport users) – compared to the base case
	Criterion 5: Reduce the level of air pollution currently affecting active transport users in the study area	Forecast change in air pollution levels in 2031 compared with the base case

2.5 Weighting

Preferred approach

Weights are a way of combining multiple scores from one level of the MCA to determine a consolidated score. **Figure 7** illustrates our preferred approach to applying MCA weights.

Figure 7: Preferred approach to applying MCA weights

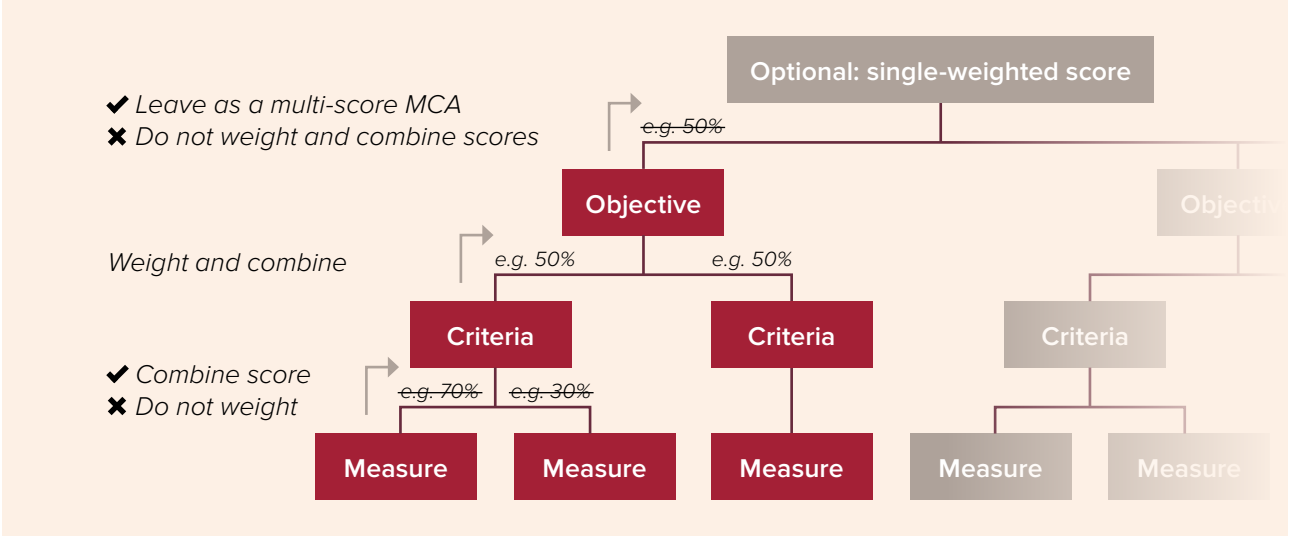


Table 5 further illustrates the approach by extending the example used to describe the MCA criteria and measures showing that:

- measures are scored but not weighted
- criteria are scored by developing a combined score based on the measures
- criteria are weighted based on an analysis of the relative importance of each criterion
- objectives are scored as the weighted product of the nominated criteria
- the scoring goes no further than the objectives, which are compared across options and used to rank and select options to proceed for more detailed analysis.

Table 5: Example of applying weights

MCA Objective(s)	MCA Scores, Weights & Criteria			MCA Scores, Weights & Measures		
	S	W	Criteria	S	W	Measures
Objective 1: Efficiency and reliability **(Objective scored as the weighted combination of the criteria scores informing this objective)**	✔	✔	**Criterion 1:** Traffic journey times and reliability **(criterion scored by proponent after considering all measures)**	✔	✖	C1.1 Average peak journey times
				✔	✖	C1.2 Peak period travel reliability
	✔	✔	**Criterion 2:** Public transport coverage and frequencies	✔	✖	C2.1 Public transport wait times
				✔	✖	C2.2 Additional public transport service kms
	✔	✔	**Criterion 3:** Pedestrian journey times	✔	✖	C3.1 Change in walk times
				✔	✖	C3.2 Change in Pedestrian Environment Review System (PERS) scores
Objective 2: Health and safety	✔	✔	**Criterion 4:** Traveller safety	✔	✖	C4.1 change in crashes and injuries
	✔	✔	**Criterion 5:** Traveller health	✔	✖	C5.1 Change in air pollution levels

Setting weights

In its simplest form, MCA weights can be applied equally to all criteria. This is appropriate where:

- there is agreement concerning the equal importance of each criterion in contributing to the investment's outcomes
- criteria are appropriately differentiated, which do not bias the analysis.

For example, if an MCA has four criteria, of which three are variations of a similar financial or economic consideration, it would not be appropriate to have unweighted criteria as this could be perceived as biased against other considerations like social benefit or environmental sustainability.

In more complex applications, MCA weights are suitable to place greater emphasis on some criteria, such as to align to government policy or objectives. They are also useful for aligning the MCA outputs with the costs and benefits that will most influence the CBA. This approach can provide transparency and counters many of the criticisms of MCA because you must specify factors that place greater emphasis on one criterion over another. **You should publish this process and the results alongside the MCA outputs to support transparency.**[8]

When developing weights, you should aim for simplicity and intuitiveness, as other approaches generally add more complexity than is necessary or useful. We recommend that you first try to derive weights qualitatively in a workshop setting informed by any available evidence, such as community surveys, benchmarks from other MCAs, or benchmarks from other quantitative analysis.

There are a variety of tools for developing weights through stakeholder engagement. For example:

- A survey could be completed to understand community or stakeholder preferences.
- A workshop of experts or decision-makers might be asked to vote on the importance of criteria using a secret ballot approach to reduce cognitive bias.
- Where consensus is required in a workshop setting, more consultative techniques like 'dot voting' or 'show of hands' voting approaches might be more appropriate. The results are reported back to participants and converted into numerical values.

The Queensland Department of Transport and Main Roads MCA User Guide[9] and MCA tool[10] include a range of numerical techniques to set weights based on ranking the criteria or comparing the relative importance of criteria using a pairwise process (compare each criterion individually against each other criterion to develop weights).

Generally, simple approaches are most appropriate for developing weights in a transparent way. In some cases, it may be helpful to consider alternative weighting approaches. However, these tools should be considered with caution as they provide a process for considering subjective inputs but may not add value or rigour, and usually cannot be validated using quantitative methods. In particular, pairwise ranking can suffer from complexity in implementation, results which are not logical, and extreme outputs.

