Infrastructure and Projects Authority

Project Routemap

Setting up projects for success

Asset Management

UK Module

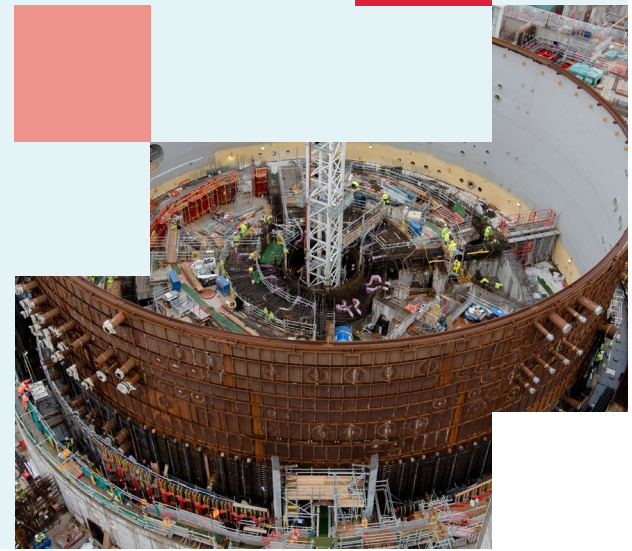
Interactive document

Handbook Hb 00

Requirements Rq 01 | Governance Gv 02 | Systems Integration SI 03 | Organisational Design & Development OD 04 | Procurement Pr 05 | Risk Management RM 06 | Asset Management AM 07 | Delivery Planning DP 08

Contents

Asset Management AM 07



Cover image
Hinckley Point C is the first new nuclear power station to be built in the UK. It will provide low carbon electricity for around 6 million homes, off-setting 9 million tonnes of carbon dioxide emissions per year.

Acknowledgements
EDF Energy

Preface

Project Routemap is the Infrastructure and Projects Authority's (IPA) support tool for novel or complex major projects. It helps sponsors and clients understand the capabilities needed to set projects up for success, incorporating learning from other major projects and programmes.

The IPA is the centre of expertise for infrastructure and major projects, sitting at the heart of government and reporting to the Cabinet Office and HM Treasury in the UK.

Over the coming years there will be more investment in infrastructure and major projects than ever before, backed by both public and private sectors. This investment will be a catalyst to building back better and stronger. Infrastructure and major projects will play a critical role in fuelling economic growth and improving the lives of people right across the country.

With greater investment comes greater responsibility and we must ensure we have a strong delivery record that demonstrates real value. This means setting projects up for success from the very start, so that they come in on time and budget, and deliver on their promises - to the benefit of the citizens of the UK.

Although setting up projects for success can take more time at the start, this will be repaid many times over in the delivery phase. Projects that focus enough attention on the early stages are much more likely to achieve their intended outcomes later on and display world-class delivery standards.

That's why the IPA developed the Project Routemap ("Routemap") - a support tool that provides practical advice based on learning from other major projects and programmes.

There is no doubt that complex projects can test the limits of organisational capability, but if applied in the most crucial early stages of project development, Routemap will ensure that best practice and learning about the most common causes of project failure and principles for project success are incorporated. This will result in benefits ranging from selection of the most appropriate delivery model, to clearer governance arrangements, proper risk allocation and accelerated decision-making.

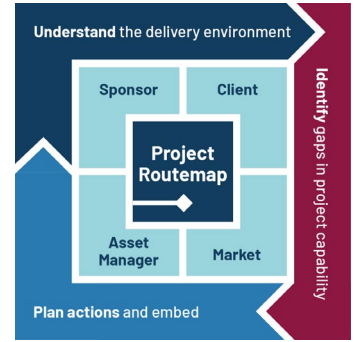
Routemap has been used by many of the UK's biggest, most complex and high-profile projects since its first publication in 2014 and more recently it has also been applied to projects internationally. However, the project delivery system and the way projects are delivered has evolved. That is why the UK Routemap handbook and accompanying modules have been updated to incorporate new and emerging best practice in project delivery and to align with standards, including the Government Functional Standard for Project Delivery and the UN Sustainable Development Goals.

Building on its success with economic infrastructure, Routemap has also been expanded to cover social and defence-related infrastructure projects and includes guidance for application to other types of projects.

Applying Routemap to more of our projects will be another step towards realising our ambition of world-class delivery standards. Whatever the project, applying Routemap will give confidence to the people delivering them, those approving them, and those investing in them.

The IPA would like to thank all those organisations and individuals who have contributed to the development, of both the original, and the updated UK Routemap handbook and accompanying modules.

Nick Smallwood
Chief Executive Officer of the Infrastructure and Projects Authority and Head of Government's Project Delivery Function

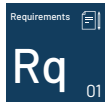


Introduction: What are the Routemap modules?

The Routemap modules provide practical advice to help set up projects for success. The modules have been developed by the UK government in collaboration with industry and academia. They capture best practice and learning from common causes of project failure and success over the past decade from £300bn of capital programmes.

These modules sit alongside the Routemap handbook. The handbook explains how Routemap can be applied to identify gaps in project capability and build an action plan to close those gaps.

There are eight modules, one covering each of the following areas:

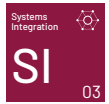


Requirements
Delivering strategic project outcomes and realising the benefits.

Procurement
Understanding how the project will buy goods and services.

Governance
Establishing clear accountability and empowering effective decision-making.

Risk Management
Managing uncertainties and opportunities.



Systems Integration
Making multiple systems work as one.

Asset Management
Balancing costs and risks to maximise whole life benefits.

Organisational Design & Development
Organising the project team to deliver successfully.

Delivery Planning
Readying the project for transition into delivery.

The best practice and learning contained in the modules reflect the collective experience of public and privately funded projects from the infrastructure and defence sectors. However, most of the principles apply to all projects, including digital and transformation projects.

These modules are aligned with the government's Project Delivery Capability Framework and help projects comply with the Government Functional Standard for Project Delivery. They also help projects to align with other recognised standards and guidance, including the United Nations Sustainable Development Goals.

They are useful whether you are using the Routemap to undertake a Full Project Review or a Modular Deep Dive, as detailed in the Routemap handbook. They can also be a useful standalone reference to identify potential risks and improvements in project capability development, and relevant good practice from other projects.

The modules are not a complete guide to project development, nor a substitute for business case development. Instead, they provide considerations to challenge your thinking and to launch your project on the path to success. The project team will need to consider their project's individual characteristics and context and identify what will be most helpful to them.

Introduction: How do you use the Routemap modules?

This table summarises how different module sections support the three key stages of the Routemap methodology.

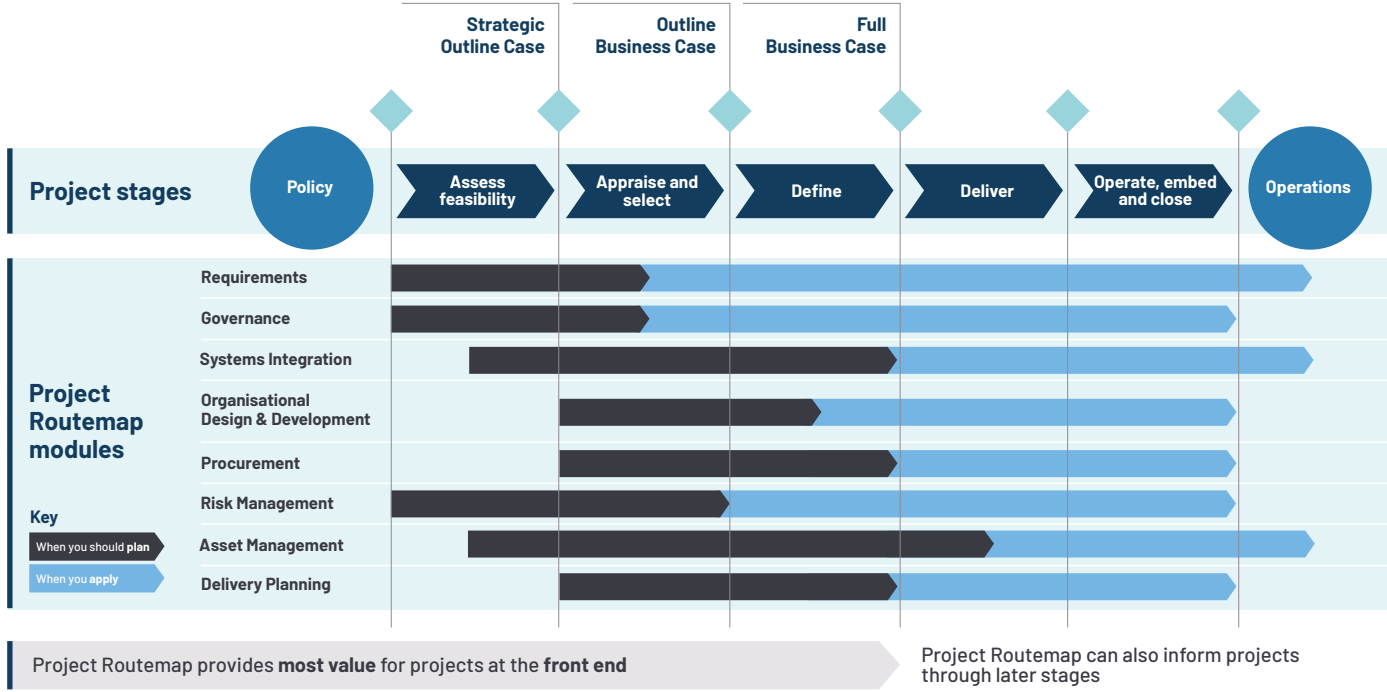
The modules are useful when applying the Full Project Review and Modular Deep Dive approaches, which are described in the Routemap handbook.

Routemap approach	Setup Determine the scope and timing of the Routemap, which can be project-wide or targeted to specific areas of capability	Diagnosis Gather information and identify where capabilities need to be enhanced	Action planning Collaborative development of practical solutions to enhance capability
Full Project Review	Determine if there is value in using Routemap to support project-wide capability development.	Determine which modules may help.	Apply best practice and learning from the modules and any other major project examples.
Modular Deep Dive	Determine if there is value in using specific Routemap modules to support development of a specific area of capability.	There is likely to be one module in particular that focusses on your selected area of capability. However, there may be value in consulting other interfacing modules too.	Apply best practice and learning from the modules and any other major project examples in the selected area of capability.
Module section			
Key project documents Documents that will help you understand the asset management arrangements for your project.	You may find it helpful to review these types of project documents, to define the areas of interest in the Routemap scope.	Cross-checking this document list against existing project documents may also help you to identify capability gaps.	You may find that developing or enhancing these types of documents will help to close capability gaps.
Typical findings Indicators that issues might arise during delivery.	If these indicators are apparent even before you start applying Routemap, this should inform the areas of interest in the Routemap scope.	You may find it helpful to review these when identifying issues and articulating your findings.	If your findings contain statements like these, this module could help strengthen capability.
Pillars of effective asset management Hallmarks of successful project set up.	Comparing your project with these characteristics of good practice may help you to identify areas of interest in the Routemap scope.	*Not applicable to this stage*	Comparing your project with these characteristics of good practice may help you set goals for your action plan.
Considerations Detailed list of questions to understand root causes and suggest improvements.	*Not applicable to this stage*	This section lists a series of questions that can help you to test the effectiveness of existing arrangements.	Working through these questions can help you understand the root causes of the findings and develop solutions.
Good practice examples and suggested reading Context to support your wider understanding.	*Not applicable to this stage*	*Not applicable to this stage*	You may find these good practice examples and suggested reading useful in developing actions to address capability gaps.

Introduction: How do the modules map to the project life cycle?

This diagram maps the Routemap modules to the stages of a project life cycle.

It shows when each of the modules should be used to support planning during project set up. It also suggests the stages when the modules' principles are expected to have been applied.



