

BS 8536:2022



BSI Standards Publication

Design, manufacture and construction for operability — Code of practice

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Published by BSI Standards Limited 2022

ISBN 978 0 539 16964 5

ICS 91.040

The following BSI references relate to the work on this document:

Committee reference FMW/1

Draft for comment 21/30433966 DC

Amendments/corrigenda issued since publication

Date	Text affected
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Summary of pages

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Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 March 2022. It was prepared by Technical Committee FMW/1, *Facilities management*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 8536-1:2015 and [BS 8536-2:2016](#), which are withdrawn.

Information about this document

BS 8536-1:2015 and [BS 8536-2:2016](#) were developed to promote a smooth transition from the delivery phase to the operational phase of an asset by embedding soft landings, building performance evaluation and information management, using building information modelling. BS 8536-1 focused on buildings and facilities management and [BS 8536-2](#) focused on infrastructure and asset management. Both have been well received, especially by public sector clients and industry, and have formed an integral part of the UK BIM Framework [1].

In order to accelerate the application of relevant practices in the delivery of sustainable assets, and also to reflect developments in the UK BIM Framework [1], BS 8536-1:2015 and [BS 8536-2:2016](#) have been consolidated into this single, revised code of practice. This British Standard promotes a smooth process through the life cycle for the delivery and operation of assets. It covers:

- needs in design, manufacture, construction and operation and use;
- requirements for safety, security, efficiency and net zero carbon; and
- awareness of end-of-life strategies for decommissioning, repurposing or demolition.

This British Standard emphasizes the importance of adopting a whole-life view of an asset and the need to realize value from it. In this regard, it is important to recognize that a vast amount of information and data about an asset are generated and exchanged during its lifetime and that a security-minded approach to the handling of such information and data needs to be adopted.

This is a full revision of the standard, and introduces the following principal changes:

- alignment with the requirements of the BS EN ISO 19650 series of standards on information management using building information modelling, and with [PAS 1192-6](#) on health and safety using building information modelling;
- alignment with the requirements of BS 40101 on building performance evaluation;
- application of the principles for sponsoring, directing, managing and transitioning projects (see [BS 6079](#)) individually or as part of a programme or portfolio (see [ISO 21500](#));
- greater consideration of risk management across the project life cycle (see BS EN ISO 31000); and
- further application of the principles and practices contained within *The Soft Landings Framework* [2] and *Government Soft Landings* [3] to the project context.

This publication can be withdrawn, revised, partially superseded or superseded. Information regarding the status of this publication can be found in the Standards Catalogue on the BSI website at bsigroup.com/standards, or by contacting the Customer Services team.

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Users may substitute any of the recommendations in this British Standard with practices of equivalent or better outcome. Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is “should”.

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

The word “should” is used to express recommendations of this standard. The word “may” is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the clause. The word “can” is used to express possibility, e.g. a consequence of an action or an event.

Notes and commentaries are provided throughout the text of this standard. Notes give references and additional information that are important but do not form part of the recommendations. Commentaries give background information.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. “organization” rather than “organisation”).

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0 Introduction

0.1 Background

Design, manufacture and construction for operability focuses on those aspects of the delivery phase that are concerned with achieving the required operational performance of new, upgraded, repurposed or refurbished assets. These aspects can include: net zero carbon operation and use; energy use; greenhouse gas emissions; water quality, abstraction, consumption and pollutant prevention; soil and landscape quality and remediation; waste prevention or reduction, reclamation, reuse, recycling, treatment and disposal; asset availability, utilization, access, inclusiveness, health and safety, building safety, capability, capacity, quality, resilience, serviceability/maintainability and adaptability; and indoor air quality, thermal comfort, noise and vibration, and user well-being.

This British Standard considers matters relating to projects for the delivery of assets according to defined operational requirements, including maintainability and reliability, and performance outcomes. For the purpose of this British Standard, “delivery team” (see [BS EN ISO 19650-1](#)) applies to the lead appointed party and its appointed parties engaged in the delivery of a new asset or the upgrading, repurposing or refurbishment of an existing asset. A project team comprising coordinated delivery teams offers benefits in terms of design and problem solving, as well as constructability and operational impacts. The “delivery team” does not extend to asset management or facilities management.

Project decisions, including those related to design, have to be based upon accurate and relevant information and data, and their impact on operational and user needs has to be understood before they are finalized. The most effective way to comment on the suitability or effectiveness of a design is through formal reviews carried out during design. Testing assumptions during design is necessary to understand how the asset will perform in operation and use and achieve its expected performance. Whilst it is usually too late to comment on the design of the asset during manufacturing and assembly or once it is operational, systematic measurement, analysis, comparison and feedback can be useful in informing the design of future assets for both constructability and operational use.

This British Standard aligns with the principles and practices of *The Soft Landings Framework* [2] and *Soft Landings and Government Soft Landings* [4] published by BSRIA, which comprise three main elements:

- setting project success criteria at the outset;
- protecting and promoting the success criteria throughout the project; and
- evaluating performance against the set success criteria.

The aim is to achieve a smooth transition from the delivery phase into the operational phase of an asset. Key to this is collaboration throughout the project between each delivery team and the operator or operations team, as appropriate, in matters affecting operations and users.

0.2 Asset management and facilities management

Asset management and facilities management have developed as two distinct management disciplines, despite both being concerned with managing the physical assets and services of an organization. Asset management and facilities management have developed their own standards and language of preferred terms. This document recognizes that both asset management and facilities management play their own part in the life cycle of an asset, but for simplicity the main body of text uses the term “asset” wherever practicable to cover both disciplines.

1 Scope

This British Standard gives recommendations on design, manufacture and construction for operability in relation to an asset(s) (e.g. buildings and infrastructure for energy, telecommunication, transport and water), taking account of the expected performance of the asset in use over its planned operational life.

This British Standard is intended to strengthen practices and procedures by:

- a) promoting the early involvement of the operator or operations team, as appropriate;
- b) improving the focus of the project team on the performance of the asset in use;
- c) promoting programme and portfolio thinking by the asset owner and, where applicable, the project sponsor to ensure that the asset meets the wider requirements of the owner's operations;
- d) providing feedback on the expected functional and operational performance of the asset at each stage of the delivery phase;
- e) extending the commitment of each delivery team to defined periods of aftercare post-handover of the asset and its safe, secure, efficient and cost-effective operation in line with environmental, social and economic performance outcomes and targets;
- f) embedding post-implementation review or building performance evaluation (BPE), as appropriate, in the operational phase based upon agreement early in the delivery phase regarding requirements;
- g) embedding information management, using building information modelling, in the processes for the delivery and operation of assets;
- h) emphasizing the importance of information and data quality; and
- i) highlighting the need to maximize both the investment value and resource value of the asset (see BS EN 12973 and [BS 8210](#)).

It is applicable to the provision of information and data supporting a) to f) in a manner that maximizes the value that the asset owner can subsequently derive from the information and data over the planned life of the asset.

This British Standard outlines the primary activities, information, issues and deliverables to be addressed by the project team and each delivery team to support their work and to provide the asset owner and the operator or operations team, as appropriate, with as much certainty as possible in regard to the required functional and operational performance of the asset.

The requirements of inclusive design, managing design in construction and managing assets and their environments inclusively when operational have been incorporated (see [BS 8300-2](#)). A defined project-managed approach to the delivery of the asset is adopted throughout (see [BS 6079](#)).

This British Standard is intended for use by individuals and organizations preparing or contributing to design, manufacture, construction and operations, including organizations procuring a new asset and owners upgrading, repurposing or refurbishing an existing asset.

This British Standard does not provide recommendations for design or construction, but is concerned with information and data that are needed to determine operability and performance requirements for the new, upgraded, repurposed or refurbished asset. It does not cover decommissioning or other end-of-life activities.

This British Standard does not give recommendations for:

- 1) asset management or facilities management in general (see BS ISO 55000 series and [BS EN ISO 41001](#) respectively);
- 2) the procurement of design, construction, asset management or facilities management services (see [BS 8534](#) and [BS 8572](#)); or
- 3) the maintenance of assets (see [BS 8210](#)).

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions of this document¹⁾. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

[BS 8300-2](#), *Design of an accessible and inclusive built environment – Buildings – Code of practice*

[BS 9999](#), *Fire safety in the design, management and use of buildings – Code of practice*

BS 40101²⁾, *Building performance evaluation of occupied and operational buildings (using data gathered from tests, measurements, observation and user experience) – Specification*

[BS EN ISO 9000:2015](#), *Quality management systems – Fundamentals and vocabulary*

[BS EN ISO 19650-1:2018](#), *Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) – Information management using building information modelling – Part 1: Concepts and principles*

[BS EN ISO 19650-2:2018](#), *Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) – Information management using building information modelling – Part 2: Delivery phase of the assets*

[BS EN ISO 19650-5:2020](#), *Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) – Information management using building information modelling – Part 5: Security-minded approach to information management*

[BS ISO 16439:2014](#), *Information and documentation – Methods and procedures for assessing the impact of libraries*

BS ISO 50004:2014, *Energy management systems – Guidance for the implementation, maintenance and improvement of an energy management system*

[BS ISO 55000:2014](#), *Asset management – Overview, principles and terminology*

ISO 5127:2017, *Information and documentation – Foundation and vocabulary*

[ISO 6707-1:2014](#), *Buildings and civil engineering works – Vocabulary – Part 1: General terms*

ISO 6707-2:2017, *Buildings and civil engineering works – Vocabulary – Part 2: Contract and communication terms*

ISO 6707-3:2017, *Buildings and civil engineering works – Vocabulary – Part 3: Sustainability terms*

[ISO 11620:2014](#), *Information and documentation – Library performance indicators*

ISO 14064-1:2018, *Greenhouse gases – Part 1: Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals*

[ISO 21500:2021](#), *Project, programme and portfolio management – Context and concepts*

¹⁾ Documents that are referred to solely in an informative manner are listed in the Bibliography.