8. Practitioners should be conscious of the potential for 'weighting by other means'. This is where weights are not explicitly defined and instead the number of criteria or scoring systems are created to favour a particular result. The effect is the same, but weighting is not conducted in an open and agreed manner.
9. Department of Transport and Main Roads 2019, *Smarter Solutions: Multi-Criteria Analysis User Guide*, Queensland Government, Brisbane, viewed 31 May 2021, www.tmr.qld.gov.au/business-industry/Business-with-us/Getting-the-most-out-of-existing-infrastructure
10. Department of Transport and Main Roads 2019, *Smarter Solutions: Multi-Criteria Analysis Tool*, Queensland Government, Brisbane, viewed 31 May 2021, www.tmr.qld.gov.au/-/media/busind/businesswithus/existing-infrastructure/nof-mca-tool.xlsm

2.6 Scoring and the role of the base case

Scoring considerations

When developing scores, you should aim for simplicity and intuitiveness. You should ensure that scores are of a scale and direction that reflects how a 'reasonable person' would understand the problem (for example, better alignment to criteria means a higher value score). Only when these approaches fail should you consider more complex scoring approaches.

Score options independently from weights, as this can bias the results. By combining the two tasks, weights can create biases in how aspects of an option are perceived.

Work with qualitative ratings first, where possible. A simple five-increment linear scale is often suited to the task. Qualitative prompts (for example, strong positive, moderate positive, no significant impact, moderate negative, strong negative) are often sufficient.[11] This approach is simple and supports other visual methods to summarise and communicate results. It also helps to avoid a common criticism of MCA, which is that the results imply a spurious level of accuracy or rigour.

Present the rating scale in a way that is familiar to people. At the outset, we encourage you to work in qualitative terms such as 'high', 'medium', and 'low'. This avoids 'priming' users to the relative differences implied by the scoring scale adopted (for example, the scoring difference between a 4 and a 5 could imply a 20% change), which can introduce bias.

However, where criteria are based on quantitative data, scoring should be directly informed by the data, rather than your perceptions of 'high' or 'low', to reduce subjectivity. For example, suppose an MCA considered an option against an affordability criterion. This could be scored based on the change in cost of the service as a proportion of the average household budget. Here, the difference between a 'low' and 'high' score could be defined based on a specific percentage, which is intuitive to most people and can be evidenced with quantitative data.

Score all options against the same criteria based on their impact relative to the base case (what would have happened without the investment). Project appraisal methods, including MCA, should compare options against a base case. The role of the base case is described further in the next section.

Do not use 'not applicable' scores. If an option does not impact a criterion, then it should be given a neutral or 'no impact' score, so as not to disadvantage or skew scores. MCA is more effective for comparing options that are similar enough that you can make meaningful relative comparisons. Scores can be developed to compare like-for-like based on either the problem definition (options to fix a problem) or desired outcome (options to achieve what we want to achieve).

Do not use negative number scores. Our preference is to use a positive scoring scale, such as between 1 (strong negative impact) and 5 (strong positive impact). In practice, we do not recommend you map ratings to negative number scores (for example, where 'strong negative impact' equals -5 and 'strong positive impact' equals +5).[12] Negative numbers are problematic and can have undesirable implications for the MCA as they can:

- reduce the impact of positive scores in the final presentation of results
- encourage interpretation as a value for money metric like a BCR
- lead to unexpected or conflicting results, which hurts the credibility of the analysis.

In many instances, options will have some sort of negative trade-off, but overall, they would be expected to improve general welfare. But this would be expected of all options under consideration, and on balance would have other corresponding trade-offs (such as cost, risk, etc.), which can be measured through other criteria.

11. Even in the case of qualitative scales, a numerical score can be implied by users. For example, a three-interval scale of low, medium, and high implies three increments of 33% each. It is important to prompt practitioners to avoid assigning numerical values.
12. This guide differs from Commissioner for Better Regulation (2014) *Guidance Note: Multi-Criteria Analysis*, which suggests a scoring scale ranging from -10 to +10. Scoring on any interval scale translates a proposal's original quantities and fits it onto a linear scale. This does not reflect the original units and does not reflect how quantities scale. As this document states, mixing positive and negative scores can produce counter-intuitive results and is not recommended. It is often more effective to sort and filter proposals onto a similar basis then apply a set scale expressed in positive terms.

The role of the base case

Project appraisal methods, including MCA and CBA, should compare options against a base case. As described in the Assessment Framework (see the **Guide to economic appraisal**):

- The base case is a real-world scenario of what is expected to occur in the absence of the project case. It is required to measure what will happen without an intervention.
- We recommend a 'do minimum' base case reflecting the ongoing actions and investments consistent with the continued operation of the network or service under good management practices (the 'business as usual' or 'keep safe and operational' situation).

The MCA criteria should analyse the impact of investment options against the base case situation. This provides a benchmark against which to analyse options and will allow options which perform worse than the base case to be identified.

As an example, **Table 6** shows estimates of the average journey times for the current situation in 2021 and without the investment in 2041 (base case estimates) and for an investment option in 2041 – these are the base case estimates.

An MCA could rate the effectiveness of the investment by comparing the journey time for Option 1 in 2041 (20 minutes) against the expected base case journey time without the intervention in 2041 (40 minutes), resulting in a 50% reduction.

This contrasts with the 33% increase if the 2041 option result is compared to the current base case journey time. While this comparison of how much the investment will improve the current situation has some intuitive appeal, it is an incorrect basis for estimating the option's impacts.

Table 6: Example of measuring change against the base case

Measure and date	Base Case	Option 1
Average journey time 2021	15 minutes	N/A
Average journey time 2031	25 minutes	18 minutes
Average journey time 2041	40 minutes	20 minutes

Scoring system guidance and application

Our preference is for you to use the type of scoring system shown in **Table 7**, with five rating categories ranging from 'strong negative' to 'strong positive' with a neutral or insignificant impact rating as the middle category.

You may choose an alternative scoring system if you think it better fits your specific MCA framework. However, **we require you to adequately document the rating scale and the thresholds that guide the scoring**. The table shows how thresholds might be set to score the impacts of one of the measures defined in the previous section.

In this example, the thresholds are quantitative but for some measures only qualitative analysis may be available. It is important that you clearly describe the basis for any scores you use.

We recommend applying the scoring system at two levels within the MCA:

- to score the measures (see **Table 7** and **Table 8**)
- to score the criteria by aggregating the scores for measures (see **Table 9**). Alternatively, scores for criteria can be determined by applying weightings and aggregating, although this may add complexity to the MCA and will require you to explain the basis for the weightings.

Table 7: Example of the proposed scoring system applied to journey-time change measure

MCA Rating	Colour	Score	Description	Example threshold
Strong positive		5	Strong, positive impact for the criteria or measure	Significant journey time reduction valued at > 30% or valued > $10 million
Moderate positive		4	Moderate, positive impact for the criteria or measure	Clear journey time reduction valued at between 5% to 30% or $1–$10 million
No significant impact		3	No significant positive or negative impact	Insiginficant journey time impacts between -5% and +5%
Moderate negative		2	Moderate, negative impact for the criteria or measure	Clear journey time increase of between -5% to -30% or -$1 and -$10 million
Strong Negative		1	Strong, negative impact for the criteria or measure	Significant journey time increase valued at < -30% or valued at < -$10 million

Table 8 further illustrates the type of scoring guidance provided for the measures set out in **Table 4**. This is an abbreviated version of the documentation that should be provided along with descriptions of the metrics and your basis for choosing these thresholds.