Project Routemap provides **most value** for projects at the **front end**

Project Routemap can also inform projects through later stages

Cross-cutting themes projects can't ignore

Six cross-cutting themes emerged from our engagement with major projects and industry, which have informed the updated Routemap modules. These place complex demands on project teams, and if overlooked during set up, can create issues during the later stages of the project life cycle.

These themes include the need for focus on behaviours and culture, consideration of wider economic, environmental, and social value and the increasing use of digital systems and tools to enable a systems-focused approach.

Planning ahead for the right skills, experience and capacity to address these themes is key to success.

To help you navigate these themes, we have developed a series of prompts. You can use these prompts to check whether your project is set up to meet the challenges ahead.

Benefits and outcomes focus

adopting a whole life perspective whilst managing the project

- Have you got a clear vision of the target outcomes, which is aligned across the sponsor, client, asset manager and market?
- Have the project outcomes been effectively communicated to key stakeholders and the supply chain?
- Has the project set realistic and transparent targets?
- Are you able to measure the realisation of benefits throughout the whole life cycle? Including any potential early releases?
- Have you considered the disbenefits and how to minimise them?

People and skills

planning ahead for the right skills, experience and capacity to deliver the project

- Have you undertaken activity-based resource planning to ensure you have the people with the right skills, knowledge, experience and behaviours at the right time to deliver the project?
- Are these plans reviewed on an ongoing basis? And do they incorporate skills development and succession planning to ensure continuity in key roles and to meet evolving needs?
- Have you considered the time commitment of your project leaders to ensure they have the right capacity to deliver the project?
- If using delivery partners or third parties, do they have the capacity and expertise to support the project as required?

Behaviour and culture

realising project success with a capable, diverse and integrated team

- Is there a plan for how desired behaviours and values will be cascaded and embedded through the sponsor, client, asset manager organisations and the supply chain?
- How are the desired behaviours and culture promoted in the project?
- Does the project have a culture that empowers constructive challenge and diversity of thought?
- How is the project planning to build relationships and invest in creating the right environment to realise project outcomes?

Economic, environmental and social value

taking in a wider view of the project's impact

- Have you considered how the project will generate economic, environmental, and social value, both through its intended outcomes and/or as a by-product of delivery? Has this been hardwired into the business case, with a clear link to the UN Sustainable Development Goals?
- Is your project aspiring to leave a "net positive" and climate resilient impact on the natural environment?
- How are you maximising benefits and minimising risk and disbenefits for project affected communities and contributing to levelling up?
- Is there clear accountability for the economic, environmental, and social benefits and outcomes?

Digital and technology

embedding systems and approaches at the front end to maximise project productivity

- Have digital and modern methods been considered at the earliest point in the life cycle to maximise their impact on benefits?
- How has the project assessed and addressed digital capability within the sponsor, client, asset manager and market?
- Has the project considered how information, data and knowledge will be shared across the project, including with the supply chain?
- What consideration has been given to potential changes in technology that may influence benefits realisation?

Transitions

planning for change and developing the required capability before progressing to the next life cycle stage

- Does the project have a clear plan for how they will transition from one life cycle stage to the next?
- Does the plan set out the changes needed to organisational and governance arrangements?
- Does the project have the necessary capability to transition to the new organisational and governance arrangements for the next life cycle stage? Including the change management capability required to embed the changes?
- Is the project clear on how the relevant documents and people will carry knowledge and learning across life cycle stage boundaries?

Asset management, and why it's important

Asset Management AM 07

"Effective asset management has become as critical as ever across the globe and in the face of mounting pressures, such as limited resources, growing urban populations, shifting patterns of employment and land use, climate-related disruptions and health emergencies, including the COVID-19 pandemic."

Managing infrastructure assets for sustainable development: a handbook for local and national government – United Nations 2021

Why asset management matters

A project to build or improve an asset should contribute to the organisation's overall strategy for asset management, but it can also drive significant value for the wider economy, environment and society. When establishing or reviewing the strategy, its scope and implementation should be consistent and aligned with the external (legal, policy and regulatory requirements) and the internal (governance, values and objectives) context of the organisation. This will enable projects to create assets that effectively integrate with the existing portfolio, support the organisation's strategic objectives and drive wider societal value over their whole lives.

From the earliest stages of a project, there should be an understanding of the current state of existing assets and how the new assets will be managed as part of the target operating model. During set up, projects also need to consider how new assets will integrate with interfacing natural, physical and digital systems and be resilient to potential changes in policy or emerging trends, such as climate change.

Just as important as an asset's creation, is its ongoing operation, maintenance, and end-of-life disposal. Involving those responsible for the asset after handover, at the front end of the project, is critical to capture their operational requirements. Every decision made during project development will influence the whole life cost of the asset, as well as the service it provides, and the economic, environmental and social value it delivers. By explicitly addressing the question of what happens after the project closes, organisations will ensure they develop the right capability to fully realise the asset's whole life value and expected benefits.

This means planning for the asset management capability needed by both:

- the project team, in particular to inform the project's requirements and to test and commission the asset prior to handover
- the organisations that will eventually operate and maintain the asset, as this is when many of the benefits will be realised

The rate of technological advancement over the past decade looks set to continue. This brings both opportunity and new challenges. This is particularly true of projects with long delivery times where strategies for anticipating and dealing with obsolescence have become increasingly important. Projects also need to weigh up the potential risks of new technology, including its integration into existing systems, with the potential gains.

This module can help to assess whether existing or proposed asset management arrangements are suitable for the scale or the complexity of your project.

What are the key project documents?

If you are seeking to find out more or to review the existing asset management arrangements on your project, the typical documents and reports set out below may contain information that will help.

- Strategic assessment management plan
- Project assessment management plan
- Target operating model
- Sponsor's requirements (Brief)
- Integrated assurance and approval plan
- Regulatory or statutory requirements
- Business case, in particular the strategic and commercial cases
- Information management plan, including asset information requirements
- Commissioning and handover plan
- Funding arrangements
- Corporate charters or codes of conduct
- Operations and maintenance strategy
- Stakeholder map and engagement plan
- Risk management plan, including the risk register

Not all projects will have all of these documents, particularly in the earliest stages of development.

Typical findings

Primary module
Other relevant modules

Typical findings relating to Asset Management

This list describes situations that might arise and would indicate that the approach to asset management needs improvement. Other relevant modules may also help you close identified capability gaps.

Relevant modules

Typical findings relating to Asset Management	Requirements	Governance	Systems Integration	Organisational Design & Development	Procurement	Risk Management	Asset Management	Delivery Planning
The project has been assessed in isolation without reference to the business and asset management strategy.	◐	●					●	
There is no defined target operating model or associated asset management plan in place to inform the project about how the asset needs to operate after handover.	◐			●			●	◐
The project requirements, business case and design indicate a lack of future thinking and insufficient focus on the experience of the end user.	●	◐					●	
There is limited strategic engagement with the asset manager throughout the project to ensure the project solution is defined, developed and made ready for handover in a way that maximises whole life value.	◐	◐		●			●	●
There is a lack of consideration of how the asset will provide economic, environmental or social value in the long term (for example. reducing resource use, achieving Net Zero goals), and how this may be impacted by changes in in legislation or risk (for example, climate risk).	●		◐			◐	●	
Assumptions are untested, and consequently there is low confidence either that the requirements are fit for the future or that the benefits can be realised.	●	◐			◐		●	
Asset life cycle parameters are not well defined in the project requirements, for example asset reliability or cost of maintenance.	●		◐				●	◐
Building Information Modelling (BIM) and digital twin strategies are not built into project development activities.	◐		◐				●	◐
The project does not have an agreed plan for how asset information produced during delivery will be handed over to the asset manager.	●	◐	◐			◐	●	
Project delivery is overly focused on 'how' the project will be delivered rather than 'what' the project will deliver.	◐	◐		◐			●	◐
Operational requirements have not been considered during procurement.	◐	◐			●		●	
Poor development and retention of asset management capability means performance deteriorates more quickly than anticipated during operations compromising asset whole life value.	◐	◐		●			●	◐
Poor decision-making, governance structures and processes undermine the asset management strategy.	◐	●		◐	◐		●	◐

Pillars of effective asset management

The four pillars below summarise the characteristics of effective asset management.

Pillar 1: Aligning project outcomes with the asset management strategy 1

- Be clear how the asset management strategy and portfolio of assets contribute to the organisational goals, business strategy and sustainability targets.
- Involve the asset manager upfront and start planning early to develop the operational capability and competence required for when the project has been completed and the asset handed over.
- Consider the whole context (internal and external) within which the project is delivering, including how it will eventually integrate with existing systems.

Pillar 2: Optimising whole life value 2

- Base decision-making on the whole life cycle, including the economic, environmental and social value the asset will bring.
- Understand the total cost of ownership of the asset by undertaking whole life cost benefit analysis, as an integral part of the business case development.
- Balance capital and operational costs and risks when setting the project's requirements. Consider how choices made in delivery will impact operations.

Pillar 3: Leveraging asset performance data 3

- Ensure that performance data aligns to industry standards, supports decision-making and provides progressive assurance on route to handover.
- Secure value for money by understanding the drivers of whole life cost. Use asset performance data to support periodic assessment of these costs and look for efficiencies.
- Set explicit whole life parameters in requirements, for example availability and reliability. Capture and report on these metrics regularly as the project progresses.

Pillar 4: Leading asset management 4

- Work to align the behaviours, values and objectives of the organisations involved in the creation and management of the asset, both physically and digitally.
- Collaborate to understand the interdependencies between the new and existing assets. Involve those who will own the end-state asset upfront to ensure their voices are heard.
- Consider how future trends and policy directions will influence the use of the asset, and its impact on end users and wider society long after the project has closed.

These four pillars underpin an effective asset management framework for projects. If one pillar is missing or out of balance, project asset management will likely be ineffective or inefficient. The pillars are expanded in the considerations section of this module.

The asset management arrangements might need to evolve during the project, so you should revisit these considerations at major transition points or approval points, or as plans change.

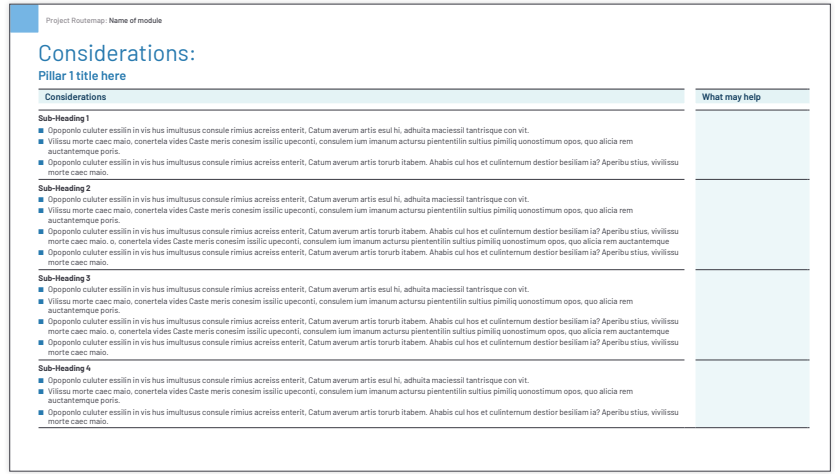
Asset management arrangements should evolve as:

- more information becomes available to inform the capabilities required to deliver the project
- the project team and their processes develop and embed
- the project progresses through its life cycle, from design and planning through implementation to operation

Considerations

Module Pillars

The considerations questions help you understand the root causes of the capability gaps and suggest improvements. You may not need to review all the considerations, just use the most relevant ones for your project.