²⁾ This British Standard contains an informative reference to BS 40101:2022.

ISO 21502:2020, *Project, programme and portfolio management – Guidance on project management*

ISO 21929-1:2011, *Sustainability in building construction – Sustainability indicators – Part 1: Framework for the development of indicators and a core set of indicators for buildings*

ISO 22948:2020, *Carbon footprint for seafood – Product category rules (CFP-PCR) for finfish*

ISO 41011:2018, *Facility management – Vocabulary*

ISO 41014:2020, *Facility management – Development of a facility management strategy*

[PD ISO/TR 21506:2018](#), *Project, programme and portfolio management – Vocabulary*

3 Terms, definitions and abbreviated terms

3.1 Terms and definitions

For the purpose of this British Standard, the terms and definitions given in [Annex A](#) and the following apply.

3.1.1 aftercare

defined period post-handover of an asset in which each delivery team passes on information and knowledge to the operator or operations team, responds to queries and problems, and monitors and reviews the asset's performance

3.1.2 as-constructed information

expression of the design, its working detail, construction work and/or installations, functions and operation and maintenance needs of an asset in a form suitable for use in managing that asset

3.1.3 asset

item, thing or entity that has potential or actual value to an organization

[SOURCE: [BS ISO 55000:2014](#), 3.2.1]

3.1.4 asset-related service

support provision for an asset delivered by an internal or external service provider

3.1.5 benefits realization

deriving benefits from project outputs and outcomes

3.1.6 building information modelling (BIM)

use of a shared digital representation of an asset to facilitate design, manufacture, construction and operation processes to form a reliable basis for decisions

[SOURCE: [BS EN ISO 19650-1:2018](#), 3.3.14, modified]

3.1.7 building performance evaluation (BPE)

gathering of a building's (or premises') quantitative and qualitative performance parameter data and the interpretation of these data against comparators to draw conclusions regarding specific aspects of performance and the overall performance of the building (or premises)

[SOURCE: BS 40101:2022, 3.5]

3.1.8 business plan

document that describes and analyses business objectives and the actions to be taken, so that these objectives are achieved

[SOURCE: [BS ISO 21401:2018](#), 3.5, modified – the words “reducing the risks and uncertainties that contain financial projections and economic viability” have been removed.]

3.1.9 classification

categorization into a common language to describe things, enabling content to be machine readable and associated

3.1.10 constructability

degree to which an object can be manufactured or constructed

3.1.11 cost-benefit analysis

process that assesses the relation between the cost of an undertaking and the value of the resulting benefits

[SOURCE: [BS ISO 16439:2014](#), 3.10, modified]

3.1.12 design responsibility matrix

document setting out responsibility for each element of the design at each stage of design development for a level of information need

3.1.13 design review protocol

procedure for performing a structured and systematic review of a design at defined points in the project life cycle

3.1.14 engineered system

combination of components that work in synergy to perform a useful function

3.1.15 extended project life cycle

addition of an adoption phase to a linear or iterative life cycle to ensure that the governance of, and accountability for, the project stays with the project team until change is fully embedded

3.1.16 flawless start-up

fault-free commencement of operations

[SOURCE: [BS 8587:2012](#), 3.1.15]

3.1.17 front-end loading

process focusing on the early stages of a project where the greatest influence on outputs and outcomes can be achieved without costly disruption

3.1.18 handover

act of passing responsibility for, and control over, an asset to the owner or operator following testing and commissioning

3.1.19 inclusive design

approach to the design of the environment, including buildings and their surrounding spaces, and managed and natural landscapes, to ensure that they can be accessed and used by everyone

[SOURCE: BS 8300-1:2018, 3.8]

3.1.20 integrated project delivery

unified process supporting an extended project life cycle

3.1.21 operability

degree to which an asset is capable of being put into use as intended

3.1.22 operational strategy

overall approach to managing the production or use of an asset

3.1.23 operations team

functional group responsible for the day-to-day running and maintenance of an asset

3.1.24 operator

organization responsible for the day-to-day operation of an asset

3.1.25 opportunity shaping (opportunity framing)

business-led process in which the project sponsor evaluates the key attributes of the project, develops and gathers information needed for key decisions, then allocates the value of the project to various stakeholders to make the project environment sufficiently stable for successful implementation

3.1.26 owner

person, group of persons or organization that possesses the exclusive right to hold, use, benefit financially from, convey, transfer, lease or otherwise dispose of an asset

[SOURCE: BS ISO 6707-4:2021, **3.7.2**, modified – the words “real estate or other” have been removed.]

3.1.27 portfolio

collection of projects or programmes grouped together to facilitate their management to meet strategic objectives

[SOURCE: PD ISO/TR 21506:2018, **3.42** and **3.43**, modified]

3.1.28 post-implementation review

measurement of the outcomes of a project for the delivery of an asset and the performance of that asset in operation with the lessons to be learned for future projects

3.1.29 programme

group of projects managed in a coordinated way to realize benefits

[SOURCE: PD ISO/TR 21506:2018, **3.50** and **3.52** modified]

3.1.30 project controls

application of measures intended to monitor a project's status, give early warning of deviations from the baseline of expected performance and provide forecasts of the project's time and cost at completion

3.1.31 project execution strategy

high-level statement of the intentions and arrangements for the execution of a project

3.1.32 project execution plan

document that sets out how the project will be executed

NOTE The project execution plan is analogous to a project management plan.

3.1.33 project sponsor

individual or organization initiating and promoting a project

3.1.34 repurpose

adapt for use in a different way

3.1.35 requirements management

process of capturing, assessing and justifying stakeholders' wants and needs

3.1.36 scope of work

work to be done to deliver an operational asset

3.1.37 soft landings

building delivery process which runs through the project, from inception to completion and beyond, to ensure all decisions made during the project are based on optimizing operational performance of the building and meeting defined requirements

[SOURCE: *The Soft Landings Framework 2018* [2]]

3.1.38 stakeholder impact analysis

method for evaluating the influence that stakeholders possess in regard to an organization, asset or project

3.1.39 success criteria

requirements set at the beginning of a project against which the project will be evaluated at key stages to decide whether or not it has been successful from key stakeholders' points of view

[SOURCE: *Success Criteria for Soft Landings Projects* [5]]

3.1.40 upgrading

major modification work on an asset or part thereof that improves its overall performance

3.1.41 value improving practice

methodology with a demonstrated, reliable connection between its use and a better outcome

3.2 Abbreviated terms

For the purposes of this British Standard, the following abbreviated terms apply.

AIM	Asset Information Model
AIR	Asset Information Requirements
ALARP	As Low As Reasonably Practicable
BAU	Business As Usual
BIM	Building Information Modelling
BPE	Building Performance Evaluation
BREEAM	Building Research Establishment Environmental Assessment Method
CDBB	Centre for Digital Built Britain
CDE	Common Data Environment

CDM	Construction, Design and Management
DQI	Design Quality Indicator
EIR	Exchange Information Requirements
FEL	Front-end Loading
HSSE	Health, Safety, Security and Environment
KPI	Key Performance Indicator
HVAC	Heating, Ventilation and Air Conditioning
LEED	Leadership in Energy and Environmental Design
OIR	Organizational Information Requirements
PACE	Project Acceleration in a Controlled Environment
PIM	Project Information Model
PIR	Project Information Requirements
RASCI	Responsible, Accountable, Support, Consulted and Informed
RIBA	Royal Institute of British Architects
SAMP	Strategic Asset Management Plan
SMART	Specific, Measurable, Achievable, Relevant and Time-bound
TCO	Total Cost of Ownership
TOTEX	Total Expenditure

4 Concepts and principles

4.1 Key principle

COMMENTARY ON 4.1

Design, manufacture and construction for operability takes into account the needs of the owner, operator, users and other key stakeholders in regard to a new, upgraded, repurposed or refurbished asset. The asset is likely to hold its value or benefit for the owner and users if it is trouble-free, efficient and cost-effective in terms of operation.

Soft landings is a key process for the successful delivery of assets. In essence, it sets success criteria at the outset, protects and promotes the success criteria throughout the project and evaluates performance against the criteria. The criteria are elaborated in BSRIA guide “Success Criteria for Soft Landings Projects” [5]. Examples include environment performance, social performance, user well-being, functional performance and financial (i.e. economic) performance [see e) below and 4.4.4].

The project for the delivery of a new, upgraded, repurposed or refurbished asset should take account of operational requirements and the expected performance outcomes from the outset, through all work stages (see 4.3.3). The delivery phase should be guided by this principle and be followed by defined periods of aftercare to allow the owner, operator, users and other key stakeholders to derive the expected benefits and required operational performance from the asset.

NOTE 1 Projects are set up for success from the outset; otherwise, they are unlikely to achieve their expected objectives or match the operational performance required by the owner, operator and users. This implies an emphasis on the front end of the project, where the ability to influence changes in design is relatively high and the

cost of making those changes is relatively low. Front-end loading involves developing sufficient strategic definition through which the owner can articulate requirements and address uncertainty and risks, then make the decision to commit resources to the project in a controlled manner. The project might not be self-standing and, instead, might form part of a programme, portfolio or network. Interdependencies are likely to exist between such projects with the need to manage them holistically; notwithstanding, this British Standard focuses on projects, including sub-projects covering an asset system (see [4.3](#) and [5.1.1](#)).

This principle should be supported by the following.