Table 8: Scoring guidance for sample measures

Measures	Threshold compared to the Base Case				
Score	**1**	**2**	**3**	**4**	**5**
C1.1 Avg peak journey times %	>+30%	>+5% to +30%	-5% to +5%	<-5% to -30%	<-30%
C1.2 Peak travel reliability %	>+10%	>+5% to +10%	-5% to +5%	<-5% to -10%	<-10%
C2.1 PT avg peak wait times min	>10 min rise	>+5 to +10 min	-5 to +5 min	<-5 to -10 min	>10 min fall
C2.2 Added PT service kms %	>+10%	>+5% to +10%	-5% to +5%	<-5% to -10%	<-10%
C3.1 Change in walk times min	>5 min rise	>+2 to +5 min	-2 to +2 min	<-2 to -5 min	>10 min fall
C3.2 Change in PERS scores	>+30%	>+5% to +30%	-5% to +5%	<-5% to -30%	<-30%
C4.1 change in crashes $ p.a.	>$1M pa rise	>+$0.2M to +$1M	+$0.2 to +$1M	<-$0.2 to -$1M	>$1M pa fall
C5.1 Change air pollution ppm%	>+5%	>+2% to +5%	-2% to +2%	<-2% to -5%	<-5%

For each criterion, you should present the same tabular form to document how multiple measures have informed your scoring of criteria. To do this, describe how you have incorporated multiple measures into the thresholds.

Table 9 shows an example of how you can score for transport criteria to aggregate measures C1.1 Avg peak journey times and C1.2 Peak travel reliability % into a single criterion score.

Table 9: Example criterion scoring to aggregate measures – 'Reducing delays to private, motorised traffic...'

MCA Rating	Colour	Score	Description	Example threshold
Strong positive		5	Strong, positive impact for the criteria or measure	Scores of 5 for journey time & reliability changes
Moderate positive		4	Moderate, positive impact for the criteria or measure	Scores of 4 for journey time and reliability changes or mixed 4/5 score
No significant impact		3	No significant positive or negative impact	Any scores with a 3 are classified in this category
Moderate negative		2	Moderate, negative impact for the criteria or measure	Scores of 2 for journey time and reliablity changes or mixed 1/2 scores
Strong Negative		1	Strong, negative impact for the criteria or measure	Scores of 1 for journey time and reliability changes

Other scoring considerations

You should note the following considerations for scoring:

- **Bias:** scores can induce unconscious bias by implying a relative value between increments (for example, an increment of 2 to 3 implying a 33% increase in performance). Scores should be informed directly by data if it is available, noting that MCA is largely a qualitative analysis.
- **Meaning:** scores with too many increments may not have any practical meaning and there may not be data available to score them accurately (for example, the difference between 99 and 100 may not be more meaningful than a score of 'high').
- **Relativity:** score increments may have no meaning at one level and considerable meaning at another, for example, an increase in travel time from 2 minutes to 4 minutes may not be as meaningful as an increase from 10 minutes to 20 minutes. Both provide the same percentage change but a very different absolute increase (2 minutes compared to 10 minutes). It is important to choose the metric (relative or absolute) that has most meaning in comparing options.
- **Outliers:** scores with too many increments can create unanticipated situations where one option (that is like the other options in all material respects) receives an extreme score while the rest do not, which creates problems for aggregating, interpreting, and presenting results.

Where different options receive similar scores, you may apply different thresholds or non-linear scores to differentiate them. This is likely to require an iterative approach to refine measures and thresholds in response to the data that is available. **Section 3.2** provides examples of how to present results, which can be used to demonstrate whether scores are appropriately differentiated.

For example, a customer satisfaction initiative might evaluate performance based on a simple linear scale from 0 to 10, where a 0 is 'low', a 10 is 'high', and a mid-point of 5 is 'moderate'. If scores are not sufficiently differentiated, the scoring thresholds might be adjusted with a higher threshold of satisfaction (for example, 'moderate' satisfaction under the old scoring scale is now scored 3), which would have the effect of differentiating options with moderate to high customer satisfaction. This would then eliminate a greater number of options and focus attention on only the best performing ones.

3

Applying a multi-criteria analysis framework

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3.1 Overview of applying a MCA framework

This section summarises the step-by-step process for applying the MCA described in the previous section. **Figure 8** summarises the design and application process.

This section also addresses the following application issues, including:

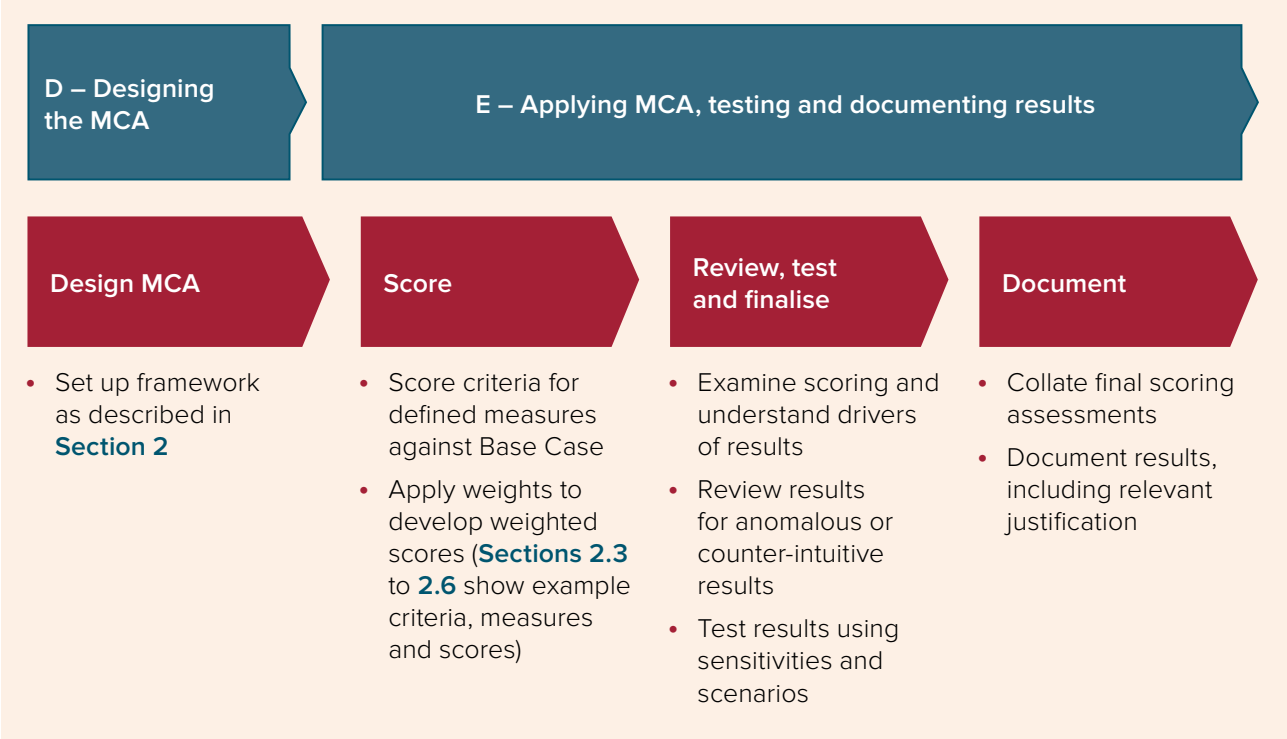
- Presenting the results
- The role of and approach to validating results, including through sensitivity and scenario testing
- Documenting the MCA results.