Project Routemap: Name of module

Considerations:

Pillar 1 title here

Considerations	What may help
Sub-Heading 1 ■ Opoponlo culuter essilin in vis hus imultusus consule rimius acreiss enterit, Catum averum artis esul hi, adhuita maciessil tantrisque con vit. ■ Vilissu morte caec maio, conertela vides Caste meris conesim issilic upeconti, consulem ium imanum actursu piententiiin sultius pimiliq uonostimum opos, quo alicia rem auctantemque poris. ■ Opoponlo culuter essilin in vis hus imultusus consule rimius acreiss enterit, Catum averum artis torurb itabem. Ahabis cul hos et culinternum destior besiliam ia? Aperibu stius, viviilissu morte caec maio.	
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Sub-Heading 3 ■ Opoponlo culuter essilin in vis hus imultusus consule rimius acreiss enterit, Catum averum artis esul hi, adhuita maciessil tantrisque con vit. ■ Vilissu morte caec maio, conertela vides Caste meris conesim issilic upeconti, consulem ium imanum actursu piententiiin sultius pimiliq uonostimum opos, quo alicia rem auctantemque poris. ■ Opoponlo culuter essilin in vis hus imultusus consule rimius acreiss enterit, Catum averum artis torurb itabem. Ahabis cul hos et culinternum destior besiliam ia? Aperibu stius, viviilissu morte caec maio. o, conertela vides Caste meris conesim issilic upeconti, consulem ium imanum actursu piententiiin sultius pimiliq uonostimum opos, quo alicia rem auctantemque ■ Opoponlo culuter essilin in vis hus imultusus consule rimius acreiss enterit, Catum averum artis torurb itabem. Ahabis cul hos et culinternum destior besiliam ia? Aperibu stius, viviilissu morte caec maio.	
Sub-Heading 4 ■ Opoponlo culuter essilin in vis hus imultusus consule rimius acreiss enterit, Catum averum artis esul hi, adhuita maciessil tantrisque con vit. ■ Vilissu morte caec maio, conertela vides Caste meris conesim issilic upeconti, consulem ium imanum actursu piententiiin sultius pimiliq uonostimum opos, quo alicia rem auctantemque poris. ■ Opoponlo culuter essilin in vis hus imultusus consule rimius acreiss enterit, Catum averum artis torurb itabem. Ahabis cul hos et culinternum destior besiliam ia? Aperibu stius, viviilissu morte caec maio.	

Considerations

Each pillar is expanded into a number of consideration questions. These questions will help you:

- to review and validate existing asset management arrangements
- to target areas for improvement
- to test the design of new asset management arrangements

What may help

Signposts other related material which you might find helpful. These include other relevant modules with related content, key project documents, good practice examples and suggested further reading.

Routemap uses four primary roles to describe the key areas of responsibility in the early stages of project development. These are sponsor, client, asset manager and market. Before reading through the detailed considerations, you should familiarise yourself with these definitions in the glossary and consider which organisation is fulfilling which role for your project. Sometimes an organisation can fulfil more than one of these roles, for example both the sponsor and client roles. Also, where a project is still at an early stage, a role might not yet be filled by any organisation, for example the market role.

Considerations:

Pillar 1 Aligning project outcomes with the asset management strategy

Considerations

Asset management planning

- Is there a strategic assessment management plan in place for the overall asset portfolio?
- Does the strategic assessment management plan align with corporate objectives and values?
- Is the strategic asset management plan:
  - forward-looking, risk-based, and built on an understanding of the relationship between asset operation and business outputs, for example defined levels of service?
  - informed by consultation and engagement with potential users and, where appropriate, communities affected by the project? Is there buy-in?
- Does the plan consider the associated resources required for management of the portfolio? Are other enablers in place? For example, consistent information management policies.
- Is there an appropriate prioritisation mechanism for asset interventions?
  - Does it include criteria for making investment decisions that are linked to the asset management strategy?
  - Does it inform the project asset management plan?
- Does the proposed project fit within the strategic assessment management plan?
- Has the optimum approach to deliver the project been determined in the context of the strategic asset management plan? Is there an appropriate balance of capital and operational investment?
- Are there appropriate and aligned decision-making mechanisms (planning, capital and operational) that consistently consider the whole asset life and value including wider economic, environmental and social sustainability considerations?
- If the asset manager is not in place at the start of project development, can a 'shadow operator' be used to develop the project asset management plan? For example, to develop operational requirements.
- Have opportunities for standardisation with other projects, programmes and portfolios been considered to encourage innovation, drive efficiency and share learning?
- Has the supply chain strategy for operations and maintenance been developed? Is it aligned with the project asset management plan?
- How does the supply chain strategy incentivise continuous improvement in asset management?

What may help

Governance Gv 02

Procurement Pr 05

Strategic asset management plan and project asset management plan

Examples 1, 2 and 3

Suggested reading 5 and 6

Considerations:

Pillar 1 Aligning project outcomes with the asset management strategy

Considerations

Requirements

- Has a high-level operating model that describes end state (post-handover) operations been defined? Is this used as a basis for requirements definition?
- Have any supporting change management and training requirements been identified to support the target operating model?
- Do the project requirements incorporate measures of success that are aligned to corporate objectives and standards? For example, asset reliability, asset availability, cost of maintenance, and whole life carbon targets.
- How will the project address any systems integration requirements? For example, identification and mapping of interfaces.
- Do the requirements include key operational parameters for the new asset, which are consistent with achieving the expected benefits of the project? These could include:
  - overall asset lifespan
  - operability
  - availability
  - reliability
  - maintainability
  - decommissioning/disposal plans
  - contingency plans
- How will these operational requirements be incorporated into any procurement activities?
- Does the asset manager understand the economic, environmental and social standards to which the new asset should be aligned?
  - Is there a plan showing how these requirements and standards will be cascaded through the supply chain? Including how compliance will be evaluated?
  - Does this plan allow for potential changes to these requirements and standards over the life of the asset?
  - Have new and emerging economic, environmental and social risks including risks relating to asset handover, operation, maintenance and eventual disposal been accounted for?
- Do the project requirements account for changes to the asset's environment over the life of the asset? For example, building in resilience or future proofing asset components.
- Is it clear what design standards should be used? Does the asset manager support these? Is it clear who will assure designs against these standards?
- Is there evidence that the complexity of technology or innovation is understood? Is this reflected in the project's risk profile? How will this be tested?
- Has the impact of potential technological development during the life of the asset been assessed? Has this been built into the requirements?

What may help

Sponsor's requirements, business case (strategic) and regulatory or statutory requirements

Examples 5 and 7

Suggested reading 2, 3 and 7

Considerations:

Pillar 1 Aligning project outcomes with the asset management strategy

Considerations

Capability

- Have the operational capacity and competency requirements been defined? Both during the project and after its completion?
- Do the project plans include activities to develop the required operational capacity and competence? Do they take account of the potential supply chain?
- Is there a sense of ownership of the project by the asset manager?
- How is the asset manager involved within the project's governance to ensure a whole life cycle perspective is maintained during project delivery? For example, informing the requirements for capability during operations.
- Is there dedicated resource and funding in the project to define optimal operations and maintenance protocols?
- Are operations and maintenance staff involved and appropriately trained in:
  - designing the operations and maintenance protocols, supported by a hazard and operability study (HAZOP) to identify issues that may arise as part of new processes related to the asset
  - legal and regulatory requirements
  - maintaining services during construction
  - managing economic, environmental and social risks
  - keeping the asset inventory up to date
  - engaging with communities and service users
  - updating emergency response plans
  - capturing all the information about possible events related to the asset, for example, remodelling, a breach, formal inspection and asset testing
- Is it clear where future contract management and performance management responsibilities lie?
- How will the project ensure capability, including knowledge and skills developed during delivery, transfers into operations? For example, between the market, client and asset manager.

What may help

Operations and maintenance strategy

Example 5

Considerations:

Pillar 2 Optimising whole life value

Considerations	What may help
Efficiency, risk and value ■ Have the overall asset energy efficiency (for example, projected energy (for example, energy costs and embedded carbon) and resource efficiency (such as water usage) been considered? – Are there targets in place in relation to energy and resource efficiency during the various stages of the asset life cycle? – Have any requirements for flexibility in asset use/performance been considered as sources of efficiency? Such as considering how the asset could cater for an increased demand without requiring another significant intervention. – Have other sources of operational efficiency been considered? For example, labour, consumables or hired and contracted services. ■ Does the project risk management plan address asset specific risks including: – obsolescence, such as parts of the asset becoming outdated at handover? – resilience, including capacity to recover from outages? – systems integration, how other systems may impact the performance of the asset and vice versa? – environmental, such as waste products produced? – social, how the asset may adversely affect local communities? – operational contingency and business continuity planning, in reaction to unplanned high impact events? ■ Is there an appropriate method for assessing value, by considering risks, opportunities, costs and benefits over the life of the asset? Does the method of assessment include economic, environmental and social costs and benefits? ■ Is there a process for driving continuous improvement in the way the asset operates over its life?	Risk Management RM 06 Risk management plan and project asset management plan Examples 4 and 8 Suggested reading 8, 9 and 10
Scenario planning ■ Is scenario planning undertaken to inform the asset requirements? Is the scenario planning undertaken in consultation with key stakeholders, including project affected communities and potential service users? ■ Are alternative options being generated and considered during option selection? Are they being given fair consideration? ■ Are options (both capital and operational) consistently assessed using the risk-based cost/benefit methodology? ■ Are there wider organisational objectives that inform project-level capital or operational expenditure decisions, such as properly considering 'no requirement for capital' options? ■ Have trade-offs between asset flexibility and impacts on project delivery been considered? For example, allowances for space-proofing could increase cost or adoption of new or untested technology, which could increase risk. ■ Has decision-making concerning the asset to be created taken account of data uncertainty? For example, regarding current existing asset condition? ■ How will the uncertainties, risks and benefits be communicated and have these been included in option scenarios?	Business case (strategic) and strategic asset management plan Suggested reading 2, 5 and 6

Considerations:

Pillar 2 Optimising whole life value

Considerations

Funding

- Are funding sources for the whole life of the asset understood? Including capital expenditure (for example, on construction costs) and operating expenditure (for example, on maintenance)?
- Are there conditions attached to any funding stream? How do these align to the asset management outcomes expected of the project? For example, levels of service captured in a service level agreement.
- Is there any conflict of interest? For example, in a public private partnership scheme, the interests of the private sector funder might not always align with the interests of the public sector client.
- What certainty is there that the future maintenance and operational phases of the project will be funded?
  - How has this influenced in the project scope and requirements?
  - Is the target operating model understood, including who will be responsible for its management, funding and resourcing?
  - Is adequate funding allocated for managing economic, environmental and social risks during operations and maintenance phases?
- Does any split between capital and revenue funding constrain resourcing of the project team? For example, by limiting direct recruitment.

What may help

Procurement Pr 05

Funding arrangements and business case (commercial)

Example 3

Considerations:

Pillar 3 Leveraging asset performance data

Considerations

Data and information

- Is there an existing asset information strategy? Does this project adhere to it?
- Is the asset information strategy aligned with the asset management plan? For example, how performance data is collected, stored and analysed to support operation of the asset.
- Is there an up-to-date asset inventory or register with associated asset condition reports?
- Have those involved in future operations and maintenance been consulted on the information requirements, including asset identification? If not, is there dedicated resource and funding to do this during the early stages in the project?
- Is it clear what asset information needs to be generated during the project that will be required:
  - beyond handover, once the asset is in operation?
  - during the project, for decisions that will impact on whole life operations?
- How will digital asset information created be used to optimise the in-use performance of the physical asset? For example, through the use of a digital twin (the real time digital representation of an asset, Examples 10 and 11 provide further information).
- Is there an efficient, structured and managed process for progressive assurance of the 'as-built' digital asset information and its transfer from the project team to the asset manager? Is it in line with relevant standards?
- What is the sensitivity of the asset information produced? What level of security is required? For example, access to authorised users and storage within data centres, which may be located overseas.
- Is the method for classifying information understood by those creating and using it?
- Are measurable data and sources for measuring project benefits identified? For example, for benchmarking key project metrics and benefits? Does the data exist? If not, what steps need to be taken to obtain it?
- Have procedures for periodically gathering data and information on the asset's economic, environmental and social benefits been defined? Both during project delivery, for any early releases and after handover.