- a) The project for delivering a new asset or upgrading, repurposing or refurbishing an existing asset should derive from the owner's strategic asset management plan (SAMP) or facilities management strategy (see [4.5](#) and [5.2.12](#)) and be aligned with business objectives and the business plan, as part of an asset management system [see BS ISO 55000, BS ISO 55001 and BS ISO 55002 (asset management) and [BS EN ISO 41001](#) (facilities management)].
- b) The owner, operator or a delegated authority on the owner's behalf, such as a project sponsor (see [4.2.3](#)), should be capable of defining the business case for the project, its objectives, constraints, expected benefits and the required operational performance of the asset (see [4.2](#)) and end-of-life considerations. Appropriate professional advice should be sought where any aspect cannot be adequately defined.
- c) The owner, operator or delegated authority should be capable of expressing the security needs for the project and the ongoing operation of the asset in relation to both the physical asset and information concerning it. Appropriate professional advice should be sought where any aspect cannot be adequately defined. Where the project relates to a sensitive asset, a suitably qualified person should be appointed to assist in the development of an appropriate and proportionate security-minded approach (see [BS EN ISO 19650-5](#)).
- d) An evidence-based approach to design, manufacture and construction should be adopted that is driven by outputs which are explicit and measurable, wherever possible, and that reflects the requirements of the owner, operator, users and other key stakeholders regarding the expected benefits and the required operational performance of the asset (see [4.2](#)).
- e) Clear targets should be set for the expected benefits and the required performance outcomes at the outset of the project (see [4.4.4](#)), which are aligned with the owner's or operator's business objectives, as reflected in the business case (see [5.1.2](#)), and capable of being cascaded through the supply chain. These targets should be reviewed at key decision points within work stages (see [4.7](#)) and, finally, during operation of the asset.
- f) Decisions in regard to design, manufacture and construction should aim to maximize the value of the asset based upon the desired balance between cost, risk and performance [see BS ISO 55000, BS ISO 55001, BS ISO 55002 (asset management) and [BS EN ISO 41001](#) (facilities management)].
- g) Appointments (see [4.2](#)) should incorporate a commitment to defined periods of aftercare (see [4.2.7](#)), where appropriate.
- h) A post-implementation review, or a building performance evaluation (BPE) in accordance with BS 40101, should be undertaken at prescribed intervals during a defined period of extended aftercare by a suitably qualified person, with the involvement of the project team and each delivery team. The post-implementation review or BPE, including the lessons learned, should be recorded and stored in the asset information model (AIM) so that it is available to the owner, operator, licensee or operations team, as appropriate, and other parties determined by the owner or operator (see [4.6.4](#) and [5.8.4.4.3](#)).

NOTE 2 A post-implementation review or BPE can assist in optimizing the benefits from, and operational performance of, the asset, through benchmarking performance, collating the lessons learned from the project to inform future projects, and updating the owner's information management system (see [4.7](#)). A

post-implementation review is appropriate for infrastructure, whereas a BPE is more appropriate for buildings and other occupied spaces (see BS 40101).

- i) The transition from the delivery phase into the operational phase should include the staged and final transfer of project information and data for operational purposes from the project information model (PIM) to the AIM (see 4.7.2).

NOTE 3 Formal methods exist for examining the relationship between benefits and costs such as cost-benefit analysis and benefit-cost ratio – see, for example, ASTM E2204-15, “Standard guide for summarizing the economic impacts of building-related projects” [6] and the TCA Value Toolkit [7].

The AIM should be created at the start of the project so that it can be operated alongside the PIM.

NOTE 4 Operating the AIM alongside the PIM allows the owner to process information received throughout the project, rather than attempting to transfer all project information and data at once prior to handover of the asset (see 5.7). Doing so provides more time for verification purposes and facilitates the training of operations personnel in readiness for the start-up of operations.

NOTE 5 The owner or operator might utilize an enterprise system to support their asset management.

4.2 Roles, responsibilities and accountabilities

4.2.1 General

COMMENTARY ON 4.2.1

BS ISO 55000, which is concerned with “management systems for the management of assets”, adopts the term “organization” throughout to refer to the entity receiving asset management. This standard is concerned with a broader range of considerations that involve multiple actors, including asset owners, operators, licensees, designers, constructors and other specialists. For clarity, this standard differentiates between actors by name; hence, the term “organization” is used in a general sense only.

The owner or any delegated authority on its behalf (see 4.2.2) should verify that there is a clear governance structure with defined roles and responsibilities that are resourced by personnel with the appropriate level of competence.

A responsibility assignment matrix (e.g. RASCI chart) should be used to differentiate roles, responsibilities and accountabilities throughout the project.

The appointment of the project team (see 4.2.4) and, if applicable, portfolio and/or programme teams (see 5.1.3.1), each delivery team (see 4.2.5) and the operator or operations team (see 4.2.8), as appropriate, should be made having regard to the need to establish the clearest possible understanding of the respective parties’ duties and obligations from the outset of the project. The incorporation of periods of aftercare within the operational phase extends the traditional involvement of each delivery team, so the particular commitments this entails from all affected parties should be made explicit. The appointment of the operator or operations team, as appropriate, should be made before any decision is reached on whether or not to proceed with the project. Where this is impractical, the owner should verify that expertise on asset management or facilities management, as appropriate, is available so that operational requirements and the expected performance of the asset form an integral part of the decision-making.

From the outset of the project, there should be an explicit working approach that requires agreement between the various parties on the work activities and their timing, with the associated information requirements and deliverables (see 4.7). The basis upon which decisions are to be made should be clearly defined and communicated to all involved parties from the earliest practicable point.

NOTE 1 This task can be greatly assisted if the owner or delegated authority is proactive in ensuring that the roles and responsibilities of the parties are properly defined and communicated.

NOTE 2 Agreeing the working approach and the basis of decisions up front is likely to avoid inefficiencies and reduce the potential for conflict between the parties.

4.2.2 Owner

COMMENTARY ON 4.2.2

Soft landings is intended to assist owners and operators in getting the best out of their new, repurposed or refurbished asset through greater involvement of each delivery team with the operator or operations team, as appropriate. Much of the information required to support soft landings is already collected in the normal course of delivering a project. The owner or operator, as appropriate, is expected to nominate a person with responsibility for ensuring that soft landings is developed to suit the project throughout design, manufacture and construction and into operation of the asset. This person might be the “project sponsor” or be referred to as the “owner’s representative” or another term of the owner’s choosing. The term “project sponsor” has been adopted in this standard (see 4.2.3) to cover this responsibility. The reliance upon soft landings could present a case for a “soft landings champion” and a “soft landings lead” or “soft landings leads” drawn from each delivery team to help coordinate meetings and gather information and data required for this purpose. It is, however, important to understand the distinction between a person acting as an agent for the owner in fulfilling day-to-day responsibilities and subject matter experts in respect of soft landings. The soft landings champion is appointed by the owner or project sponsor and the soft landings lead(s) is identified by each delivery team.

The owner should appoint a project sponsor (see 4.2.3):

- a) whose principal tasks are to own the business case for the project, verifying its alignment with the business plan, and to oversee the planning, implementation and control of design, manufacture and construction to achieve a smooth transition into operation and defined periods of aftercare; and
- b) who has first-hand working knowledge of the owner’s organization and an understanding of the asset’s future.

Where an existing asset is to be upgraded, repurposed or refurbished, the project sponsor should have an understanding of its history or acquire such understanding.

NOTE The project sponsor is not a project manager. The project manager leads the project team and is responsible for delivering the asset to an agreed scope of work, schedule and cost/budget in accordance with the business case and, normally, has no involvement or interest once the project has been completed and the asset is operational. Similarly, the operations team might have limited expertise or interest in the project’s delivery, other than to verify that the asset, once delivered, performs as required. There is, therefore, the need for a person who understands the business rationale for the project and possesses a strategic interest in, and understanding of, an integrated process for asset delivery and operation.

Where soft landings has been adopted, a soft landings champion should be appointed. Where the scale, complexity or other key factor is suggestive of a greater focus on soft landings, the additional role of soft landings leads should be introduced.

4.2.3 Project sponsor

COMMENTARY ON 4.2.3

A project sponsor often acts as the owner’s “internal client” to provide leadership during project development, to verify that the project is efficient and cost-effective, and if part of a portfolio and/or programme, is effectively coordinated with other portfolios or programmes. The project sponsor is normally accountable for the business case, obtaining funding and determining performance and other requirements, and is supported by the project team, or delivery team(s), if appointed at this time (see 4.2.4 and 4.2.5). The project sponsor maintains an overview of the project’s progress towards delivering the required operational performance and achieving the expected benefits.

The project sponsor should be appointed for the entire period from initiation of the business case through to operation of the asset, including the full period of extended aftercare, to provide continuity of purpose and consistency of approach. The project sponsor should report to the owner or operator and consult with the representative(s) of users or other key stakeholders as appropriate. The role of the project sponsor should not duplicate that of the project manager.

The project sponsor should maintain the focus of all parties on the required project outcomes and operational performance. The role of the project sponsor should not be delegated to another party, but another person(s) may be engaged to deal with any day-to-day questions and issues that arise which would otherwise distract the project sponsor from more strategically important matters.

NOTE 1 Support for the project sponsor could be provided by the soft landings champion.

NOTE 2 The project sponsor is the primary risk taker and has ultimate accountability and overall responsibility for the project.

The project sponsor should promote collaborative working based on shared responsibilities and goals that are aligned with those of the owner and operator, where the latter is a separate entity, or the operations team, as appropriate.

The project sponsor should make regular reference to the schedule or equivalent documentation that identifies the work activities of the project team, with their associated information requirements and deliverables. The project sponsor should facilitate input from the operator or operations team, as appropriate, and users to the work of the project team.

The interests and needs of the users of the asset should be taken into account through a process of stakeholder engagement.

The project sponsor should facilitate feedback on the design from the operator or operations team, as appropriate, and users to the project team on the integration of operational objectives, specification and maintenance requirements into the design.