Conducting the MCA itself follows a similar process to filtering or merit testing, but with more detail and structure. You should be flexible and iterative in your approach, as criteria and scoring scales may need refinement in response to the data that is available and if options are not sufficiently differentiated.

Within the context of the Assessment Framework, the output of the MCA process will be a refined list of options that can be taken forward for more detailed analysis using rapid CBA or detailed CBA.

It is important that you adequately document how you have applied MCA (see **Box 5**).

Figure 8: Steps for applying the MCA



Box 5: **Documenting the MCA**

You should provide sufficient information so a reader can understand the rationale supporting the relative scores of the options, and what evidence and judgements underpin these scores.

It is not sufficient to report the combined, weighted objective scores and the criteria scores. Rather, you must provide sufficient commentary to explain the connection between the measures and criteria scores and the likely resilience of these scores and options' ordering through sensitivity testing.

3.2 Scoring the MCA

Steps for scoring the MCA and documenting the results

Once an MCA framework has been created and the input data analysed, you should:

- **score options against the measures** chosen to represent the defined criteria as the difference in impacts compared to what would have happened under the base case
- **score the criteria** as a combination of the scores for each of the contributing measures
- **apply weights** to the criteria scores contributing to each objective to calculate objective scores
- **review the results** and ensure they are in line with expectations and consistent with the expected economic drivers of a CBA. Make any modifications required in light of this review
- **apply sensitivity and scenario testing** to examine the repeatability of the option ordering.

Table 10 provides a numerical example for calculating the scores for two objectives based on five criteria and eight measures for two options. In this table, calculations go from the scoring of measures on the right-hand side to the application of weights to criteria on the left-hand side and show:

- The scores allocated by option for each of the eight measures in columns 6 and 7.
- The combined scores in columns 3 and 4. The scores for the measures have been simply combined. In practice, where there are multiple measures informing a criterion score, the proponent will have to determine how to combine these into a single criterion score.
- The weights ('Wt' in column 2) applied to each criterion contributing to the objective.

In this example, when the weights are applied to the combined scores, the results show that Option 1 scores more highly than Option 2 across both objectives.

Table 10: Objective scoring example

1	2	3	4	5	6	7	8
MCA Objective(s)	**MCA Scores, Weights & Criteria**				**MCA Scores, Weights & Measures**		
	Wt	**Combined criteria scores**		**Criteria**	**Option measure scores**		**Measures**
		Opt 1	**Opt 2**		**Opt 1**	**Opt 2**	
Objective 1: Efficiency and reliability.	0.3	3	5	**Criterion 1:** Traffic journey times and reliability	3	5	C1.1 Average peak journey times
					3	5	C1.2 Peak period travel reliability
	0.4	5	3	**Criterion 2:** Public transport coverage & frequencies	5	3	C2.1 Public transport wait times
					5	3	C2.2 Additional public transport service kms
	0.3	4	2	**Criterion 3:** Pedestrian journey times	4	2	C3.1 Change in walk times
					4	2	C3.2 Change (PERS) scores
Objective 1 score		***4.1***	***3.3***				
Objective 2: Health and safety	0.7	3	4	**Criterion 4:** Traveller safety	3	4	C4.1 Change in crashes and injuries
	0.3	5	1	**Criterion 5:** Traveller health	5	1	C5.1 Change in air pollution levels
Objective 2 score		***3.6***	***3.1***				

Presenting the overall results

For reference, our **MCA template** illustrates our recommended application of an MCA and includes examples of how the results can be effectively represented.

For either a multi-score MCA or a single weighted score MCA, the mechanics of aggregating and reporting the results is relatively straight forward. The results and analysis are best captured in a matrix.

Table 11 is an example of how a MCA matrix of results can be presented. It lists the objectives and supporting criteria in the first column, with the criteria weights and options listed across the table. **Table 12** provides the key for the heat map.

This indicative example presents the scores and a heat map of the weighted objective scores (green is the first-ranked, amber for the second-ranked and red for the third-ranked score and below). This approach aligns to our preference to present multi-score MCA results. The approach to the heat map may need to be adjusted if a larger number of options is considered, such as using quartiles.

Based on these scores, a proponent might select options 3 and 1 to progress to a more detailed analysis. Option 3 stands out, ranking first for two objectives and equal second for the remaining objective. Option 1 achieves the best efficiency and reliability score while recording similar scores to options 2 and 4 for the other criteria.

Table 11: MCA matrix, indicative example

Objectives and criteria	Weights	Option Scores			
		1	2	3	4
Objective 1: Efficiency and reliability	**1.0**	4.1	3.3	3.0	2.6
Criterion 1: Traffic journey times and reliability	0.3	3	5	1	5
Criterion 2: Public transport coverage & frequencies	0.4	5	3	3	2
Criterion 3: Pedestrian journey times	0.3	4	2	5	1
Objective 2: Health and Safety	**1.0**	3.6	3.1	5	3.8
Criterion 4: Traveller safety	0.7	3	4	5	5
Criterion 5: Traveller health	0.3	5	1	5	1
Objective 3: Cost and related risks	**1.0**	2.5	2.5	3.5	2.5
Criterion 6: Whole-of-life discounted cost	0.5	2	1	4	1
Criterion 7: Risk of cost over-run	0.5	3	4	3	4