What may help

Gv 02

Information management plan and commissioning and handover plan

Examples 10 and 11

Suggested reading 11, 12 and 15

Considerations:

Pillar 3 Leveraging asset performance data

Considerations

Cost model

- Is there an operational cost model in place? Is it set within an overall whole life cost model that includes capital expenditure?
- Are the asset costs captured at the right level of granularity to support effective asset management? Do they include embedded economic, environmental and social costs? For example, carbon costs.
- Is there appropriate contingency allowance in the project costings to rectify any inaccurate/out-of-date information about existing asset condition?
- Is the asset operational cost model for the project built on actual operational data? Does the model include:
  - all the operational costs? For example manpower, consumables including energy usage and costs, hired and contracted services and disposal.
  - all the maintenance costs? Such as planned maintenance, reactive maintenance, strategic spares.
  - all the costs and contingencies associated with ongoing/periodic assessment and management of economic, environmental and social risks?
- Have any potential disposal cost and timescale issues (especially for hazardous or polluting materials) been assessed? Including how these costs may vary over time considering changes in legislation and the amount of time it takes for materials to break down.

Performance

- Has the probability of failure (reliability and its deterioration over time and/or usage) been assessed?
  - Is the impact of failure of each asset understood?
  - Has it been assessed against the corporate objectives (such as loss of service, income or reputational damage)?
  - Have economic, environmental and social costs of failure been considered?
  - Has the asset's resilience to low likelihood, high impact operational events been considered?
- Are procedures in place for structured monitoring of operations and maintenance after handover?
  - Are these clearly set out in the operations and maintenance strategy and manuals?
  - Are there clear lines of escalation that enable issues to be raised and dealt with at the appropriate level of authority?
  - Is technical support provided to operations and maintenance for an appropriate period after handover?
  - Is data and information on economic, environmental and social risks and impacts used to periodically evaluate performance against targets and metrics?
- What effective learning and feedback mechanisms are there to improve future projects and asset decisions, and asset planning more generally?
- How will the achievement of the project objectives be measured and communicated for at least 10 years after the project is completed?

What may help

Target operating model and information management plan

Example 4

Gv 02 RM 06 DP 08

Project asset management plan and integrated assurance and approval plan

Examples 5 and 9

Suggested reading 8, 10 and 14

Considerations:

Pillar 4 Leading asset management

Considerations

Leadership and alignment

- Does the project leadership understand the context for the new asset? Including the present, and potential future, political, economic, sociological, technological, legal and environmental landscape the asset will operate in.
- How will the project's leadership evolve to ensure that requisite knowledge and experience are available for each stage of the project life cycle? For example, composition of senior management at definition versus various delivery stages, such as main construction works and operational testing.
- Does the project leadership ensure that effective asset management is considered with the same level of importance as other delivery factors? For example, ensuring that speed of project delivery does not compromise asset performance due to poor quality construction.
- Does everyone working on the project feel that they can communicate emerging risks to the eventual performance of the asset? Is constructive challenge to decisions made during delivery encouraged?
- Are the leadership styles of the sponsor and asset manager organisations understood and aligned? Do they align with the culture and behaviours required for benefits realisation during operations?
- Has the project leadership considered the culture of the various teams and organisations involved? Is there a need to take action to manage any differences in culture?
- Is there a culture of continuous improvement in place, based on honest appraisal of past successes and failures?
- Does the project have a strong collaborative work culture that is focused on delivering the outcomes and benefits from the asset?
- Has the project team engaged with the needs of the key external stakeholders, including communities who may or may not benefit from the new services?
- Is there an integrated approvals framework that shows a clear plan, across all parties involved, for planning, coordinating and granting approvals throughout the project's life cycle?

Intelligent co-operation

- Is the project driven by whole system thinking? Have the project team considered how development of the asset will:
  - affect existing assets it interfaces with?
  - affect future assets it will interface with?
  - rely on existing assets for completion?
  - render existing assets obsolete?
- Do project leaders understand the interdependencies between new and existing assets, appreciating that essential information to enabling accurate decision-making may exist outside of their own organisation?
- Does the project actively foster co-operation between the different teams and organisations towards better decisions?
- If there are multiple organisations involved in delivery, are their ways of working compatible?

What may help

Gv 02 OD 04

Integrated assurance and approval plan and corporate charters or codes of conduct

Example 6

Suggested reading 1 and 8

SI 03

Business case (strategic), target operating model and operations and maintenance strategy

Example 11

Suggested reading 2, 4 and 15

Considerations:

Pillar 4 Leading asset management

Considerations	What may help
Fit for the future ■ Has the project actively considered what liabilities it may be passing on to future generations, including debt, running costs, and risks? For example, ease of decommissioning, use of hazardous substances and onerous financial commitments. ■ How will capability be developed and retained to manage the overall asset portfolio? For example, operations and maintenance capability for legacy assets or upskilling for the implementation of digital twins. ■ Has the total cost of ownership of the asset or system been thoroughly investigated and estimated, not just upfront or short-term costs? ■ Have any options for the future been ruled out by the choices made for this project? What are the potential implications? ■ Have the direction, opportunities and threats of future technologies (and how the asset or system will work with them) been considered? ■ Has the direction of public policy, for example relating to climate change, been considered in developing the asset and its target operating model? ■ Has the cumulative impact of the asset on the economy, the environment and society informed decision-making? ■ How will the asset's performance indicators be reviewed over its whole life account to ensure that the asset still meets the expectations of its evolving external environment? For example, increasing demands on emissions reductions.	Target operating model and business case (strategic) Examples 8 and 9 Suggested reading 7, 16 and 24

Good practice examples

Good practice examples	Pillar 1: Aligning project outcomes with the asset management strategy	Pillar 2: Optimising whole life value	Pillar 3: Leveraging asset performance data	Pillar 4: Leading asset management
It is important to assess how applicable each example is to your specific project, and tailor it as appropriate. This table shows which of the four pillars of good practice are characterised by each example.	1	2	3	4
Example 1 The relationship between a project and the asset management life cycle	●			
Example 2 The integral parts of a strategic assessment management system	●			
Example 3 The relationship between organisational context and desired asset management outcomes	●	●		
Example 4 An asset management value framework	●	●	●	
Example 5 The role of the sponsor, client, market and asset manager through the project life cycle	●		●	
Example 6 Defining leadership for asset management through corporate policies and vision: An SSE case study				●
Example 7 Establishing a target operating model: A High Speed 2 case study	●			●
Example 8 Embedding climate risk assessment into asset management		●		●
Example 9 Moving from a short-term to a long-term focus on asset management			●	●
Example 10 Integrating your physical and digital assets			●	
Example 11 Developing your digital twin strategy			●	

Good practice examples

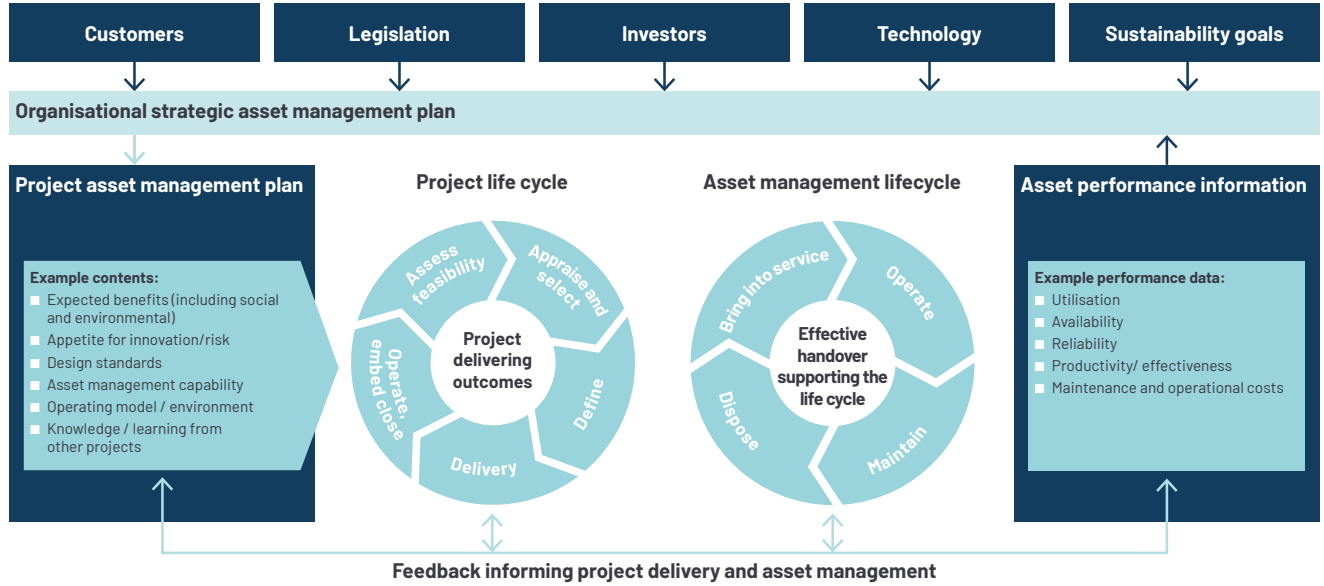
Example 1

The relationship between a project and the asset management life cycle

An infrastructure project either creates or improves an existing asset base, owned by the asset manager organisation. To define and then successfully deliver the outcomes expected from a project, you must first understand the objectives of the wider organisational asset management strategy. Every decision made during project development will influence the whole life cost of the asset, as well as the service it provides. Once the project is complete and the asset is handed over, its ongoing operation will generate performance information that in turn will inform future investment. This is summarised in the diagram on the right.

The information and performance data produced by the project and the asset in service should support measurement of objectives within the organisational strategic asset management plan. This will ensure that the right information is produced to support the ongoing asset management activities (for example, continuous improvement of processes and procedures). Further detail is provided in Example 2 on how this feedback of information should work in practice.

Examples of influences on an organisation:



Good practice examples

Example 2

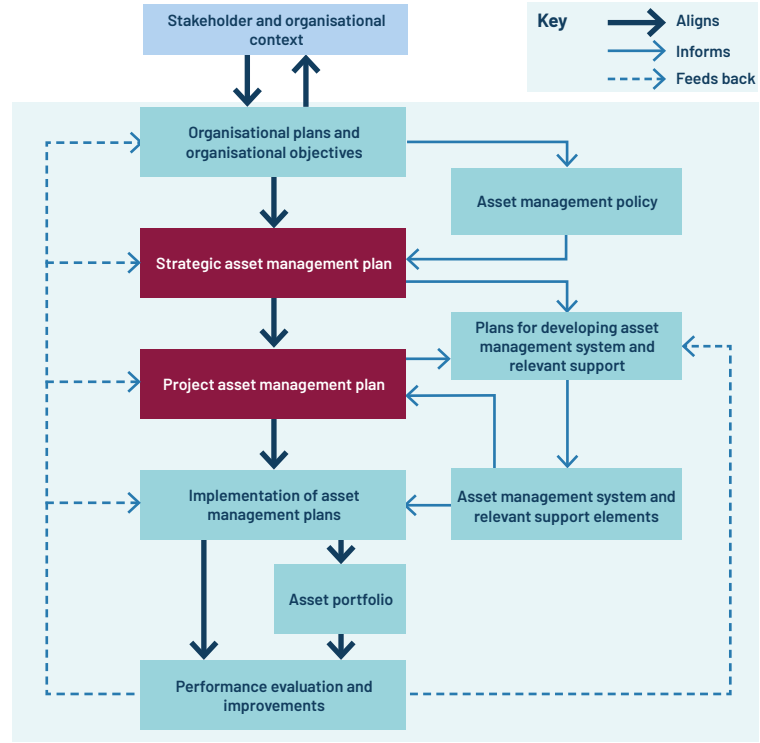
The integral parts of a strategic assessment management system

This example shows the relationship between an organisation's plans and objectives, asset management policy, strategic asset management plan and an individual project asset management plan. The graphic has been adapted from ISO55002 (Suggested Reading 6).