The project sponsor should verify that the following are achieved, as a minimum:

- a) establishment of the information requirements (e.g. OIR, PIR, AIR and EIR);
- b) establishment and validation of the expected benefits and required operational performance of the asset (see 4.2) and the operational budget;
- c) verification through successive work stages that the expected benefits and required operational performance will be achieved (see 4.4.4);
- d) planning for operational readiness in advance of the start-up of operations and the phasing in of asset management or facilities management, as appropriate (see 5.6, 5.7 and 5.8);
- e) liaison with the owner's appointee on a security-minded approach to project delivery;
- f) post-implementation review or BPE to establish if the asset is performing as expected (see 4.6.3, 4.6.4 and 5.8.4.4), including measurement of actual operational performance against the required performance, including environmental, social and economic perspectives (see 4.4.4, 4.6.3 and 4.6.4), based on information and data taken from reliable sources during the extended period of aftercare; and
- g) preparation of an advisory report by the operator or operations team, as appropriate, with input from each delivery team where required (see 5.8.6 and 4.2), during the extended period of aftercare, covering the need for any corrective actions, the presentation of benchmarking data and the lessons learned (see 5.2.3).

NOTE 3 BS 40101 provides a comprehensive methodology for evaluating the performance of buildings at any point during the operational phase. Three levels of evaluation are recognized. A Preliminary BPE is the lightest entry-level

evaluation using readily available information and data plus occupant feedback; Light BPE is a basic study and the lightest level to take account of internal environmental monitoring; and Standard BPE is an all-round study based on granular data, enabling greater insight and a basis for decision-making and further performance investigations. An Investigative BPE aimed at specific elements can augment or follow the above.

4.2.4 Project team

COMMENTARY ON 4.2.4

The project team comprises all demand-side and supply-side individuals, groups and organizations, including those with design, construction, commissioning and start-up responsibilities, including each delivery team. Supply-side responsibility extends beyond the handover and start-up of the asset to cover periods of aftercare within the operational phase.

The day-to-day management of the project based on an extended project life cycle should be vested in a project team under the direction of a project manager, where each delivery team is a subset of the project team (see [Figure 1](#)). In all cases, roles, responsibilities and accountabilities should be clearly defined.

NOTE RASCI charts are useful for this purpose (see [4.2.11](#)).

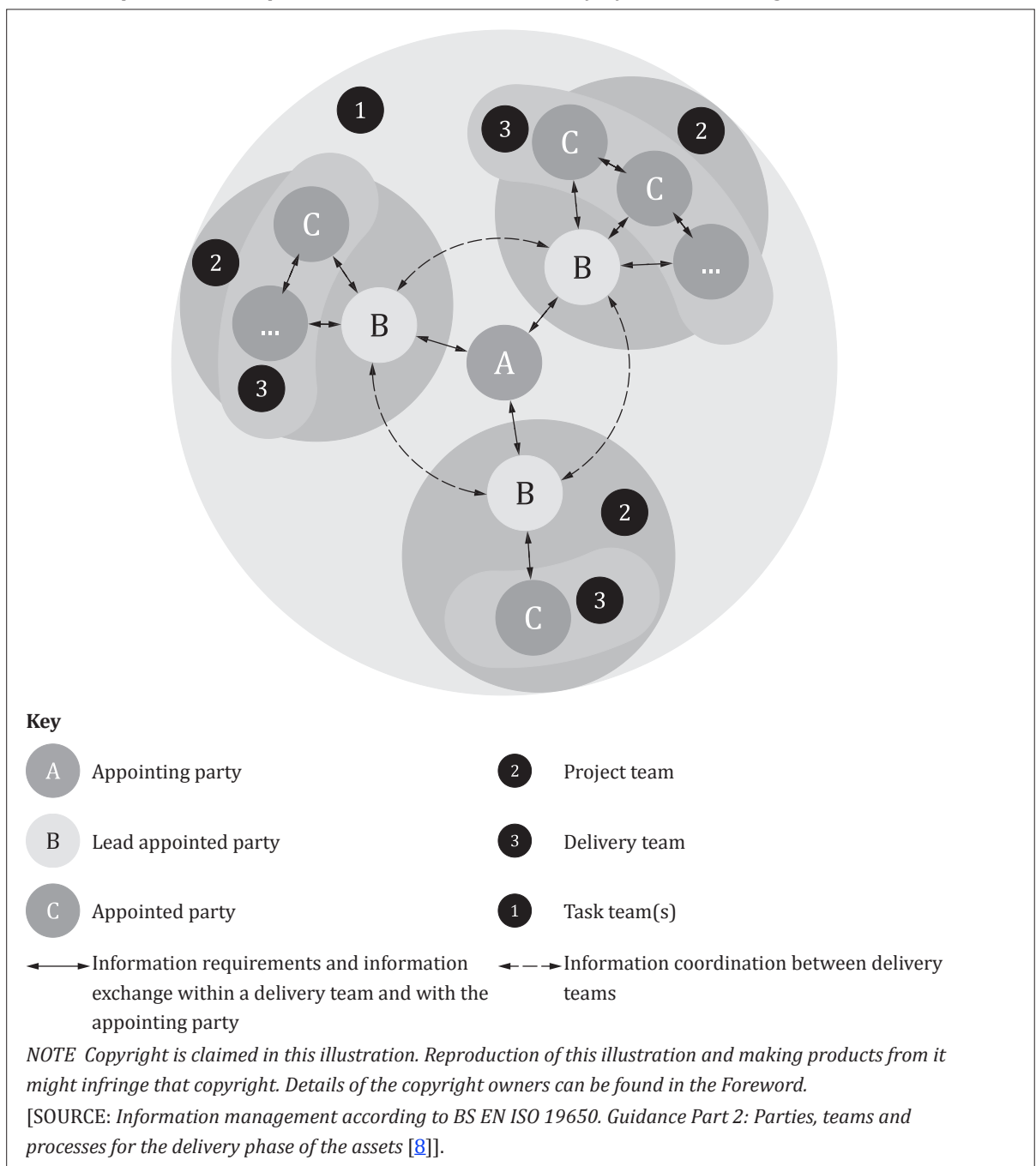
The project team should include personnel from the operator or operations team. Where no such arrangement presently exists, a person or organization with appropriate experience of operations should be appointed to verify that operational requirements and performance outcomes (see [4.4.4](#)) are taken into account in each work stage.

4.2.5 Delivery team

COMMENTARY ON 4.2.5

An integrated, collaborative approach to design, manufacture and construction is necessary to verify the constructability of the design and the operational performance of the asset. The term “delivery team” is used in the context of information management to refer to each lead appointed party and its appointed parties as required to assist in transforming the owner’s business objectives into an operational asset or the upgrading, repurposing or refurbishing of one existing. An integrated project team reduces the likelihood of “silo working”, decreasing the prospect of errors and omissions. Specialist contractors, suppliers and manufacturers can be regarded as an integral part of each delivery team’s supply chain. See [4.2.6](#) and [4.7.8](#) for exchange information requirements for supply chain actors.

The project manager should verify that each delivery team has the capability and capacity needed for the duration of its appointment.

Figure 1 — Relationships between the parties and teams in the context of information management

Each delivery team should support the project manager in pursuing an operational asset that meets defined performance outcomes and targets. One member of each delivery team should be nominated to be responsible for coordinating all transition-related activities.

NOTE 1 This coordination role can be fulfilled by the soft landings lead(s).

Each delivery team should align roles and responsibilities for the project to work activities and their associated information requirements and deliverables. A responsibility assignment matrix (e.g. RASCI chart) should be prepared by each delivery team for this purpose. The format of the matrix should be approved by the project manager and project sponsor in turn. The matrix should be aligned with an organization chart for the project, which should be prepared by the project team to show reporting/communication between all parties within the project organization and interfaces to external actors and other key stakeholders. Matrices should be updated as necessary in each work stage and in

readiness for the subsequent work stage (see [Clause 5](#)). Design responsibility matrices should complement the use of RASCI charts by providing a focus on assigned design responsibilities and the level of information need (see BS EN 17412-1).

NOTE 2 [Annex B](#) gives an example RASCI chart.

Each delivery team should advise the project sponsor of the need for any additional competences, skills and experience required as soon as any gap becomes apparent. Where the engineered systems are complex, the owner, project sponsor or operator, as appropriate, should appoint an independent commissioning manager if not already appointed. The commissioning manager should be appointed early in the project's life. Where there is a known or perceived security threat to the asset, a suitably qualified person should be appointed at the outset of the project, if not already appointed, to assist in the development of an appropriate and proportionate security-minded approach.

4.2.6 Supply chain considerations

COMMENTARY ON 4.2.6

In the course of delivering a new, upgraded, repurposed or refurbished asset, much work devolves to suppliers and manufacturers. The success of the transition from design through manufacture, construction and into operation depends on the effective integration of the supply chain covering all the actors necessary for delivering the operational asset. The management of multiple organizational, technical and contractual interfaces between these actors is part of the task and is a factor in that success. It is essential that all suppliers of services, products and materials are effectively integrated into the approach to be taken, including work activities, information requirements and deliverables in each work stage. There are implications for the exchange of information between appointees and the appointing party (see [4.7.5](#), [4.7.6](#) and [4.7.7](#)).

As far as practicable, suppliers and manufacturers should adopt an approach that supports the key principle (see [4.1](#)) throughout all work stages in which they are involved. Each supplier and manufacturer, as appropriate, should identify a person for the purpose of transition into operation of the asset and inform the transition coordinator (see [4.2.5](#)) within its delivery team, which should be the soft landings lead where appointed. This person should attend meetings, when requested, to present proposals concerning the respective parties' work, including details of the operational requirements of systems, equipment, controls and user interfaces, as appropriate.