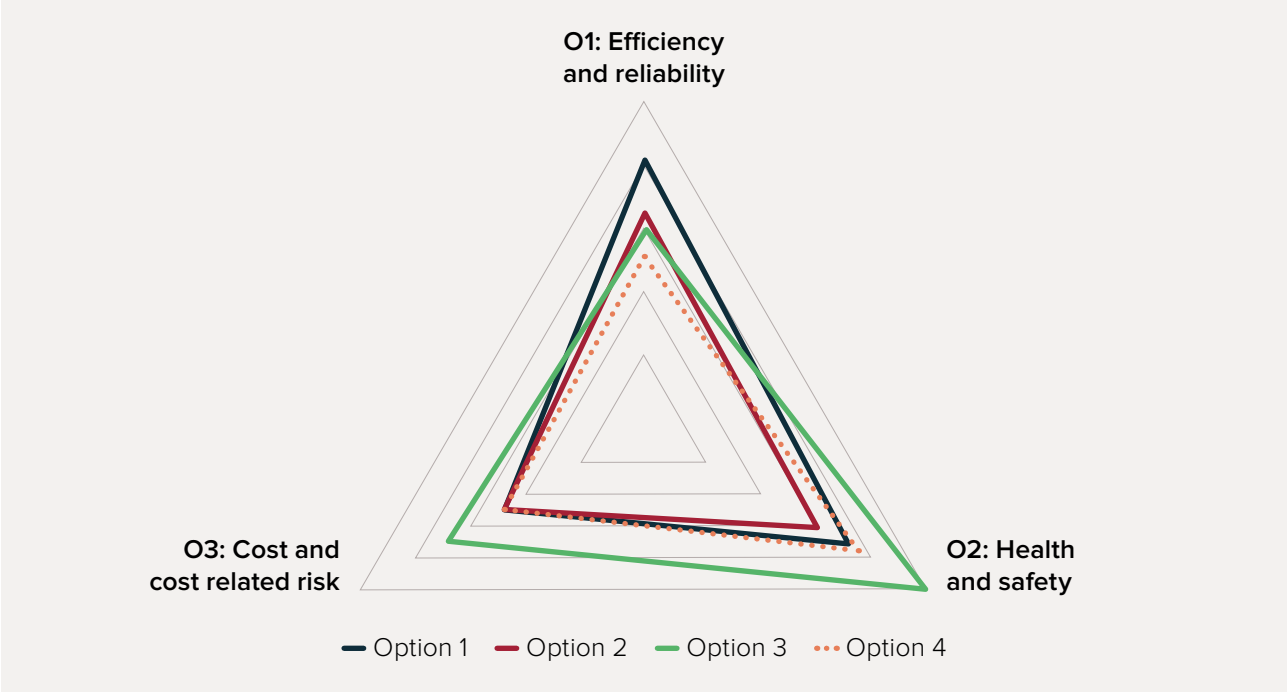
Table 12: MCA matrix key, indicative example

First-ranked option	
Second-ranked option	
Third-ranked score and below	

As noted previously, it is not recommended to present the results as a single weighted score, instead it may be appropriate to present the scores in full, or aggregate option performance under a smaller number of key criteria. A **radar graph** is another way to help visualise and present results.

Figure 9 provides an illustrative example of a radar graph. In this example, Option 3 appears to be best aligned with health and safety, and cost, while Option 1 appears to be best aligned with efficiency and reliability. In some cases, this might be expected, while in others this might be an issue to explore in greater detail (for example, problems with option specification).

Figure 9: Radar diagram, indicative example



For completeness, **Table 13** provides an indicative example of how a single weighted score MCA can be presented to select options that should be filtered, **noting this is not preferred**.

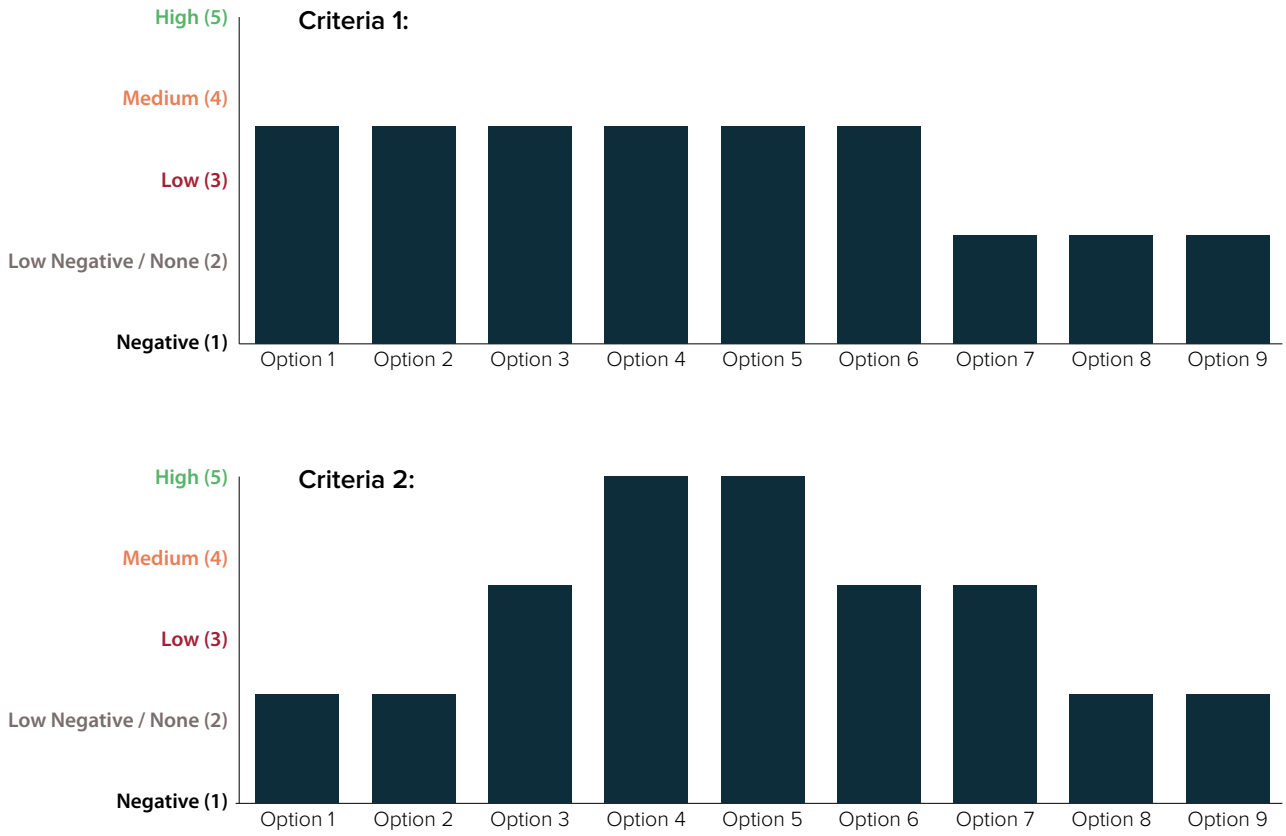
Table 13: Single weighted score MCA matrix, indicative example

Objectives and criteria	Objective Weights	Option Scores			
		1	2	3	4
Objective 1: Efficiency and reliability	**0.4**	4.1	3.3	3.0	2.6
Objective 2: Health and Safety	**0.4**	3.6	3.1	5.0	3.8
Objective 3: Cost and related risks	**0.2**	2.5	2.5	3.5	2.5
Weighted Average Score	**1.0**	**3.58**	**3.06**	**3.90**	**3.06**
Rank		2	3	1	3

It may be useful to examine how specific criteria compare across each option. For example, a bar chart is a simple way of viewing **score variability** across options, and whether there is any clustering or lack of differentiation that might need to be explored. **Figure 10** provides an indicative example illustrating how scores could be distributed.