An asset management system (blue shaded area) is used by an organisation to direct, coordinate and control asset management activities. Near the top of this sits the strategic asset management plan. The plan describes how ongoing asset management including the creation of new assets, will contribute to fulfilling wider strategic objectives, informed by the asset management policy (see Example 6). It should also define how the organisation will measure the contribution of their asset management activities.

The strategic asset management plan should remain at a high level and be used as a basis to develop individual project asset management plans. These more detailed plans set out how the asset will be created and operated along with the associated resourcing requirements. They should be reviewed periodically to ensure continual alignment with the strategic asset management plan and asset management policy.

Although a project may close with handover of the asset to operations, the overall asset management process does not end there. As shown in the diagram, there is a continual feedback loop, evaluating the performance of the asset, and overall portfolio, and using this to information to update the strategic and individual project asset management plans. Projects will therefore need to work with those involved in ongoing asset management to develop the capability required to implement this performance evaluation process for the asset that they will be delivering.



Pillar 1: **Aligning project outcomes with the asset management strategy** 1 | Pillar 2: Optimising whole life value 2 | Pillar 3: Leveraging asset performance data 3 | Pillar 4: Leading asset management 4

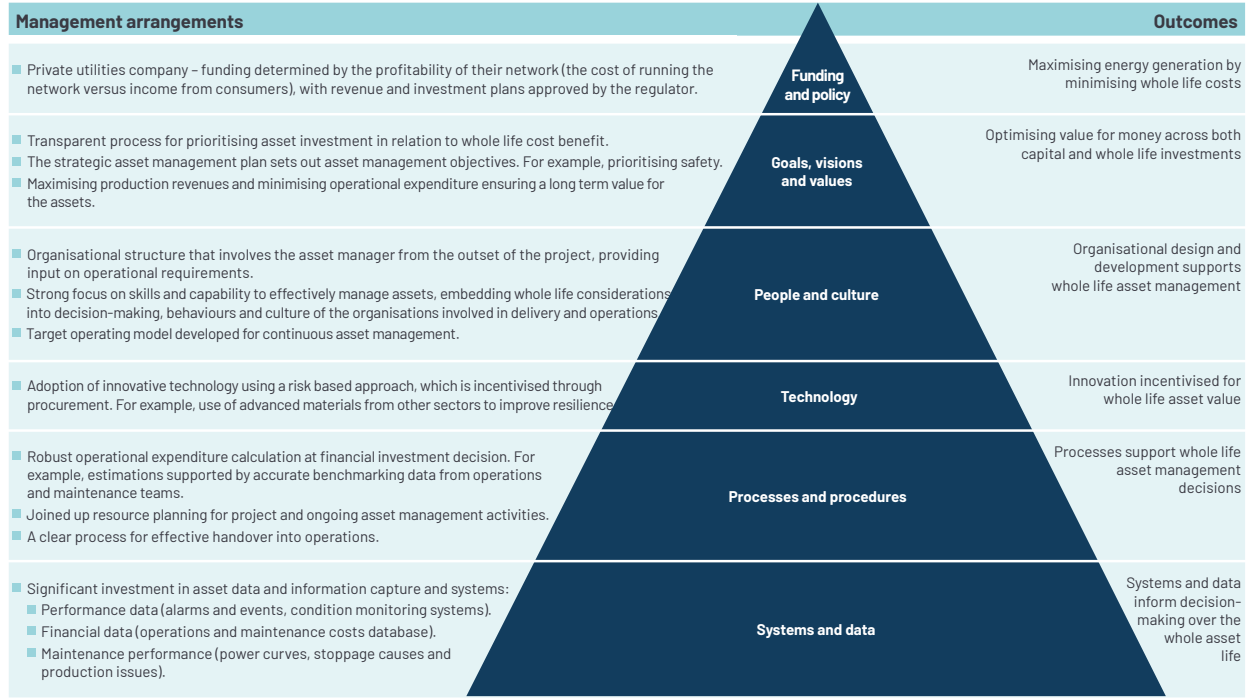
Good practice examples

Example 3

The relationship between organisational context and desired asset management outcomes

As shown in Example 2, the wider organisational context, within which a project is commissioned, will significantly influence the successful delivery of asset management outcomes. Factors such as the funding model, policy decisions and any conditions imposed by sponsors can either support or compromise the realisation of the intended asset management benefits.

This example demonstrates the relationship between the wider organisational context and a successful whole life asset approach. It is based on a private utilities company that has aligned its funding model, asset management strategy and project delivery approach.



Good practice examples

Example 4
An asset management value framework

A consistent methodology for assessing the whole life value of a project can ensure that investment activities are aligned with the strategic aspirations of an organisation.

In this example, a UK utility company aimed to achieve a significant reduction in its carbon footprint. A capability assessment showed that to achieve this goal, the organisation would need to develop a method for objectively comparing all alternative investment options across their portfolio of projects and programmes (from operational site upgrades to laptop replacement programmes). This would need to take into consideration:

- whole life costs, including ongoing operational and maintenance costs, and
- their respective benefits, based on a consistent definition of value which takes account of long-term commitments (such as reducing carbon emissions to meet net zero)

The organisation developed their first value framework (shown overleaf), aligned to the Forums for the Future's Five Capitals Model (Suggested Reading 23) and subsequently developed a cost-benefit assessment methodology to apply the framework.

The Five Capitals				
Manufactured capital comprises material goods or fixed assets which contribute to the production process rather than being the output itself. For example, tools, machines and buildings.	**Financial capital** plays an important role in our economy, enabling the other types of capital to be owned and traded. For example, shares, bonds or banknotes.	**Human capital** consists of people's health, knowledge, skills and motivation. All these things are needed for productive work.	**Natural capital** is any stock or flow of energy and material that produces goods and services. For example, farmland, water and mined minerals.	**Social capital** concerns the institutions that help us maintain and develop human capital in partnership with others. For example, families, communities and businesses.

Measures of value were developed for each of the Five Capitals, so that risk, performance and benefits could be quantified consistently based on available data. Using industry guidance on cost-benefit assessment in combination with these measures, the organisation now challenges their investment plans from an informed position on whole life cost, benefit-cost ratio, payback and other useful metrics.

For example, to measure the value of an investment from the perspective of its carbon emissions, the organisation would:

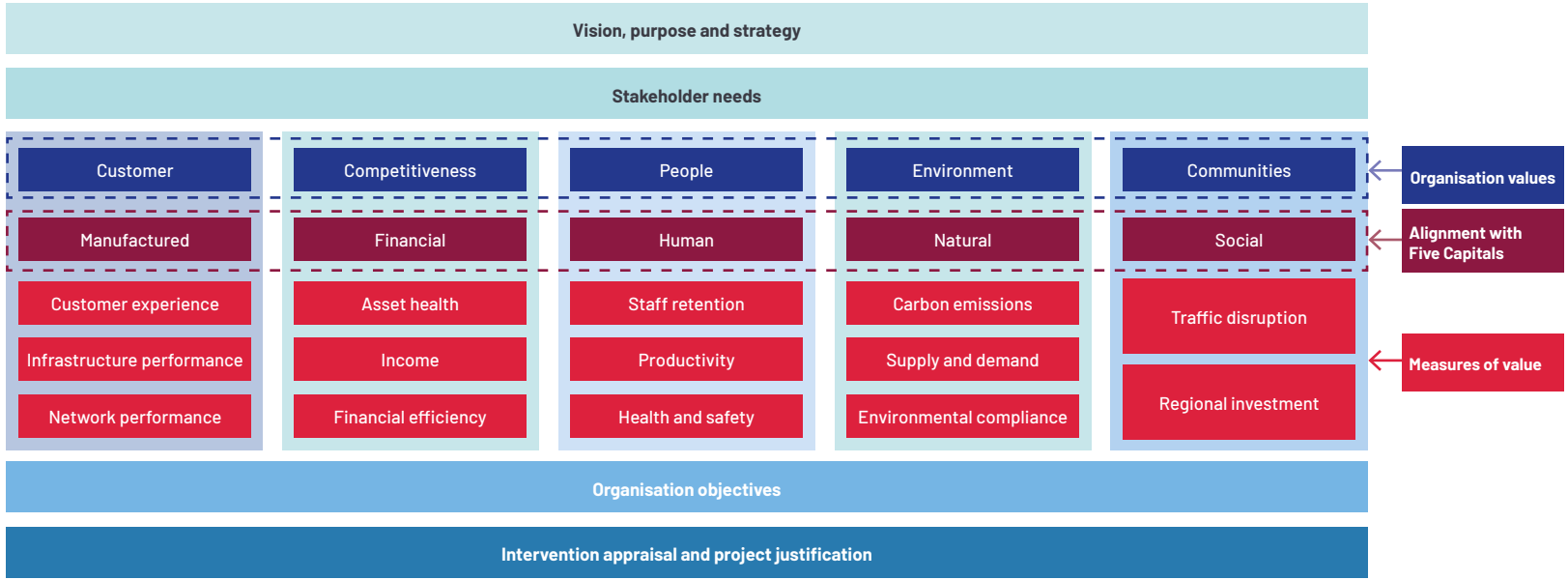
- identify sources and types of carbon emitted within their asset portfolio (kg of CO_2 emitted)
- quantify the cost of their carbon emissions using spot prices on carbon trading markets and ISO140641 (Suggest reading 22)
- examine the reduction of carbon emissions as a financial saving using the above measure, against the level of investment required to realise this reduction, to determine if the project was viable

Good practice examples

Example 4

An asset management value framework

This framework allows asset owners to compare alternative investment options, and to identify those which may provide similar value but at a lower cost. With senior leaders owning and developing the value framework, other business priorities beyond commercial concerns are now being considered in the planning process that were previously not measured.



Good practice examples

Example 5

The role of the sponsor, client, market and asset manager through the project life cycle

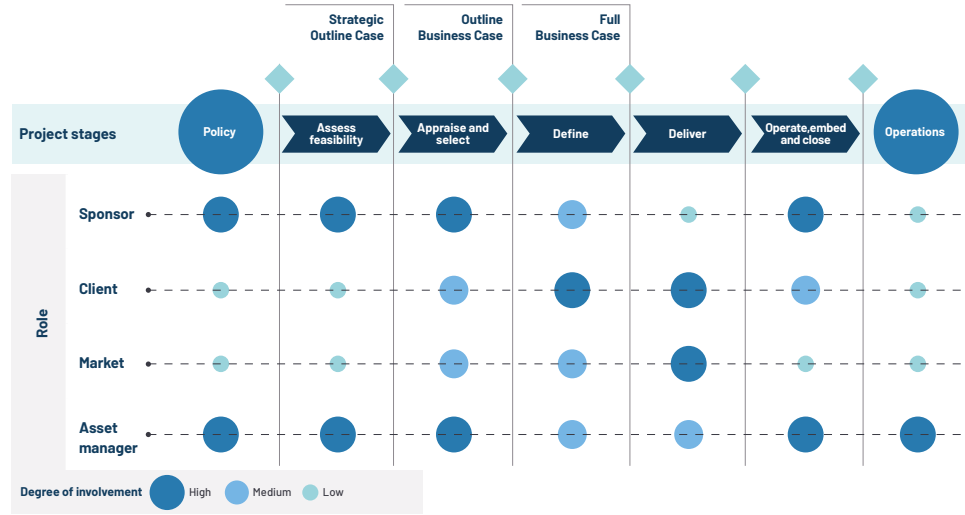
Organisational design aligns the capability of the project organisation with its objectives over time. Whilst aligning project complexity and organisational capabilities during the early stages of your project will set you up for success, the level of capability required by the project will vary through its life cycle.