Where highly specialized plant and equipment is involved, provision should be made to retain the services of the supplier to assist during handover and in monitoring performance during start-up and operation of the asset. These suppliers may be based on site full-time during an initial period of aftercare (see [5.8.3](#)) to assist with user queries and to undertake optimization of systems as necessary. In this case, the project manager should make these conditions clear and verify that they are embodied in the scope of work and subsequent agreements with the supplier.

Where suppliers of highly specialized plant and equipment are required to provide support for an extended period of aftercare (see [5.8.4](#)), the roles and responsibilities should be the same as those required in the operational phase (see [5.8](#)). The applicable RASCI charts for this purpose should be updated where necessary to reflect these arrangements.

Suppliers should be required to contribute information and data to the common data environment (CDE) (see [4.7.4](#)) in accordance with their exchange information requirements (EIR) and other appointment information.

4.2.7 Aftercare team

An aftercare team should be appointed to manage interventions and provide solutions to problems identified in the normal operation of the asset or as a result of a post-implementation review or BPE

(see [4.6.3](#), [4.6.4](#) and [5.8.4.4](#)). This team should be staffed by representatives of each delivery team with sufficient coverage of the disciplines to cope with a wide range of potential interventions and solutions that might be required to optimize functionality and performance of the asset.

NOTE The aftercare team does not manage, maintain or operate the asset. Its role is to fine-tune and de-bug systems in the period of aftercare. The findings of a post-implementation review or BPE might highlight the need for such action.

4.2.8 Operator or operations team

COMMENTARY ON 4.2.8

The asset might be operated by the owner or another party where, for example, a licence is granted to operate a service based on the asset as would occur in the case of a toll road, bridge or tunnel. It is necessary that the interests of the operator are taken into account from the outset. These interests extend to the needs of the users of the asset. In a larger organization, an operations team might be responsible for the asset on a day-to-day basis, including its maintenance; or a separate organization, acting as a concessionaire or licensee, might be responsible. In a smaller organization, there might be no equivalent arrangement.

Expertise is required on operational matters and this might be provided by a consultant engaged for this purpose. This person is necessary to provide comment and advice on the implications of design, manufacture and construction proposals from an operational perspective as they are developed from the Strategy work stage through to Handover and Closure.

The project sponsor should give the operator or operations team, as appropriate, authority to provide appropriate information and data to each delivery team concerning the operational strategy and operational requirements, including performance targets and outcomes, operational cost and budgets, and procurement of asset-related services where applicable (see [BS 8572](#)). The applicable RASCI charts for these purposes should reflect these arrangements. The operator or operations team, as appropriate, should identify the owner's information needs in this regard as part of the organizational information requirements (OIR) (see [4.7.5](#)).

NOTE [Annex B](#) gives an extract from a RASCI chart.

4.2.9 Users

COMMENTARY ON 4.2.9

The occupants, visitors and other users of the asset are a key stakeholder group and are collectively referred to as users because they are generally the ultimate beneficiaries of the services provided by the asset in operation.

The users should verify that their interests and needs are taken into account through a process of stakeholder engagement on the part of the project manager (see [4.2.11](#)).

NOTE 1 Depending on the number and diversity of users, the project sponsor could arrange for representation on a group, rather than an individual, basis.

Personally identifiable information and data should be collected, used and stored in a security-minded manner.

NOTE 2 Asset-related systems might contain a range of information and data about users, for example, information about passes or access tokens and emergency contact details. Attention is drawn to duties under data protection legislation.

4.2.10 Other stakeholders

The project team should identify those parties that are external to the project organization but who can impact it in some way, either negatively or positively.

NOTE Example stakeholders external to the project can include local authorities and other public bodies, utility companies, non-governmental organizations and the general public. The latter might have little power on an individual level but, collectively, could exert influence over decision-making.

4.2.11 Collaboration and alignment

COMMENTARY ON 4.2.11

Success is due, in large part, to a collaborative approach between the various parties, but also to monitoring and verifying the alignment of the work of each delivery team and the developing design with the expected benefits and required operational performance of the asset.

The project sponsor should verify that each delivery team understands the necessity of a collaborative approach to its work and the importance of active engagement with the operator or operations team, as appropriate. Each delivery team should provide evidence of its approach in the form of a schedule of work activities, with their associated information delivery plans, for each work stage (see [Clause 5](#)). This should take the form of a RASCI chart covering the work activities and their associated deliverables for each work stage. The RASCI chart should be supplemented by design responsibility matrices covering assigned design and information delivery responsibilities.

NOTE 1 [Annex B](#) gives an example RASCI chart.

The project team should obtain early input about the interests and needs of owners, operators, users and other key stakeholders. To assist with this, the project manager should prepare a plan for stakeholder engagement (see [5.1.6](#)).

Users, or their representative(s), should be allowed to express their views in an environment that is conducive to obtaining an honest and accurate understanding of their needs (see [4.5.5](#)). A participative stakeholder engagement process should be adopted wherever practicable.

NOTE 2 The adoption of value improving practices, if properly controlled, can assist in identifying functions that add cost, but which are of no value to the owner, and then in eliminating them. Value engineering is a common and proven methodology for this purpose and is, increasingly, incorporated into routine practice. It is important, however, to establish that value engineering is a genuine attempt to seek value improvement, which implies a relationship between cost and quality, and is not simply a cost-cutting exercise. The adoption of constructability and operability studies, whole-life costing and applying lessons learned can be similarly regarded as value improving practices.

Commissioning, training and handover should be planned jointly by the project team and the operator or operations team, as appropriate, and overseen by the owner, project sponsor or another person with delegated responsibility for operational readiness, flawless start-up and early optimization of operational performance. Users, or their representative(s), should be involved in this planning.

The project team, working through the aftercare team (see [4.2.7](#)), should be involved in post-implementation review or BPE, as appropriate, as a process for assessing the performance of the asset over the first three years of its operational life, to establish actual outcomes and to record and share lessons learned (see [4.6.3](#)). Where actual performance of the asset falls below expected performance, the aftercare team should be empowered to intervene and rectify any issue or propose a solution to the reasonable satisfaction of the owner, operator or project sponsor and users or their nominated representative. The post-implementation review should extend to measuring the impact of the operator's or operations team's operational strategy for the performance of the asset (see [4.2](#)).

NOTE 3 The advantages of this approach, including post-implementation review or a BPE, are the optimization of operational performance of the asset within the operational budget as soon as possible and the alignment of operational performance with the required performance outcomes set prior to the start of design, manufacture and construction. Achievement of the required outcomes could be regarded as an indication of the operator's

or operations team's and users' likely satisfaction with the asset and offers some assurance with respect to operational cost.

The project sponsor should verify that operational input is a continual, but controlled, contribution during design, manufacture and construction work to demonstrate that the design of the asset is subject to evaluation from an operational perspective. A design review protocol should be used to support this work, together with a plan for information exchange (see 5.3.3). The project team should respond on matters of alignment of the developing design with the expected outcomes, changes to the design that have been necessary, and the extent to which performance targets for the operational asset are likely to be met. Confirmation of the associated capital and operational costs should be provided by the project team, with input from the operator or operations team, as appropriate, at points defined for the purpose of information exchange (see 4.7).

4.3 Project-managed approach

4.3.1 Project life cycles

COMMENTARY ON 4.3.1

All projects pass through phases in their life cycle, enabling the work involved to be broken down into manageable parts. A life cycle defines the interrelated phases – sometimes referred to as stages by some organizations – in a project and provides a structure for governing the progression of work. In the basic case, there are two overarching phases in the life cycle of assets: the delivery phase and the operational phase. A linear life cycle is appropriate for most situations involving assets. Derivative life cycles, typically involving iterative processes within phases, might be encountered as part of, for example, an agile project management methodology or a hybrid life cycle. Many organizations have devised their own life cycle to move projects through a sequence of phases to the delivery of the asset and some have extended the approach into operations and the realization of benefits. Increasingly, time is devoted to shape (or frame) the opportunity that gives rise to the project as part of front-end loading.

The owner, operator or project sponsor should define the life cycle for the asset, including its phases and the extent to which they constitute the project life cycle.

NOTE *An extended project life cycle recognizes the adoption phase of the project during which benefits realization takes place. The thinking here is to derive the required benefits from the outputs of the project. Often, the responsibility for operating the asset and benefits realization falls outside a delivery team's remit and influence. An adaptation of the extended life cycle to incorporate operations and the terminal act of decommissioning and repurposing or dismantling the asset establishes the product life cycle. This life cycle is relevant when determining the total cost of ownership (TCO) or whole-life cost of the asset.*

4.3.2 Phases

The project should be divided into phases, as appropriate to the selected life cycle and its terminology, where each equates to a distinct period or state in the life cycle, to improve the effectiveness of its management.

NOTE 1 *Each phase could be managed as a sub-project to ensure that it is started correctly, planned, monitored and closed with lessons learned documented for the next project.*

The owner, operator or project sponsor, as appropriate, should specify the phases, key decision points, criteria for progression and deliverables and provide this information to the project team to organize and plan its work.

NOTE 2 *Decision points are referred to variously as decision gates or gateways.*

Decisions should be made at each key decision point where they are planned and should not be carried over to the next decision point.

Each decision gate or gateway should be preceded by reviews as part of the project's governance and assurance and be accompanied by a simple question to which an affirmative answer is necessary to move the project forward to the next stage.

When planning work and deliverables, sufficient time should be allowed for review or evaluation of proposals prior to a decision gate or gateway so that decision-making is not at the very end of the phase or work stage (see [4.3.3](#)).

NOTE 3 Decision gates serve a business purpose, not a design or construction purpose. Decision gates check the progress of the opportunity and ascertain the likelihood of realizing the expected value for the benefit of the project's stakeholders. Changes, for example new or revised design proposals, have to be assessed in terms of their impact on cost and schedule. Allowing little or no time to evaluate changes before a decision gate or gateway can result in issues or problems being carried over to the next work stage, thereby undermining their purpose as a check and control mechanism.