Examining score variability can provide insights into whether scores are spread out or clustered together. This is important because if all the scores show no natural differentiation (or conversely significant outliers) there could be problems with the specification of options (that is, 'apples to apples' comparison) or the MCA design. In this figure, all options are scored 2 or 3, so the measures could be reviewed to better differentiate the options.

Figure 10: Score variability, indicative example



3.3 Reviewing, testing and finalising the MCA

As with more robust methods, such as CBA, it is important to test the results of the analysis to understand how they perform under different conditions. Because MCA does not have fully defined and quantitative parameters like in a CBA, the MCA results testing process is more open-ended and flexible.

Relevant approaches for testing results include sensitivity testing and scenario testing, which examine two separate aspects of a decision:

- **Sensitivity testing** examines the robustness of a model by testing how changes to key technical parameters impact the outputs. This may include changes to economic parameters, MCA inputs such as weightings, or other technical assumptions. For example, common sensitivity tests include decreasing benefits by a fixed percentage or adjusting MCA weightings.
- **Scenario testing** focuses on 'big-picture' changes like materially different forecasts (for example, population or economic growth rates) or shocks (for example, climate or technology changes). Scenario testing analyses the robustness of the results to changes in macro-level assumptions. This is accomplished by changing several underlying assumptions simultaneously to mirror an alternate view of the future. For example, this might include slower economic growth, increases in unemployment, and decreases in net population migration.

The **Guide to risk, uncertainty and sensitivity analysis** provides further guidance on the role of sensitivity and scenario testing in CBA, which also applies to MCA. You should consider how sensitivities and scenarios are likely to impact MCA measure scores, criteria weights and how these will change criteria scores and the ranking of options:

- **MCA measure scores** may be impacted through sensitivity and scenario testing. For example:
  - Uncertainty in the accuracy of forecasts about how many people will change their mode of travel in response to a road network improvement could be sensitivity tested by running low and high growth assumptions and examining how this changes performance measures.
  - Big picture scenario changes, such as economic development or technology disruption, are likely to impact a range of measures used to determine MCA criteria – for example, a low growth scenario may reduce traffic pressures and lower the potential journey time savings of a capacity enhancement.
- **The MCA criteria weights** and the weighted objective scores are subject to change because:
  - There is uncertainty about these settings that are informed by policy priorities but also based on qualitative inputs about stakeholders views on the relative importance of criteria and objectives. The allocated weights should be varied as part of the sensitivity testing.
  - Big picture scenario changes may change policy priorities and the weights assigned to various criteria. For example, the impact of COVID-19 might change the policy focus from addressing quality-of-life and congestion criteria (with the drastic fall in demand), to ensuring that criteria covering health and safety, including improved access to health services, are given greater weight.
- **The MCA criteria scores**, under the preferred approach that weights criteria and scores based on scoring underlying measures, will change in response to sensitivity and scenario changes affecting MCA measures and criteria weights.

Importantly, **testing the MCA results does not overcome the risks and limitations of MCA**, although it may improve user confidence. Therefore, the MCA is only appropriate as a filtering tool during Stage 2 of the Assessment Framework. Generally, it will be more appropriate to highlight key risks and sensitivities, or other considerations such as resilience or deliverability, to be analysed in detail with more robust methods.

Sensitivity testing

For the sensitivity testing, you should focus on changing the measures (and costs and benefits) that are likely to be most material in driving the option ranking and where there is thought to be the most uncertainty.

You should identify the measures underpinning these cost and benefit categories and determine reasonable low and high variations around the current estimates. It may be more practical and manageable to group these changes into alternative low and high value MCAs.

Sensitivity testing encompasses altering criteria weights to test the resilience of the MCA ranking of options. This should include ranking based on an unweighted analysis and determining how to alter criteria weights based on consultation about where these are most uncertain.

Examples of potential sensitivity tests are:

- Where modelled estimates of benefits have an inherent level of uncertainty because of natural variation in the input data (for example, forecasts of the exact timing and location of population and employment growth) or in the modelling techniques applied (for example, uncertainty around the behavioural parameters used to estimate responses to the investment).
- Unexpected changes in costs because the central cost estimates did not adequately incorporate the risks or did not take account of input price changes from an overheating or declining construction sector.

Scenario testing

For scenario testing, you need to:

- Identify relevant scenarios that should be considered in testing the resilience of the MCA results and review and amend the MCA measures' scores and the criteria scores and weights.
- Determine the sources of greatest uncertainty within the current scenario, develop parameter variants that adequately test this uncertainty, and reflect these in the MCA measures' scores and criteria scores. This might involve re-running any models under these revised scenarios.
- Report the results alongside those for the central case and parameter values and illustrate the implications for the option ranking.

Table 14 provides an example of how you might specify and test scenarios.

The outcome of scenario testing may be to recommend further analysis because there is insufficient data, untested assumptions, or an inability to adequately quantify risk and uncertainty. The MCA and following quantitative analysis techniques should be tested and iterated as new information becomes available.

Table 14: Additional scenarios, indicative example

Scenario	Description	Changes to MCA model
Central case	• Economic and population growth in line with historical trends	• Central case tested in the MCA
Lower and higher economic and population growth	• Significant variance to central case with widespread demand implications for services across the public sector and for travel	• Changes the relative performance for options that provide additional capacity to deal with high demand – through reduced quality-of-life benefits • Impacts on the financial viability of options that rely on increasing demand and user pays
Global impact scenario e.g. COVID 19	• Significant short to medium term impacts on demand across multiple sectors • Change in government policy priorities • Impact on public and private sector finances	• Significant short-term demand impacts that affect the relative performance of different options. For example, where previous high urban population growth is suppressed, options that increase capacity (e.g. road, public transport, water) mitigate further supply constraints will perform worse compared to less expensive measures to manage current demand and delay major capacity upgrade expenditures • Change relative priorities and weights of criteria e.g. greater focus on community health and safety versus mobility
Climate change varies significantly from its expected change pathway	• Medium term changes in disruption and cost due to the increased frequency and severity of climate-related natural disasters, such as bushfires and floods • Increased number of very hot days impact on the health and mortality of the very old and young	• Greater levels of disruption to transport and logistics systems • Higher costs of dealing with more intensive and frequent natural events • Higher levels of mortality and illness from extreme temperatures.