This example shows the most critical periods for strong sponsor, client, market and asset manager involvement for a hypothetical project. You will need to think about who needs to be involved and when for your project, for example, you may also need early involvement of the market.

The graphic shows all roles being active throughout each stage of the project life cycle up to project close. At this point, the client role finishes but that of the sponsor and asset manager continue into operations to oversee benefits realisation.

The asset manager should be an integral part of the project team throughout the life cycle of the project. The availability of their specific capability is key to ensuring that operational requirements are properly incorporated from the start. The asset manager should have a continual relationship with project delivery, especially at key points such as:

- development of the end-state target operating model, identifying where capability needs to be developed, for example through training
- design and implementation of the procurement strategy. This will ensure that operational needs are conveyed accurately within contract specifications, and incentivisation mechanisms are appropriate
- supporting the development of life cycle plans. For example, operations and maintenance plans
- providing input on inspection and testing regimes
- engaging in progressive assurance of digital and physical project outputs as they are produced
- acceptance of the new asset upon completion



Pillar 1: **Aligning project outcomes with the asset management strategy** 1

Pillar 2: Optimising whole life value 2

Pillar 3: **Leveraging asset performance data** 3

Pillar 4: Leading asset management 4

Good practice examples

Example 6

Defining leadership for asset management through corporate policies and vision: An SSE case study

To realise full value from physical infrastructure assets, senior leaders need to visibly commit to, and role model, the standards expected of the wider organisation (Suggested Reading 5). This example provides an overview of the key components of a good asset management policy and shows how it can support delivery of the organisation's strategic objectives.

An asset management policy is a short statement that sets out the expectations for decisions, activities and behaviour concerning asset management. The policy document should be easy to communicate to the whole organisation and the supply chain.

SSE are responsible for maintaining the electricity networks supplying over 3.8 million homes, and own distribution and transmission comprising 106,000 substations and 130,000 km of overhead lines and underground cables across one third of the UK. As an ISO55001 certified company (Suggested Reading 5), their asset management policy demonstrates the critical components needed to effectively translate strategic objectives into asset management activities.

SSE use their policy to ensure that:

- they have the right capabilities to fulfil whole life cycle activities
- appropriate data is collected to review project progress and inform decision-making on future investments
- planning is aligned with providing a safe and reliable supply to their customers
- the integrity of the overall network remains optimised (for example, by prioritising the collection of accurate data to understand asset performance and drive improvement)

You should refer to your organisation's own asset management policy to ensure it drives alignment between the organisation's strategic objectives and its asset management plans. There should be processes in place to review and update the policy and plans to ensure that they remain applicable to the organisation's external or internal context, which may shift significantly over the life of an asset.

Pillar 1: **Aligning project outcomes with the asset management strategy** 1

Pillar 2: **Optimising whole life value** 2

Pillar 3: **Leveraging asset performance data** 3

Pillar 4: **Leading asset management** 4

ISO55002 principles supported by the policy and its implementation (Suggested Reading 6)

"...aligned to and demonstrate support for the organizational objectives."

"...organization's commitments and expectations for decisions, activities and behaviour concerning asset management."

"...adherence to applicable laws, legislation and regulations."

"...authorised by top management and thereby demonstrate commitment to asset management."

SSE Asset Management Policy

sse

We shall organise ourselves to ensure that we:

- Ensure that our customers, shareholders and other stakeholders interests are safeguarded by our responsible decision-making in building and operating our assets;
- Evaluate our decisions based on safety and environment, costs, risks and performance implications over the whole asset lifecycle;
- Co-ordinate our activities to realise value from assets;
- Balance costs, opportunities and risks against the desired performance of assets, to achieve our objectives;
- Maintain accurate data for our assets;
- Meet our regulatory and statutory obligations as agreed with our regulators;
- Simplify and continually improve our asset management processes to deliver better value for our customers and shareholders;
- Meet or exceed our customer performance targets; and
- Meet our contractual obligations to provide security of supply to consumers.

People

We ensure that our people have clear roles and responsibilities for asset management for the full lifecycle of our assets.

We engage with our customers, stakeholders, regulators, the communities we operate in and other interested parties to ensure our plans are sustainable and appropriately aligned with their priorities to deliver value.

We communicate with our customers and supply chain on how their behaviour influences our performance, our services and impact on the environment.

We employ people who do the right thing and have the capability, training and experience to develop and implement our strategies and plans effectively within a customer-centred culture.

Process

We make risk-based decisions on investment and operations to deliver the required performance from our assets using high quality data.

We provide the right standards, processes, tools and capability in design and engineering, project delivery, programme management, planning, risk management, quality management and operations to manage our assets.

Our plans are integrated and holistic supporting excellent project and operational management.

We have systems to collect accurate data and to analyse and report information on asset performance, customer service, safety performance, environmental performance and costs.

We use innovation to drive efficiency, improve performance and reduce total lifecycle costs and work collaboratively with our supply chain to deliver value for our customers

Standards

Applying our SSE standards means that we build, operate and maintain our assets brilliantly.

We value our asset data as much as the assets themselves and apply excellent quality management to both to ensure we meet our standards.

Alistair Phillips-Davies
Chief Executive

Colin Nicol
Managing Director, Networks

Issue date: January 2017 | Review date: January 2018 | PO-COR-029

Good practice examples

Example 7

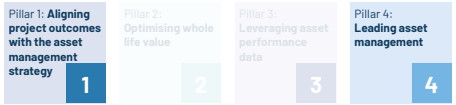
Establishing a target operating model: A High Speed 2 case study

An historic challenge often faced by capital programmes is a lack of understanding of how the new asset system will be operated. The asset is designed and constructed from conceptual or high-level requirements without a detailed understanding of the end-state. Having a well-defined target operating model for the organisation that will operate and maintain assets ensures that the requirements for handover and subsequent operations and maintenance are considered during design and construction. This example shows how High Speed 2 (HS2) are following a strategy to de-risk the handover of assets into operations and maintenance.

Previous major projects have encountered problems during the transition from the programme delivery phase into ongoing asset management, including necessary testing, and commissioning, achieving readiness for service. In the case of HS2, this could be especially challenging when the assets to be created are 'greenfield' without an existing asset management organisation and set of requirements to be met for operations. Without a defined target operating model and associated asset management strategies in place, projects can become overly focused on 'how' the project will be delivered rather than 'what service' the project needs to deliver. This ultimately leads to challenges at handover where the assets or information about them does not meet the required maturity for effective operations.

There could also be a misalignment between what is designed and delivered, the readiness and maturity of the asset manager to make use of the physical and digital assets created. For example, the asset manager may not have the necessary competency and capacity to accept and prepare data for end state operations, nor necessary analytical skills to provide insights from data and sensors.

Building on lessons from previous major programmes, HS2 made the decision to create the infrastructure management organisation, fulfilling the role of the asset manager, early in the programme life cycle. The diagram below shows the key phases of project delivery and how they align with the activities to establish the infrastructure management organisation, including the necessary interfaces. This ensured 'internal customers' were in place early to define the operational needs of the new railway, including the West Coast Partnership service operator.



The target operating model is being progressively implemented to ensure the right capabilities including the necessary people, process, data, and technology are in place to accept and operate the railway. By implementing infrastructure management capabilities in a timely manner, HS2 will have the ability to progressively assure assets and information into end-state processes. This approach will ensure the physical and digital assets produced meet the needs of the service they will support, streamlining testing, commissioning, and trial operations.

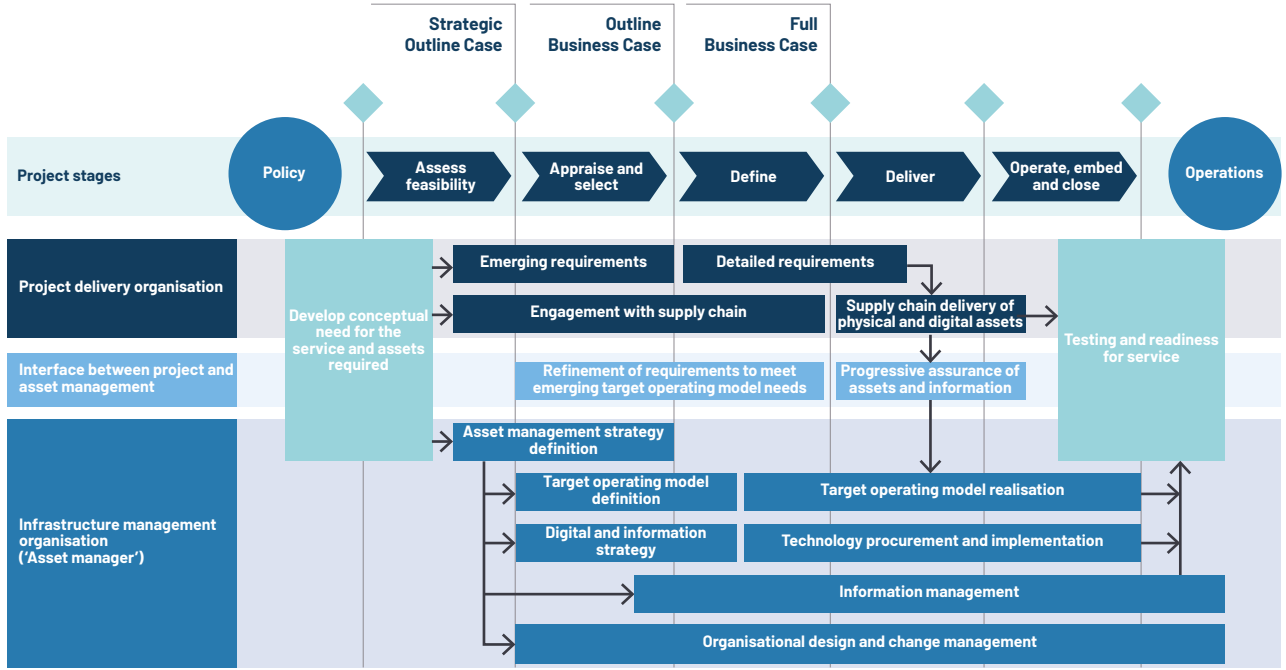
By following this approach, the emerging target operating model is supporting the following:

1. Development and assurance of programme requirements used for market engagement and ultimately contracts with suppliers.
2. Enablement of organisational design and governance, including the outsourcing of business capabilities.
3. A roadmap of key activities required to establish the core business capabilities in the target operating model through to commercial operations.
4. The development of a digital and information strategy to ensure the decision needs of the target operating model are met.
5. A communication and stakeholder engagement approach to engage with other transport service providers.

Good practice examples

Example 7

Establishing a target operating model: A High Speed 2 case study



Good practice examples

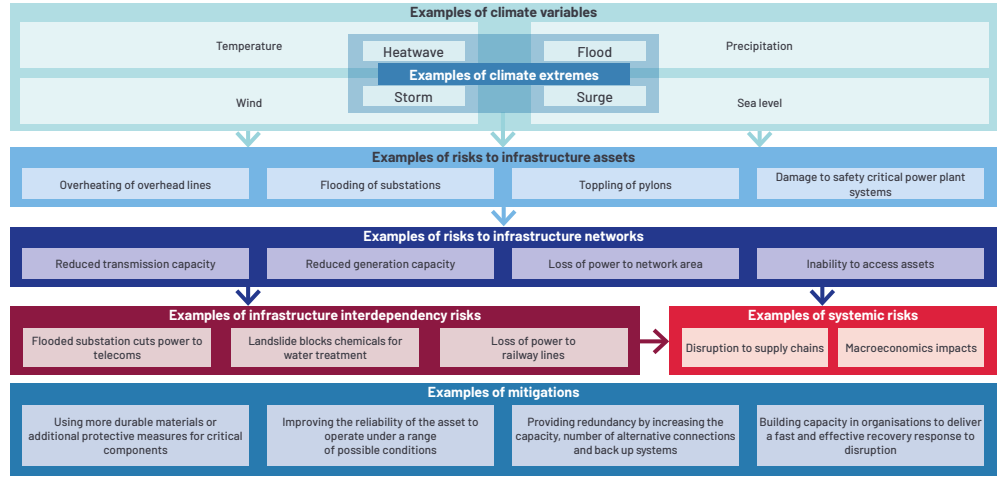
Example 8
Embedding climate risk assessment into asset management

This example, based on the UK climate change risk assessment 2017 evidence report (Suggested Reading 17), presents a useful framework for assessing climate change risk for infrastructure assets. To ensure that assets have long-term resilience, it is essential that future infrastructure investment, including the adaptation of existing infrastructure, is considered in the context of the potential climate risks. A more recent appraisal of climate risks is available in the 2021 evidence report (Suggested Reading 18).