4.3.3 Plans of work

COMMENTARY ON 4.3.3

A plan of work maps the project life cycle and defines the work stages, the work to be done and the level of information need (see BS EN 17412-1) with respect to each appointee. Progression depends on satisfying predefined criteria at decision gates or gateways that include requirements relating to environmental, social and economic performance. In this regard, it is important to recognize the iterative nature of some work, where the reassessment of assumptions is a normal feature. In the case of design, the process is not always linear and is likely to involve some iterative processes to converge on an acceptable solution or deliverable.

The work stages should reflect the following suggested plan of work, which may be adjusted to suit the specific needs of the owner, operator or project sponsor.

- 0 Strategy – defines the owner's or operator's business objectives, plan and case for the project, including required outputs, outcomes and expected benefits, and the relationship of the project with any overarching portfolio and/or programme.
- 1 Preparation and Brief – develops the project objectives, including required project and performance outcomes from the asset over different planning horizons.
- 2 Concept – prepares the concept design, including outline proposals for the general design treatment, structural design and engineered systems.
- 3 Definition – develops the design, including coordinated and updated proposals for the general design treatment, structural design and engineered systems.
- 4 Technical Design – prepares the technical design, including structural and engineering design information, detailed cost and operational data.
- 5 Manufacture, Construct and Commission – plans, organizes and coordinates off-site fabrication with on-site construction, including transportation, assembly, installation, testing and commissioning.
- 6 Handover and Closure – training of operations personnel and handover of the asset to the owner or operator and start-up of operations.
- 7 Use – steady-state operation, aftercare, post-implementation review or BPE, as appropriate, including benchmarking and lessons learned.

The plan of work should be used to verify that the deliverables of all originators of information and data are identified and appropriate to the decisions required at each work stage, and should be adopted as the basis for delivering and operating the asset.

NOTE 1 Decision points can occur at any time within a work stage and are likely to be determined by the owner's internal policy and decision-making. These are additional to the decision gates or gateways at the end of each work stage. It would not be appropriate for a delivery team, when appointed, to determine such timing although it can communicate its expectations to achieve a workable plan. Discussion between the owner, operator or project sponsor, as appropriate, and each delivery team on the alignment of decisions and information exchanges would therefore be in all parties' interest.

Figure 2 illustrates the progression from the Strategy work stage through to Use, including end of life, where the decision to proceed from one work stage to the next depends upon the owner, operator or project sponsor, as appropriate, accepting key decisions. For this reason, decision gates or gateways should be incorporated into each work stage to evaluate the progress achieved in alignment with the expected benefits, operational requirements and the required performance of the asset (see 4.4.4 and Figure 3). The owner, operator or project sponsor, as appropriate, should determine the timing of decision points, information exchanges (see 5.3.3) and the criteria to be satisfied, taking into account the adopted procurement method and arrangements for appointing each delivery team.

Progression to the next work stage should be conditional upon satisfying defined criteria relating to the expected benefits, operational requirements and the required performance of the asset (see 4.4.4).

Figure 2 — Work stages

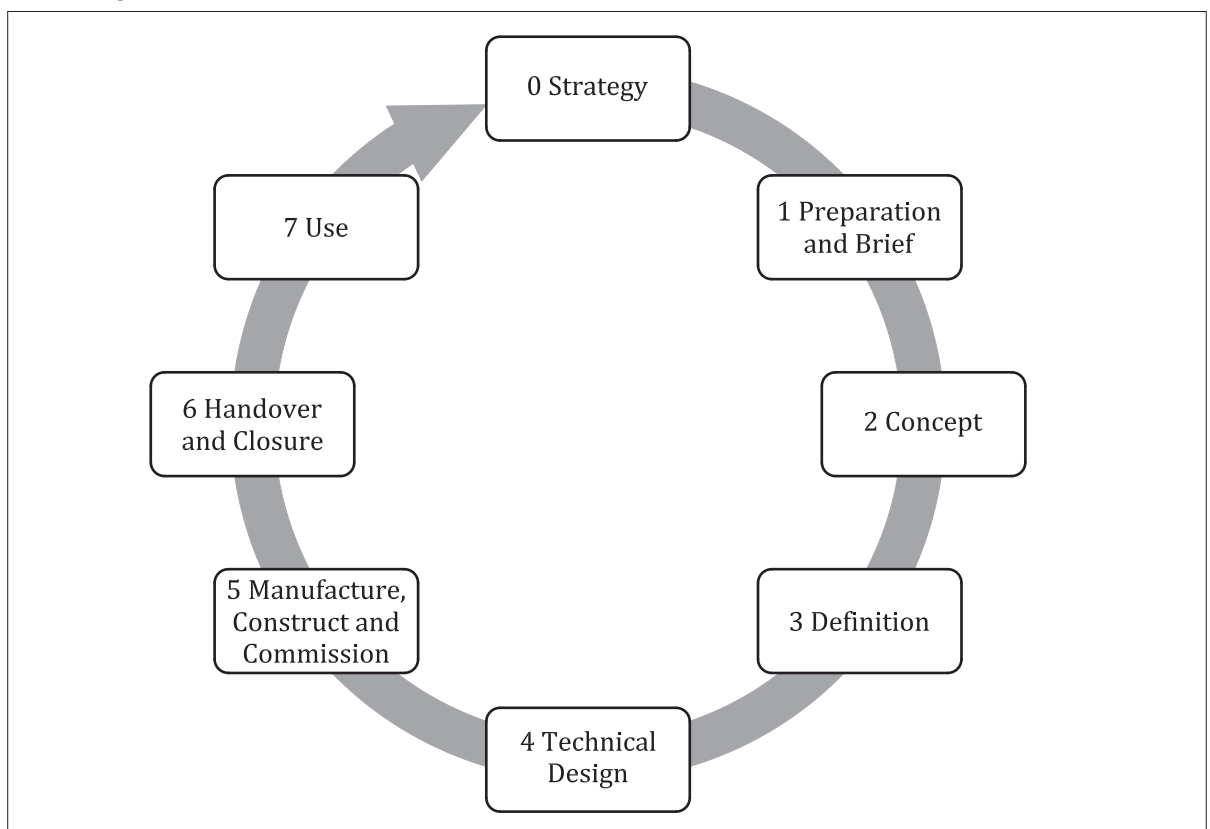
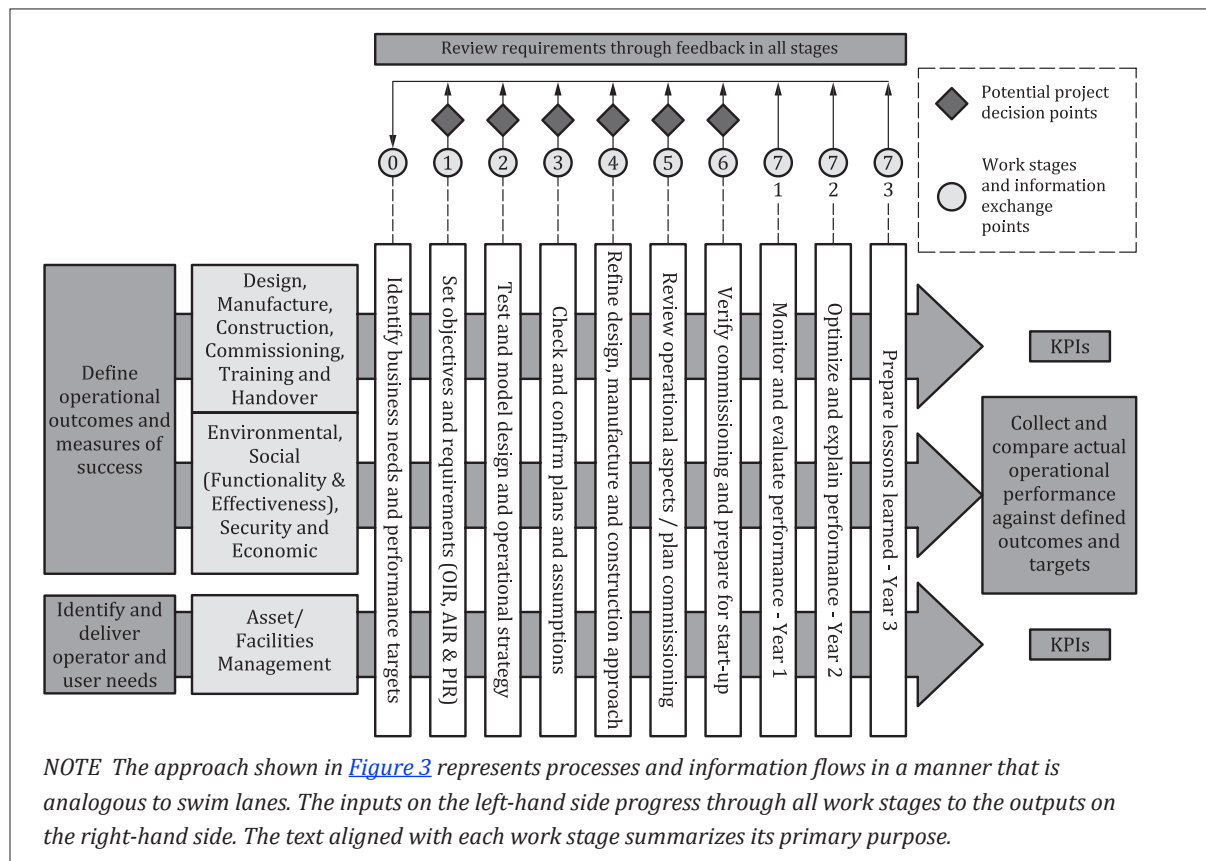


Figure 3 — Processes and information flows

The requirements contained in each work stage (see [Clause 5](#)) should be properly defined before they are encountered and the preceding stage, where applicable, should be concluded satisfactorily before the transition to the next work stage. Work stages or parts of them should not be omitted, but the approach may be scaled down if it is felt that the requirements are inappropriate or exceed reasonable needs.