3.4 Documenting the MCA

Throughout this guide we have emphasised the importance of adequately documenting the MCA framework and the results. The documentation should be sufficient to adequately describe:

- the options analysed using the MCA
- the MCA framework including:
  - the MCA objectives and how these were derived
  - the MCA criteria, with commentary showing how they adequately measure the objectives
  - the MCA criteria weights and how these were set
  - the MCA measures, and how these adequately cover the information needed to inform the scoring of the MCA criteria
  - the scoring framework, and specifically how this has been applied to each measure and criteria included in the MCA framework (score, description and threshold information)
  - the attributes of the core application of the MCA and descriptions of any tests applied, such as sensitivities and alternative scenarios
- the MCA results including:
  - option scores by objective, for the core application and any scenario and sensitivity tests
  - supporting tabulations (in an appendix) of the criteria scores and weights and the scores for the measures underpinning the criteria scores
  - the options' ranking and recommendations about the shortlist that should proceed
  - commentary to adequately explain the basis for these findings and recommendations.

3.5 Summary

This document has outlined the conceptual aspects of MCA in detail to allow users to undertake an MCA in practice. When applied in infrastructure appraisal, and when risks of MCA are considered and addressed, MCA can be a useful tool in the options analysis process for filtering options.

If you are applying MCA as part of a Stage 2 submission to Infrastrastructure Australia, you should produce and document from the MCA:

- a refined list of options that can be taken forward for more detailed analysis
- supporting commentary on all results.

Refer to **Stage 2** and **Stage 3** of the Assessment Framework for further details on the respective analysis processes.

Glossary

Term	Definition
Appraisal	The process of determining the impacts and overall merit of a proposal, including gathering and presenting relevant information for consideration by the decision-maker.
Appraisal summary table (AST)	This table succinctly captures both the qualitative and quantitative elements of a proposal. It will assist decision-makers to quickly understand the broader strategic, societal and deliverability aspects of the proposal.
Assessment	For the purposes of the **Assessment Framework**, this refers to Infrastructure Australia's evaluation of proposals submitted to us for inclusion on the ***Infrastructure Priority List*** or for a funded proposal review.
Assessment Criteria	The three criteria Infrastructure Australia assesses proposals against: **Strategic Fit**, **Societal Impact** and **Deliverability**.
Assessment Framework	A publicly available document that details how Infrastructure Australia assesses infrastructure proposals. It provides structure to the identification, analysis, appraisal, and selection of proposals and advises proponents how to progress through the following four stages: • Stage 1: Defining problems and opportunities • Stage 2: Identifying and analysing options • Stage 3: Developing a business case • Stage 4: Post completion review
Australian Infrastructure Audit	Published in August 2019, the Audit was developed by Infrastructure Australia to provide a strategic assessment of Australia's infrastructure needs over the next 15 years. It examined the drivers of future infrastructure demand, particularly population and economic growth. Data from the Audit is used as an evidence base for assessments of proposals for inclusion on the ***Infrastructure Priority List***.
Australian Infrastructure Plan	The 2021 Plan was developed by Infrastructure Australia as a positive reform roadmap for Australia. Building off the evidence base of the Audit (see ***Australian Infrastructure Audit***), the Plan sets out solutions to the infrastructure challenges and opportunities Australia faces over the next 15 years, to drive productivity growth, maintain and enhance our standard of living, and ensure our cities remain world class. The 2021 Plan supersedes the February 2016 Plan.
Base case	A project **appraisal** compares the costs and benefits of doing something (a 'project case') with not doing it (the 'base case'). The base case should identify the expected outcomes of a '**do-minimum**' situation, assuming the continued operation of the network or service under good management practices. We recommend the committed and funded expenditure approach to defining the base case, but recognise that some states and territories use the planning reference case approach.
Benefit–cost ratio (BCR)	This is the ratio of the present value of economic benefits to the present value of economic costs. It is an indicator of the economic merit of a proposal presented at the completion of a cost–benefit analysis. (See **cost–benefit analysis**).
Business case	A document that brings together the results of all the assessments of an infrastructure proposal. It is the formal means of presenting information about a proposal to aid decision-making. It includes all information needed to support a decision to proceed, or not, with the proposal and to secure necessary approvals from the relevant government agency. Unless otherwise defined, we are referring to a final or detailed business case, rather than an early (for example, strategic or preliminary) business case, which is developed in accordance with state or territory requirements. A business case is prepared as part of Stage 3 of the Assessment Framework.

Term	Definition
Capital cost	The initial fixed costs required to create or upgrade an economic asset and bring it into operation. This includes expenses such as the procurement of land, buildings, construction, labour and equipment.
Cost–benefit analysis (CBA)	An economic analysis technique for assessing the economic merit of an infrastructure proposal. It involves assessing the benefits, costs, and net benefits to society the proposal would deliver. It aims to attach a monetary value to the benefits and costs wherever possible and provide a summary indication of the net benefit. (See **benefit–cost ratio**).
Deliverability	One of three overarching **Assessment Criteria** we use to assess the merit of every proposal, at every stage. This criterion asks: can the proposal be delivered successfully? We assess whether the proposal is capable of being delivered successfully, whether risks have been identified and sufficiently mitigated, and whether there is a plan in place to realise the benefits. This criterion is divided into five themes: ease of implementation, capability and capacity, project governance, risk and lessons learnt.
Demand forecasting	The activity of estimating future demand (such as public transport patronage, vehicle volumes or water usage) in a particular year or over a particular period.
Discount rate	The interest rate at which future dollar values are adjusted to represent their present value (that is, in today's dollars). This adjustment is made to account for the fact that money today is more valuable than money in the future. **Cost–benefit analysis** should use real social discount rates.
Do-minimum	A base case reflecting the continued operation of the network or service under good management practices. It should assume that general operating, routine and periodic maintenance costs will continue to occur, plus a minimum level of capital expenditure to maintain services at their current level (e.g. maintaining access or reliability) without significant deterioration. This may include asset renewals and replacement of life-ending components on a like-for-like basis, as well as committed and funded projects and smaller scale changes required to sustain viable operations under the base case. (See **base case**).
Impact	A generic term to describe any specific effect of a proposal. Impacts can be positive (a benefit) or negative (a cost).
Infrastructure	Physical assets and facilities that enable organisations to provide goods and services to the community and improve quality of life, efficiency, accessibility and liveability of our cities and regions. This includes, but is not necessarily limited to, transport, energy, telecommunications, water and social (such as health, education, social housing and community facilities) infrastructure.
Infrastructure Priority List	The Priority List is a credible pipeline of nationally significant infrastructure proposals that are seeking investment. Every proposal on the Priority List is expected to contribute to national productivity or to be otherwise socially beneficial. It is a statement of where governments, the community and the private sector can best focus their infrastructure efforts.
Longlist of options	A comprehensive list of potential options to address the problems and realise the opportunities identified in Stage 1. The longlist includes all options that are identified for a proposal and should represent a range of reasonable alternatives, including capital and non-capital options, as well as demand-side and supply-side options.
Monetised	Where a quantified impact has a corresponding dollar value attached to it. (See **impact**).
Multi-criteria analysis (MCA)	An analysis tool that differentiates and evaluates options using a set of project-specific criteria with weights assigned to each criterion. The analysis involves scoring and weighting each option against each criterion. MCA can be used for analysing a longlist of options against how they address problems and opportunities, but should not be used by itself to develop a shortlist of options.
Mutually exclusive	In the context of the **Assessment Framework**, the term is used to refer to options where choice to adopt one option precludes adoption of all the other options.
Network	Infrastructure networks are the physical assets that enable the provision of services such as transport connectivity, power, water and internet.