Climate risk is a function of the likelihood of a climatic event, and the magnitude of the associated impacts, both positive and negative. A risk assessment must consider a wide range of possible climatic conditions and should be specific to the project. A consistent methodology should be used to ensure that an organisation-wide climate risk profile is available to inform strategic decision-making on long-term investment.

It is recommended that climate risk assessments should consider:

- analysis of climate variables – lifetime future projections of temperature, rainfall, storm surges, wind speed - if the asset is based in a particular location, then projections should be localised
- characterisation of each infrastructure asset - fragility (against different risks - heat, cold, wind) and capacity (impact on the wider network if it fails)
- network-wide effects caused by asset failures - impacts on multiple components and/or system functions (electricity distribution, rail network transit) and existing mitigations (back up, redundancies)
- analysis of interactions and interdependencies between infrastructure networks to understand cascading impacts. For example, an electricity outage shutting down a water treatment plant
- assessment of systemic risks caused by network-level failures and exacerbated by cascading impacts. For example, loss of infrastructure services that lead to indirect impacts on economic growth, social wellbeing and environmental protection
- assessment of existing or planned adaptations/resilience measures and mitigations, including society-wide policies. For example, national water usage restrictions increasing the resilience of the water supply



Climate risk mitigations might address risks at the asset level (such as the installation of fire suppression systems) or at higher levels (such as back up assets to improve network resilience). These mitigations should be considered in the context of the economic, environmental and social benefits that the project or portfolio is seeking to realise.

Good practice examples

Example 9

Moving from a short-term to a long-term focus on asset management

There is a tendency for the management of assets to focus on day-to-day upkeep rather than the overall life cycle of the asset. While it is important to address urgent and emergency situations in the short term, when this is the only form of intervention that takes place, the long-term viability of the asset suffers.

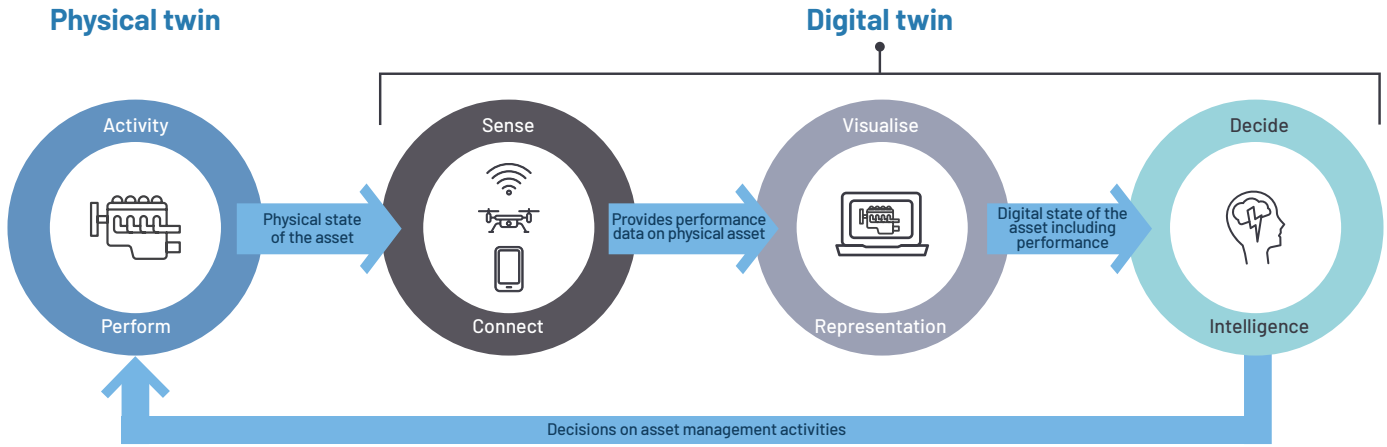
This example shows some of the changes to mindset and asset management strategy necessary to ensure the long-term performance of the asset. Adopting this approach can save on unnecessary costs and help to ensure the safety and satisfaction of users.

Short-term focus	**Daily snapshot** Evaluating the performance of the asset day-by-day.	**Age** Judging the viability of an asset based on age alone. Preparing a maintenance cycle at timed intervals.	**Up-front cost** Considering the initial capital costs of the asset's creation to determine whether it is financially viable.	**Maintenance** Continuous short-term repairs to keep the asset in operation to a minimum standard.	**Knowledge loss** Relying on the skills of third parties brought in temporarily and losing knowledge of the asset when their work is complete.	**Reactive** Only dealing with issues as they arise - cure rather than prevention.
Long-term focus	**Long-term trends** Evaluating the performance of the asset in the long-term, such as considering any cyclical performance trends.	**Condition and risk** Evaluating the condition of the asset and balancing the costs and risks of intervention vs non-intervention.	**Whole-life cost** Considering costs over the whole life of the asset including maintenance and commissioning to determine whether it is financially viable in the long-term.	**Life cycle management** Consideration of the whole life implications of each intervention. Analysis of upgrade or replacement options that could be more beneficial in the long-term.	**Continous learning** Retaining essential knowledge and skillsets within the owner organisation for the life of the asset.	**Proactive** Predicting and addressing issues before they occur - prevention rather than cure.

Good practice examples

Example 10
Integrating your physical and digital assets

This example demonstrates how to maximise the benefits from your asset by creating its digital twin. The purpose of a digital twin is to increase the effectiveness of decision-making during project development and in operation. It does this by combining data and technology ('sense') to provide a digital representation ('visualise') of a potential or actual physical asset, process or system. The live digital and physical representations are connected through real time performance data to inform decision-making ('decide') to optimise the performance of the physical asset. The interaction of sensing, visualising and decision-making (artificial intelligence or human) are the three key components of the digital twin.



Good practice examples

Example 10
Integrating your physical and digital assets

During project development, it is important that any digital representation is developed in tandem with the creation of the physical asset and aligns with the overall asset management strategy. You can use the following eight critical success factors (Suggested Reading 11) to evaluate if there is a gap between the current and required capability of all those involved in the project (client, suppliers, asset manager) to develop and implement the digital twin.

Critical success factors for developing your digital twin capability

- Creation of digital twins should be driven by clear business need. The asset management strategy should demonstrate the benefits to support the investment required to develop organisational capability.
- Ensure the level of digitalisation matches the asset manager's capability maturity. Select attributes of the digital twin based on an assessment of the organisation's current maturity and the affordability of the technology required to make use of the twin as part of asset management.
- Check the requirements of the digital twin are aligned to the intended target operating model. Use industry data standards to ensure consistent high quality data is collected that can be shared internally and externally.
- Leverage the digital twin to inform asset management life cycle activities (operations, maintenance). The twin should be used to aid decision-making to optimise the asset portfolio, not solely viewed as a static representation of the physical asset.
- Consider the levels of cyber security and data classification required for both the physical and digital twin and how this will be continually managed to safeguard against malicious attack.
- Consult with the asset manager upfront so that the digital twin and the data it produces is right first time. Inadequate or corrupted data may delay decision-making and hamper handover efforts.
- Reflect on how the digital twin may connect with other digital twins outside of the organisation. External integration may be required to understand the asset or system context.
- Establish a framework for the governance of data produced. Consider data as an asset in its own right and ensure ownership is clear.

By adopting this approach, alongside the principles in this module, you will be able to realise the benefits of a digital twin, including:

- ✓ reducing conflict and aiding clash detection and systems integration during design and delivery stages
- ✓ improving user experience through the simulation and modelling of potential and actual asset performance
- ✓ capturing and tracking how the asset has performed, to optimise future asset and organisational design
- ✓ reducing maintenance costs through enhanced human decision-making using visualisation, data access and machine-suggested action
- ✓ increasing asset uptime with a proactive approach to predicting failure and maintenance scheduling, thereby reducing the need for physical inspections

Good practice examples

Example 11
Developing your digital twin strategy

This example demonstrates how the development of a digital twin strategy can be aligned with the stages of a project's life cycle.

To improve the performance, sustainability and value for money of projects and programmes, the Construction Playbook (Suggested Reading 21) highlights the need for those involved in projects to embed digital technologies and processes, especially the UK BIM Framework (Suggested Reading 20). A digital twin will allow you to effectively retain and manage the 'golden thread' of asset information as it passes from those delivering the project to the asset manager at handover.

A digital twin adds most value when the vision for its use, technical requirements and any investment needed are considered at the early stages of project planning. Implementation of the digital twin strategy should remain aligned with the project's delivery plan for the physical asset. This will allow the digital twin to be developed progressively using data captured during creation of the physical asset and also to provide feedback to inform project delivery.

A clear digital twin strategy at the early stage of project set up will aid:

- collaboration with the asset manager to understand how they expect to operate the digital and physical assets after handover, which in turn inform the requirements for the digital twin
- definition of the sponsor's requirements, by providing a means of measuring outcomes and benefits digitally
- early engagement with the market on the design and selection of systems that will underpin the connection between the physical and digital asset
- option selection, by providing alternative scenarios for consideration, helping to ensure that the right solution is chosen and that it is resilient
- assurance activities as the project progresses, through provision of performance data

The checklist below is an extract from the Construction Innovation Hub's digital twin interactive navigator (Suggested Reading 19). It will help you mature your digital twin strategy through the stages of your business case. You may wish to consult subject matter experts to support development of your digital twin strategy.

Further information on the Gemini Principles, mentioned in the checklist, is available in Suggested Reading 13. They provide a set of guiding principles that can be adopted across industry to underpin the development of digital twins.