NOTE 2 [Clause 5](#) is structured in accordance with the work stages outlined in the plan of work as the project progresses from its commencement to the operation of the asset. The same or similar subclause headings are used in each work stage, wherever practicable, to ensure consistent treatment of both recommendations and guidance. In a number of cases, the latter are broadly similar, although might contain important differences.

NOTE 3 Attention is drawn to the RIBA Plan of Work 2020 [\[9\]](#) and Toolbox [\[10\]](#) as a proven blueprint for project success for buildings and to The Construction Playbook [\[11\]](#). In the case of infrastructure, a number of sector-specific plans of work or delivery models exist, for example, “Project Acceleration in a Controlled Environment (PACE)” and the “V model”, each of which is reflective of the business objectives and practices of particular sub-sectors, owners and operators.

4.3.4 Project controls

Controls should be applied at key or critical points in the project life cycle and should extend to the programme and portfolio level, as appropriate. They should coincide with decision points and decision gates or gateways but may also be applied at other points in the life cycle to help monitor progress and compliance with the project’s governance and assurance. Project controls should focus on determining whether the required actions, tasks and decisions have been accomplished satisfactorily or if further action or adjustment is necessary before proceeding.

NOTE 1 Project control is a discipline with functions designed to control scope, quality, schedule, resources, cost and HSSE. The primary purpose is to inform the project’s management of performance and progress so that the project’s

current status and forecast of completion is maintained continuously such that any deviation from the approved baseline of the project can be detected and corrective action taken, where necessary.

The owner, operator or project sponsor, as appropriate, should confirm the basis upon which costs and budgets are to be controlled, including limits on authorization for expenditure and supplementary budgets where, for example, scope changes are approved.

NOTE 2 Cost and budget are not the same. Typically, once a final investment decision has been reached, based on an estimate of the cost of delivering the asset, a budget for the purpose of capital expenditure is authorized. This approved budget represents a cap on expenditure under which commitments can be entered into through the issue of purchase orders and the award of contracts. Commitments represent assigned budget, which is funds earmarked for expenditure, and so cannot be used for any other purpose.

4.3.5 Project risk management

The project team should implement a structured process of project risk management. The project manager should be accountable for the effective management of risks to which the project is exposed and verify that the consequences are reflected in the project's current status and forecast of completion date and cost.

NOTE 1 APM Mini Guide, "Project risk analysis and management" [12] offers a suitable basis for helping project teams to implement risk management.

The risks, both threats and opportunities, that could affect realization of the required functionality, expected performance and outcomes for the asset should be systematically assessed and managed in each work stage. Assessment should be undertaken periodically to identify any condition or event that could erode value or impact negatively or positively on the operation of the asset and determine the actions necessary to manage them. The assessment should include identification and analysis of threats (downside risks) and opportunities (upside risks), treatment of those risks and the controls to be applied (see BS EN ISO 31000). Security risks, in particular, should be assessed at regular intervals and predefined points throughout the life cycle and when certain trigger-related events occur, with the security strategy updated accordingly.

NOTE 2 Downside risks are factors that can have a potentially negative impact on the asset, such as potential hazards faced in the construction work, and are commonly referred to as threats. Upside risks are factors that can add value to the outcome and are more commonly referred to as opportunities. The latter might arise from a change in the economic or market environment or the re-examination of the scope of work against the business objectives and project objectives, e.g. a change to take advantage of the likely availability of more energy-efficient equipment by a particular date.

For risks to be managed effectively they should be expressed in terms of a definite cause and the uncertain event that might occur, in terms of quantifiable probability, and its effect on project objectives if it were to occur together with a quantifiable consequence. The risk event should be connected with the project in terms of, for example, specific activities in the project schedule or items in the cost estimate (or budget) that would be affected if the event were to occur.

NOTE 3 A risk is not a certain event; there is only a probability of its occurrence. If a risk event is going to occur, then it is no longer a risk but an issue to be resolved by whatever means are available and appropriate.

Risks should be identified as relating to defined activities or decisions in the project.

NOTE 4 A list of risks that states, for example, weather, labour shortages and material delays does not give many clues as to the event that might occur which, if it did, would have an impact on objectives. These are likely to be issues to be resolved by the project manager and the project team in the normal course of construction project management.

NOTE 5 Issues might exceed the capacity to be resolved at the project level and might have to be escalated to the programme or portfolio level or to the project sponsor. Similarly, risks at the project level might have to be escalated to the project sponsor or the programme or portfolio level.

An up-to-date risk register is one of the key deliverables in the Strategy work stage and should be established and maintained from the outset (see [5.1.10](#)). It should be used to record any identified threats and opportunities, an assessment of their potential impact and the likelihood of their occurrence. For threats, actions should be explored to reduce or avoid their potential impact. For opportunities, actions should be explored to realize or enhance the potential benefits. The risk register should be kept up to date throughout all work stages so that it reflects the current situation and should be utilized in the process of collating lessons learned.

Account should be taken of the operator's and users' interests in the asset when identifying and assessing threats and opportunities. Details of such risks and the treatments arising should be recorded in the risk register and reflected in estimates of capital cost and operational cost and the project schedule.

NOTE 6 A risk register formally records conditions or events, which could threaten or improve outcomes, to be taken into account in risk assessment/analysis. The register is not simply a repository, but a tool to help gain a current understanding of conditions or events and the threats and/or opportunities they represent. As time passes, some threats and opportunities materialize, others might disappear, and new ones appear.

4.4 Objectives, outputs, outcomes and benefits

4.4.1 Projects, programmes and portfolios

COMMENTARY ON 4.4.1

This subclause addresses instances where organizations owning and operating assets might manage their projects collectively rather than individually as part of a programme or portfolio.

The project team should be aware of the project's possible relationship with any other project or projects. Where the project forms part of a programme or portfolio, governance and assurance matters should be clarified so that the project is best able to contribute to the overall success of the programme or portfolio. Arrangements and undertakings affecting the project, by the nature of its relationship with other projects or the interdependency of projects, should be made explicit.

NOTE 1 It is essential that the project team and each delivery team within it have a clear understanding of the context within which the project fits within the organization that "owns" it. For instance, the project might be an enabler for later projects or, simply, be contingent upon the success of a project preceding it. In the public sector, the organization might have a set of predefined outcomes or objectives to which all projects within a programme or portfolio will contribute.

The appointing party should verify that arrangements to resource the project take into account demands on personnel, equipment and materials that might be shared by other projects.

NOTE 2 In multi-project organizations, sharing of resources is common and so plans to support the project might draw on resources that are supporting other projects concurrently, as would be the case with a matrix organizational structure for project work.

4.4.2 Project objectives and outputs

COMMENTARY ON 4.4.2

Project objectives tend to be couched in terms of the broad scope of the asset as the deliverable, its cost and the time required to deliver it safely, securely and efficiently. The defined scope, cost and time for completion of a deliverable can also be regarded as the outputs from the project. In many situations, project objectives are set in terms of either deliverables or outputs. For example, the delivery of a new 50-bed intensive care unit, within 18 months, for a cost of £x million captures both objectives and outputs. Detailed requirements are expected to support the objectives (see [4.5.5](#)).

The owner, operator or project sponsor, as appropriate, should verify that the objectives for the project are stated clearly and in quantifiable terms.

4.4.3 Project outcomes and benefits realization

COMMENTARY ON 4.4.3

Stakeholders in the project, including external stakeholders, to varying extents expect to realize value or benefits from the project outputs (or deliverables). For example, a 50-bed intensive care unit is intended to improve access to specialist healthcare for patients, as one stakeholder group, and to the hospital trust as another stakeholder. There will be many individuals and organizations who have an interest in improved healthcare. In addition to the obvious benefits to patients and the hospital trust, gains could accrue to other stakeholders from shorter stays in hospital. The realization of benefits is, for many stakeholders, the ultimate goal and the project is the means to their achievement. It is important, therefore, to recognize the different perspectives and expectations that each stakeholder or group of stakeholders might possess and to treat these as value drivers for the project.

The owner, operator or project sponsor, as appropriate, should verify that the value drivers for the project are documented to inform design decision-making, required project outcomes and the expected benefits to be derived from the project outputs (or deliverables).

NOTE The Value Toolkit [7] provides a structured approach for value-based decision-making across the life cycle of a project, programme or portfolio.

4.4.4 Functional and operational performance

COMMENTARY ON 4.4.4

The performance required or expected of an asset can be regarded as measures of success. BSRIA guide “Success Criteria for Soft Landings Projects” [5] gives example measures that include environment performance, social performance, user well-being, functional performance and financial (i.e. economic) performance (see 4.1). Importantly, success criteria are set at the outset of the project and used as a constant reference through all work stages (see 4.3.3) to determine if the asset is likely to be successful from key stakeholders’ perspectives.

Performance outcomes should be set at the Strategy work stage (see 5.1) and monitored during each subsequent work stage up to and including Use (see 5.8), with post-implementation review (see 4.6.3) or BPE (see 4.6.4), as appropriate, during a defined period of extended aftercare (see 5.8.4). The following performance outcomes should be used as the basis for measuring operational performance.

- a) Environmental – the asset should meet performance targets, such as those for net zero carbon operation and use, energy use, greenhouse gas emissions [carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O) and hydrofluorocarbons among others], water (e.g. quality, abstraction, consumption and pollutant prevention), soil and landscape (e.g. quality, remediation and changes), waste (e.g. prevention or reduction, reclamation, reuse, recycling, treatment and disposal) and/or other environmental indicators defined by the owner, operator or project sponsor.