Term	Definition
Non-infrastructure options/ solutions	Proposals that avoid the need for significant expenditure on new or upgraded infrastructure. For example, changes to pricing or reforms to regulations.
Opportunity	An evidence-based reason for action that results from a gap between an actual and a desired outcome. In the context of the Assessment Framework, an opportunity is informed by the ***Australian Infrastructure Audit*** and by our collaboration with proponents to identify jurisdictional and national opportunities.
Option	A possible solution to a problem, including base case options such as 'do nothing' or '**do minimum**'. (See **base case**).
Options analysis	The analysis of alternative options for solving an identified problem or realising an identified opportunity. (See **option**).
Place	A geographical area within a clearly defined boundary. A 'place' can be scaled at different levels, for example, a precinct, strategic centre or sub-region.
Place-based	A 'place-based' approach to infrastructure applies a wide lens to consider the total impact and needs of a particular community or place over the longer-term. It adopts an integrated approach to land use and infrastructure planning. It takes a cross-sectoral view of the interrelated infrastructure and amenity needs of a place, and identifies how and when these should be delivered. (See **place**).
Problem	An evidence-based reason for action that results from a gap between an actual and a desired outcome. In the context of the **Assessment Framework**, problems are informed by the ***Australian Infrastructure Audit*** and by our collaboration with proponents to identify jurisdictional problems and national problems.
Productivity	The efficiency with which the economy as a whole convert inputs (labour, capital and raw materials) into outputs. Productivity grows when outputs grow faster than inputs, which makes the existing inputs more productively efficient.
Project	An infrastructure intervention. A project will move through the stages of project initiation, planning, delivery and completion. A suite of related projects to address a common problem or opportunity will create a **program**.
Program	A proposal involving a package of projects that are clearly interlinked by a common **problem** or **opportunity**. The package presents a robust and holistic approach to prioritise and address the projects, and there is a material opportunity to collaborate and share lessons across states, territories or agencies. The projects can be delivered in a coordinated manner to obtain benefits that may not be achieved by delivering the interventions individually. (See **project**).
Proponent	An organisation or individual who prepares and submits infrastructure proposals to us for assessment. To be a proponent of a business case (a Stage 3 submission), the organisation must be capable of delivering that proposal. (See **business case**).
Proposal	The general term we use for successful submissions to the ***Infrastructure Priority List***, across the key stages of project development: specifically early-stage (Stage 1), potential investment options (Stage 2) and investment-ready proposals (Stage 3). Proposals that have been delivered would be assessed in Stage 4.
Qualitative	A description of an impact that does not rely on quantitative or monetised information.
Quantitative/quantified	A description of an impact that utilises, presents or references values, numbers or statistics.
Rapid cost–benefit analysis (rapid CBA)	A rapid CBA incorporates standard CBA principles and techniques but at a lower level of accuracy. (See **appraisal** and **cost–benefit analysis**).
Resilience	The ability of the community to anticipate, resist, absorb, recover, transform and thrive in response to shocks and stresses to realise positive **social, economic and environmental** outcomes.

Term	Definition
Risk	Events that have probabilities of occurrence that are predictable and outcomes that can be estimated with some confidence.
Scenario analysis	Scenario analysis provides a framework for exploring the uncertainty about future consequences of a decision, by establishing a small set of internally consistent future scenarios and assessing options against each of them. This form of analysis is especially useful for decision-makers faced with forms of uncertainty that are uncontrollable or irreducible (e.g. future technology change or increased climate variability).
Sensitivity analysis	Changing a variable, or a number of variables, in a model or analysis to test how the changes affect the output or results.
Shortlist of options	The set of options determined as most likely to benefit the Australian community using a structured, quantitative and unbiased analysis (in Stage 2). The shortlist of options is taken to Stage 3 for detailed analysis. We recommend the shortlist includes at least two viable options.
Social, economic and environmental impact	The positive and negative effects of a proposal, with regards to: • social: quality-of-life effects, such as social exclusion and access to services, employment and safety • economic: productivity effects, such as productive capacity, economic capability, global competitiveness • environmental: effects such as greenhouse gas emissions, waste treatment, noise pollution, visual intrusion, heritage impacts
Societal wellbeing	The welfare of Australian society as a whole. Effects on societal wellbeing, often referred to as impacts, can be positive (a benefit) or negative (a cost), and form the basis for **cost–benefit analysis**.
Societal Impact	One of three overarching **Assessment Criteria** we use to assess the merit of every proposal, at every stage. This criterion asks: what is the value of the proposal to society and the economy? We assess whether the social, economic and environmental value of the proposal, and its contribution to community sustainability and resilience is clearly demonstrated by evidence-based analysis. This criterion is divided into five themes: quality of life, **productivity**, environment, **sustainability** and **resilience**.
Strategic Fit	One of three overarching **Assessment Criteria** we use to assess the merit of every proposal, at every stage. This criterion asks: is there a clear rationale for the proposal? We assess whether there is a strong case for action, the proposal aligns to the achievement of stated goals and there is a clear fit with the community. This criterion is divided into five themes: case for change, alignment, network and system integration, solution justification and stakeholder endorsement.
Strategic review	Strategic review involves a high-level review of the **Strategic Fit** and feasibility of options before moving on to more structured analysis. This is intended to form an initial view of each option and can be conducted informally with less effort than is required for quantitative analysis. Two tools that practitioners can consider for strategic review are initial screening or strategic merit testing, which can be applied consecutively.
Sustainability	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs.
Themes	Themes are outcome areas within our **Assessment Criteria**. Each criterion is divided into five themes. (See **Assessment Criteria, Strategic Fit, Societal Impact** and **Deliverability**).
Uncertainty	Events where probabilities of occurrence are difficult to predict and outcomes are challenging to quantify.

Infrastructure Australia is an independent statutory body that is the key source of research and advice for governments, industry and the community on nationally significant infrastructure needs.

It leads reform on key issues including means of financing, delivering and operating infrastructure and how to better plan and utilise infrastructure networks.

Infrastructure Australia has responsibility to strategically audit Australia's nationally significant infrastructure, and develop 15-year rolling infrastructure plans that specify national and state level priorities.

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