Good practice examples

Example 11
Developing your digital twin strategy

Project stages	Activities	Project stage checklists	
Assess feasibility	**Strategic Outline Case** This is the scoping phase for the project, which results in the production of the Strategic Outline Case, it is where the strategic fit of the digital twin is ascertained and how it can support the developing options.	✓ Review key baseline digital twin literature and guidance to have a good understanding of the high level value proposition ✓ Embed the consensus values of the Gemini Principles into your project ✓ Define your digital twin value architecture aligned with your case for change, purpose statements and overall investment outcomes	✓ Identify an appropriate digital twin sophistication level that considers how performance will be measured ✓ Develop a headline digital twin strategy based upon clearly articulated purposes ✓ Consider how your digital twin can link with other digital twins in your ecosystem, now or in the future to allow data sharing or integration ✓ Build digital recommendations into project assessment report as appropriate
Appraise and select	**Outline Business Case** This is the planning phase for the project, which results in the production of the Outline Business Case. At this stage we are building the user stories and foundational principles as to how the digital twin functional model will start to build.	✓ Review key baseline digital twin literature and guidance such as the Gemini Principles ✓ Develop a headline digital twin strategy based upon clearly articulated purposes ✓ Identify an appropriate digital twin sophistication level ✓ Define your key digital twin characteristics ✓ Define your digital twin value architecture aligned with purpose statements and overall investment outcomes	✓ Align your digital twin strategy with building information modelling, 'soft landings' and your project asset management strategy ✓ Identify headline investment considerations ✓ Develop headline return on investment model ✓ Build digital recommendations into project assessment report as appropriate ✓ Undertake a digital twin legal and commercial review
Define	**Full Business Case** This is the development phase for the project, which results in the production of the Full Business Case. At this stage, we need to understand how the digital twin fits within the tender and procurement process and how it can be fully evaluated.	✓ Develop a digital twin architecture along with the operational strategy ✓ Consider data hosting options and data sovereignty ✓ Develop a fully scoped out invitation to tender (ITT)	
Delivery	**Implementation and monitoring** This is the delivery phase for the project, which results in the outcomes that were defined in the original strategy starting to be produced.	✓ Review proposed specifications and installation details to ensure the digital twin goals and objectives can be met ✓ Evaluate security vulnerabilities of proposed connected products and systems reviewed to ascertain and vulnerabilities and develop controls to remove or mitigate ✓ Ensure the digital twin forms part of the security risk register ✓ Monitor development of digital representation (building information modelling/gaming engines) to ensure they will be a suitable interface, and level of information need appropriate	✓ Commission of digital twin data capture in concert with operational technology and business management systems commissioning ✓ Conduct user acceptance testing and audits of system ✓ Undertake user training and operational manuals in place ✓ Ensure digital curation strategy in place ✓ Obtain formal sign off that the digital twin is ready to support service
Operate, embed and close			
Operations	**Evaluation and feedback** This is the operational phase of the asset, which results in the outcomes and benefits that were defined in the original strategy.	✓ Carry out curation activities with systems monitoring in place ✓ Monitor security of the digital twin and related systems through regular audits ✓ Realise and capture benefits of, and through, the digital twin	✓ Establish a structured feedback loop where data can inform future investment decisions ✓ Capture, share and implement lessons from development ✓ Embed the operation and maintenance plan in place for key digital technologies such as sensing devices

Suggested further reading

	Reference	Use
1	**Guidance** Principles for project success – Infrastructure and Projects Authority 2020	A quick guide for practitioners on things to get right for any project to succeed.
2	**Guidance** The green book: appraisal and evaluation in central government - HM Treasury 2020	This guidance issued by HM Treasury outlines how to appraise policies, programmes and projects. It also provides advice on the design and use of monitoring and evaluation before, during and after implementation.
3	**Guidance** Accounting for the effects of climate change - supplementary green book guidance – Department for Environment Food & Rural Affairs 2020	This supplementary guidance to HM Treasury's green book supports analysts and policymakers to ensure, where appropriate, that policies, programmes and projects are resilient to the effects of climate change, and that such effects are being taken into account when appraising options.
4	**Guidance** Guide to developing the project business case – HM Treasury 2018	This guidance has been prepared to assist senior managers and executives to develop project business cases using the better business case approach.
5	**Standard** ISO 55001:Asset management systems - requirements - International Organization for Standardization 2014	This standard specifies the requirements for the establishment, implementation, maintenance and improvement of a management system for asset management.
6	**Standard** ISO 55002: Asset management – management systems- guidelines for the application of ISO 55001 - International Organization for Standardization 2018	This document provides guidance for the application of a management system for asset management, in accordance with the requirements of ISO 55001.
7	**Guidance** Value toolkit - Construction Innovation Hub 2021	A structured approach for value-based decision-making across the investment life cycle of a project, programme or portfolio.
8	**Standard** Government functional standard GovS 004: property - Office of Government Property, Cabinet Office and Government Property Function 2021	This standard sets expectations for the management of all government property, and is mandatory for central government organisations with property responsibilities.
9	**Policy paper** Transport infrastructure efficiency strategy – Department for Transport 2017	This strategy outlines 7 challenges which were planned to be addressed to improve transport infrastructure efficiency and provide better outcomes for transport users.
10	**Standard** The orange book: management of risk – HM Treasury & Government Finance Function 2020	This guidance establishes the concept of risk management and provides a basic introduction to its concepts, development and implementation of risk management processes in government organisations.

Suggested further reading

	Reference	Use
11	**Guidance** Understanding digital twins - Asset Management Consulting Ltd 2020	Provides useful definitions and a method for you to consider how much technology and change is required to deliver the benefits of a digital twin.
12	**Standard** ISO 19650-5: Organization and digitization of information about buildings and civil engineering works – Part 5: Security-minded approach to information management - International Organization for Standardization 2020	This standard sets out requirements for the security-minded management of sensitive information within building information modelling (BIM).
13	**Guidance** The gemini principles - Centre for Digital Built Britain 2018	This paper sets out proposed principles to guide the national digital twin and the information management framework that will enable it.
14	**Guidance** Government soft landings: Revised guidance for the public sector on applying BS8536 parts 1 and 2 - Centre for Digital Built Britain 2021	This report provides guidance on enabling a smooth transition from construciton to operation, including assuring asset performance and maintaining the "golden thread" of an asset's purpose.
15	**Report** A systems approach to infrastructure delivery – Institution of Civil Engineers 2020	A review of how systems thinking can be used to improve the delivery of complex infrastructure projects.
16	**Guidance** Managing infrastructure assets for sustainable development: A handbook for local and national governments – United Nations 2021	This guidance aims to inform local and national governments on how to manage the assets on which people rely everyday.
17	**Report** UK climate change risk assessment 2017 evidence report – Climate change committee 2017	The UK climate change risk assessment evidence report sets out the priority climate change risks and opportunities for the UK (2017).
18	**Report** UK climate change risk assessment 2021 evidence report – Climate change committee 2021	The UK climate change risk assessment evidence report sets out the priority climate change risks and opportunities for the UK (2021).
19	**Guidance** Digital twin navigator – Centre for Digital Built Britain and Construction Innovation Hub 2021	A toolkit which provides guidance to align business case development with the creation of a strategy for the digital twin.
20	**Framework** The UK BIM Framework - Centre for Digital Built Britain 2021	This framework is an overarching approach to implementing BIM in the UK, using the framework for managing information provided by the ISO 19650 series.

Suggested further reading

Reference	Use
21 **Guidance** The construction playbook – Cabinet Office 2020	Sets out key policies and guidance for how public works projects and programmes are assessed, procured and delivered.
22 **Standard** ISO 14064-1: Greenhouse gases — Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals- International Organization for Standardization 2018	This standard provides the principles and requirements for the quantification and reporting of greenhouse gas emissions and removals.
23 **Guidance** The five capitals - a framework for sustainability – Forum for the future 2021	The five capitals model provides a basis for understanding sustainability in terms of the economic concept of wealth creation or 'capital'.
24 **Guidance** Accounting for the effects of climate change	Supplementary Green Book guidance on how to account for the effects of climate change when making asset investment decisions and how to build in climate resilience into solutions.

Glossary

Accountability
The accountable person is the individual who is ultimately answerable for an activity or decision. This includes 'yes' or 'no' authority and veto power. Only one accountable person can be held to account. An accountable person has to be accountable to someone for something. Accountability cannot be delegated or shared.

The responsible person is the individual who actually undertakes the task: in other words, they manage the action/implementation. Responsibility can be shared. The degree of responsibility is determined by the individual with the accountability.

Asset
Anything tangible or intangible that is owned or controlled with the expectation of present or future benefit.

Asset manager
In the context of Routemap, the asset manager is the organisation (or parts of) responsible for day-to-day operations and maintenance of the asset. The asset manager may be a part of the sponsor or client organisations, or a separate entity. Similarly, the operator and maintainer of the assets may be separate entities.

Benefits
In the context of project delivery, benefit is the measurable value or other positive impact resulting from an outcome perceived as an advantage by one or more stakeholders, and which contributes towards one or more objectives

Capability
In the context of Routemap, capability describes the ability of the sponsor, client, asset manager and market to organise for effective and efficient delivery. It refers to all or part of an organisation, and not the individual.

Client
In the context of Routemap, the client is the organisation that is responsible for undertaking the work to fulfil the sponsor's requirements. The client translates the requirements from the sponsor and manages the delivery. The client selects the most appropriate suppliers. In some contexts, the sponsor and client could be from the same organisation.

Client model
The client model refers to how the client structures and resources the project. The model will set out how delivery, transition and operational activities will be split between the client, advisors/partners and supply chain (in-house versus external) to ensure a successful outcome and realisation of the sponsor's goals.

Complexity
In the context of Routemap, project complexity is a measure of the inherent difficulty of delivering a project. This is assessed on factors such as the stability of the wider delivery environment, the level of innovation required, and the number of stakeholders involved

Delivery model
The delivery model is the form of structural and commercial arrangements to be deployed to meet the sponsor's requirements. The selected model should be the best option from those available, taking into account the capabilities and constraints of the project. For example, the creation of an arm's-length body like High Speed 2 or the formation of a special purpose vehicle as has been used to deliver Thames Tideway Tunnel.

Delivery strategy
The delivery strategy describes how the selected delivery model will be implemented and how it will need to change over time.

Digital twin
A digital twin combines data and technology to provide a digital representation of a potential or actual asset, process or system. The digital twin's functionality can be specified to understand, control and optimise the performance of the physical asset. The digital twin connects to the physical asset through the collection/collation of data (including sensor connections). Intelligence can be applied to support both human and autonomous decision-making to change the asset's design and behaviour.

Environmental, economic and social value
The impact a project has on the environment, economy, and society. This may be global or localised, and may result both from meeting the project's objectives (for example, improved transport links) and from by-products of delivery (for example, job creation). It relates to reducing negative impacts as well as increasing positive impacts, and it is important that value delivered against one category is not at the expense of another (for example, delivering economic development but at significant cost to local biodiversity).

Glossary

Environmental, social and governance (ESG) criteria
These are key criteria for sustainability reporting, in response to widespread investor and consumer demand. They are also increasingly used to inform investment decision making.

Market
In the context of Routemap, the market comprises organisations which integrate and compete to deliver goods or services to one or more clients. This includes

- the players, for example, sellers/buyers/partner
- the rules, for example, regulation, legislation
- processes, for example, procurement, delivery
- structure, for example, relationships between buyers, sellers, partners

Outcomes
The result of change, normally affecting real-world behaviour or circumstances. Outcomes are desired when a change is conceived. Outcomes are achieved as a result of the activities undertaken to effect the change; they are the manifestation of part or all of the new state conceived in the target operating model.

Outputs
A specialist product (the tangible or intangible artefact) that is produced, constructed or created as a result of a planned activity and handed over to users.

Requirements
Requirements are the project stakeholders' wants and needs, clearly defined and with acceptance criteria.

Risk
The effect of uncertainty on objectives. Risk is usually expressed in terms of causes, potential events, and their consequences.

- a cause is an element which alone or in combination has the potential to give rise to risk
- an event is an occurrence or change of a set of circumstances and can be something that is expected which does not happen or something that is not expected which does happen.
- the consequences are the outcomes of an event affecting objectives, which can be certain or uncertain, can have positive or negative direct or indirect effects on objectives, can be expressed qualitatively or quantitatively.

Sponsor
In the context of Routemap, the sponsor is an organisation that secures the funding, oversees the business case and is responsible for specifying the requirements to the client. In some contexts, the sponsor and client could be the same organisations.

Stakeholders
Any individual, group or organisation that can affect or be affected by, or perceive itself to be affected by an initiative (programme, project, activity or risk).

Sustainability
This means making the necessary decisions now to stimulate economic growth, maximise wellbeing and protect the environment, without affecting the ability of future generations to do the same.

Target operating model
The target operating model refers to how the asset or change will be funded, owned, operated and maintained once the project has closed.

UN Sustainable Development Goals (SDGs):
Adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet, and ensure that by 2030 all people enjoy peace and prosperity. The 17 SDGs are integrated and recognise that action in one area will affect outcomes in others, and that development must balance social, economic and environmental sustainability.

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