NOTE 1 An indicator is a quantitative, qualitative or descriptive measure. See Annex C for an approach and typical measures forming a part of a post-implementation review or POE and BS EN 15643-2 on environmental performance.

- b) Social (i.e. functionality and effectiveness) – the asset should be designed and constructed to meet functional performance targets, such as those relating to asset availability, utilization, access, inclusiveness, health and safety, building safety, capability, capacity, quality, resilience, serviceability/maintainability and adaptability, and internal conditions such as air quality, thermal comfort, noise and vibration, user well-being and others defined by the owner or operator, as appropriate.

NOTE 2 Building safety encompasses fire safety, structural safety, public health and public safety (see BSI Flex 8670). BS 40101 provides guidance on the evaluation of user experience and internal conditions, among other factors, which could usefully inform the setting of required performance outcomes for a building.

NOTE 3 See [Annex D](#) for an approach and typical measures forming a part of the post-implementation review or BPE, BS ISO 15686-2 for an approach to service life prediction and BS EN 15643-3 on social performance.

- c) Economic – the asset should meet performance targets for capital cost and operational cost so that whole-life costs can be estimated and value and benefits can be assessed (see [4.4.3](#)).

NOTE 4 See [Annex E](#) for an approach and typical measures forming a part of a post-implementation review and elements of a BPE and BS EN 15643-4 on economic performance.

- d) Security – the asset and the creation, use, storage and disposal of asset-related information and data should meet the security requirements of the owner, operator, licensee, operations team, as appropriate, and users.

NOTE 5 See [5.2.6](#) for the development of an appropriate and proportionate security-minded approach.

Performance outcomes and targets should be specific to the project and should be verified in each work stage (see [Clause 5](#)) as part of a formal review process. As far as practicable, a quantitative approach should be taken to measuring performance and value or benefits, as appropriate.

The processes in a) to d) should be measured principally through key performance indicators (KPIs) to determine their effectiveness.

NOTE 6 KPIs measure progress towards achieving objectives or other factors that are critical to success (see BS EN 15221-1). They represent the significant measures that allow the owner to act quickly upon any deviation in performance.

The outcomes should be differentiated over various planning horizons (i.e. short, medium and long term) or other agreed basis, particularly in regard to environmental performance and certain aspects of social performance (e.g. asset availability, inclusiveness, utilization, health and safety, building safety, capacity, resilience and serviceability/maintainability, air quality, thermal comfort, noise and vibration, and user well-being). Wherever possible, commitment to net zero carbon operation and use should be pursued as part of the measurement of environmental performance over the long term and as a basis for the assessment of the asset's sustainability (see PAS 2080).

NOTE 7 PD ISO/TS 21929-2 provides examples of environmental, social and economic performance indicators. It includes a framework for developing indicators for use in the assessment of economic, environmental and social impacts, and establishes a core set of aspects and impacts to be taken into account when developing systems of indicators.

BS 40101 provides a methodology for evaluating a building's performance, which is relevant when setting quantitative measures for performance outcomes and targets. Other methods exist for measuring performance. One example is the Design Quality Indicator (DQI) [[13](#)], which is a five-stage method for evaluating the design over the project life cycle against three quality principles: functionality, build quality and impact. Another example is the BREEAM Communities [[14](#)], which is a scheme for measuring and certifying the sustainability of large-scale development plans. It provides a framework to support planners, local authorities, developers and investors through the master planning process.

NOTE 8 PAS 2080 specifies requirements for the management of whole-life carbon in infrastructure, both in the provision of new assets and the upgrading of existing infrastructure. It specifies requirements for establishing effective governance systems for reducing whole-life carbon through the use of a carbon management process.

NOTE 9 A new, upgraded, repurposed or refurbished asset can help the owner meet the requirements of key stakeholders, such as regulators, and new legislation. The preparation and maintenance of a health and safety file, and a fire and emergency file, as appropriate, throughout design, manufacture and construction and into operations is covered by legislation [[15](#)].

NOTE 10 It is important to recognize that the full impact of the new, upgraded, repurposed or refurbished asset might not be seen for many years. For this reason, the evaluation of the asset's performance over what might be regarded as the long term falls outside the scope of this British Standard.

NOTE 11 The realization of value from an asset depends upon many factors, including striking the desired balance between cost, risk and performance. The definition of what constitutes value depends to some extent on the owner's or operator's perspective and could extend to other key stakeholders. Value can be tangible or intangible, financial or non-financial, and changes over the life of the asset (see BS ISO 55000 and [BS EN ISO 41001](#)). Benefit and utility are synonymous with value and all three are linked to cost and risk.

4.4.5 Evidence-based approach

COMMENTARY ON 4.4.5

Evidence-based design, manufacture and construction are likely to result in improvements to the project's expected benefits and the achievement of more exacting operational requirements with respect to environmental, social and economic performance, including demonstration of the owner's, operator's and users' satisfaction with the asset in operation.

An evidence-based approach to design, manufacture and construction should be adopted, in which decisions are based on the best available information from multiple sources, including but not limited to the owner's business objectives and plan, current operations, lessons learned from previous projects, design modelling and simulation, and performance evaluations. This approach should be extended to include the provision of evidence to support proposals and recommendations prepared by each delivery team. Information and data for these purposes should be handled, stored and protected in accordance with the security requirements of the owner or operator, as appropriate (see [5.2.6](#)).

NOTE 1 Information and data related to the owner's current and future business objectives and operations might include sensitive commercial and economic details, as well as intellectual property, that need to be afforded appropriate and proportionate protection.

NOTE 2 [BS 7000-4](#) provides guidance on the management of design, including a general approach to briefing.

4.5 Processes

4.5.1 High-level processes

COMMENTARY ON 4.5.1

This subclause gives recommendations on high-level processes. Other processes and sub-processes are addressed in subsequent subclauses, especially those covering work stages (see [Clause 5](#)).

The following recommendations should be met as the minimum.

- a) Design, manufacture and construction – the asset should be delivered to the required operational requirements to allow it to perform as expected for its planned life subject to an appropriate maintenance regime (see [5.3.4](#), BS ISO 15686-2, BS ISO 15686-5, [BS 8210](#) and [BS 8544](#)). Where the project covers an asset system, additional processes for capturing and managing requirements should be adopted where necessary (see [5.5.1](#)). In this regard, the owner should determine whether or not specific processes for configuration management, system integration and verification are required during design, manufacture and construction (see [4.5.6](#), [5.2.4](#) and BS ISO/IEC/IEEE 15288). Where deemed necessary, these processes should be incorporated in the relevant work stages (see [Clause 5](#)).

NOTE 1 Operational requirements can extend to the owner's, operator's or project sponsor's internal technical standards for design, construction, operation and maintenance.

NOTE 2 The distinctions between requirements management, configuration management and change control can be misunderstood. Defining and separating the roles and responsibilities is therefore essential.

In requirements management, the focus is on stakeholders, their needs and requirements; in configuration management, the focus is on functional relations within an asset system or an element of a facility. In change control, the focus is on an effective process that links needs and requirements with functional relations to achieve and maintain performance of the asset.

- b) Commissioning, training and handover – the commissioning and handover of the asset should be supported by training to meet the needs of the operator, users and other key stakeholders (see [5.6](#) and [5.7](#)).
- c) Operations management – the SAMP or facilities management strategy, as appropriate, should be aligned with the owner's or operator's business strategy (see [5.1](#)).
- d) Information management – the management of information and its security should be efficient and effective in terms that are quantifiable.

4.5.2 Integrated project delivery

COMMENTARY ON 4.5.2

An integrated delivery team brings benefits in coordinating design and problem solving, as well as in determining constructability and operability impacts. A related principle is extending the commitment of each delivery team to defined periods of aftercare during operation and use (see [4.6.2](#)) as part of an extended project life cycle (see [5.7](#) and [5.8](#)). An integrated process and delivery team overcomes the potentially disjointed relationship between the process for delivering the asset (i.e. project management) and its operation (i.e. asset management or facilities management). A further advantage is that information management, using building information modelling, acts more effectively as an embedded set of coordinated procedures and practices.

A unified process of design, manufacture, construction and operation should be adopted for the project and be supported by an adequately resourced, integrated project team. The project team should be led by a project manager reporting to the owner, operator or project sponsor, as appropriate (see [4.2.4](#)).

NOTE The owner, operator or project sponsor might have a specific model in mind for operating the asset, which the operator will be expected to implement.

Where a target operating model is necessary to support the delivery of the owner's or operator's business strategy, requirements should be expressed in terms of the personnel, processes, data and technology required for this purpose as part of the SAMP or facilities management strategy.

4.5.3 Front-end loading

COMMENTARY ON 4.5.3

Front-end loading (FEL) focuses on those work stages that bring the project to a state of readiness for manufacture and construction. It is a process for addressing the robustness of the business case, developing the concept, determining its strategic fit, assessing the risks (threats and opportunities) and evaluating the project's feasibility. FEL aims to maximize the potential for success by committing appropriate resources to establish that the "right project has been selected". The front end of the project is where the greatest influence on the project and its outputs can be brought to bear. It is also the time during which expenditure is relatively low, typically representing around 3% to 5% of the total project cost. The quality of FEL is one of the most significant factors, if not the most significant, in determining project success. FEL typically comprises three phases: FEL-1, where the business case, overall feasibility and strategic fit of the potential investment are evaluated; FEL-2, where scope definition, alignment of stakeholder interests and scope, quality, time, cost and value trade-offs are determined; and FEL-3, where design is advanced to the point that technical design and execution planning are sufficient to move the project into manufacture and construction. FEL in these three phases maps directly to the