Department for Transport

UK ROADS LIAISON GROUP

BIM Better Information Management

guidance for INFRASTRUCTURE BODIES

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1 Introduction

This guide has been produced to help organisations, in the transport and infrastructure sectors, to get to grips with BIM and we start by defining what the BIM acronym means. The industry has been in discussion for a while about what the acronym BIM stands for, whether it is Building Information Modelling or Building Information Management, or some other variant. However, we believe that it is easiest to understand what it actually means for those who have been charged with 'doing BIM' for infrastructure, by adopting the following definition:

BIM = Better Information Management

The BIM revolution has arisen because the industry has realised that it does not manage its construction and asset information effectively, and does not make best use of emerging technologies that have been adopted by other industries. That said, it is worthy of note that BIM is not something completely new or different — many organisations are already undertaking elements of BIM including how they define, store and share information. BIM, in simple terms, is providing a formal framework for how organisations define, store, share and maintain their asset data — and this will enable them to maximise BIM's benefits by ensuring the right person has the right information, at the right time and in the right format. The challenges, complexities and cost of achieving this should not be underestimated — however the business benefits more than justify the effort.

In 2011 the UK Government published its Construction Strategy, which called for a profound change in the relationship between public authorities and the construction industry, to ensure that the Government consistently obtains a good deal and that the country has the social and economic infrastructure it needs for the long-term. In the wake of the Global Financial Crisis, the strategy set out the levers for achieving savings of at least 20% on typical capital expenditure costs and delivering higher quality built assets.

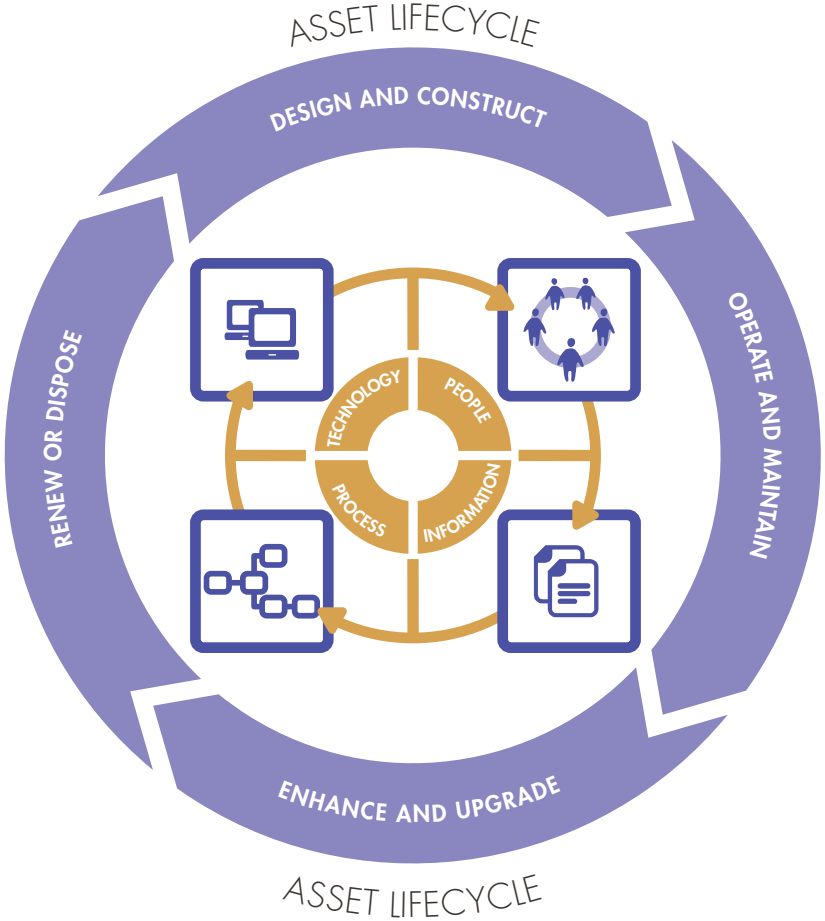


Figure 1.1 Visual explanation of the BIM scope in the context of the whole life of an asset.

This is to be achieved through a number of initiatives including the utilisation of BIM tools and processes — and in fact BIM is a key enabler for many of the other initiatives in the strategy. The Government has recently published its 2025 Construction Strategy, which aims to achieve savings in costs, delivery time and greenhouse emissions, and to increase export volumes for construction products and materials, as shown in Figure 1.2 below. BIM is a fundamental enabler to achieving these aims, and will assist in improving collaboration both within asset owning organisations and externally with supply chains, offering a more positive experience for employees and customers.

1.1 About this guide

This guide will assist asset owning organisations to plan and successfully implement BIM tools and processes, helping them to achieve the targets defined in the 2025 Construction Strategy. This guide first provides an overview for those seeking to understand what BIM means for assets. This is followed by a practical pathfinder on how to implement BIM, with a focus on the management of assets including the design, construct and operate phases.

This guide aims to provide practical guidance to introduce BIM to organisations as well as provide pointers on where to go for further guidance and assistance. Examples are used to illustrate how BIM has been implemented on different types of assets and within different businesses.

Figure 1.2 Targets set out in Government Construction 2025 Strategy. Source; HM Government, 2013.

We suggest that this guide is read from beginning to end. Upon reading the document to gain an overall understanding, you can use each chapter to specifically navigate any pillar of your BIM journey. Understanding as much about BIM before you embark on your journey is vital — reading this guide is a start and you should further build your knowledge by discussing BIM with other organisations and industry experts.

Figure 1.3 provides:

i) an overview of the information flows and demands throughout an organisation, and

ii) some of the benefits that can flow from managing these better. Namely the ability to extract the right information, at the right time, and in the right format to be able to run our organisations more efficiently.

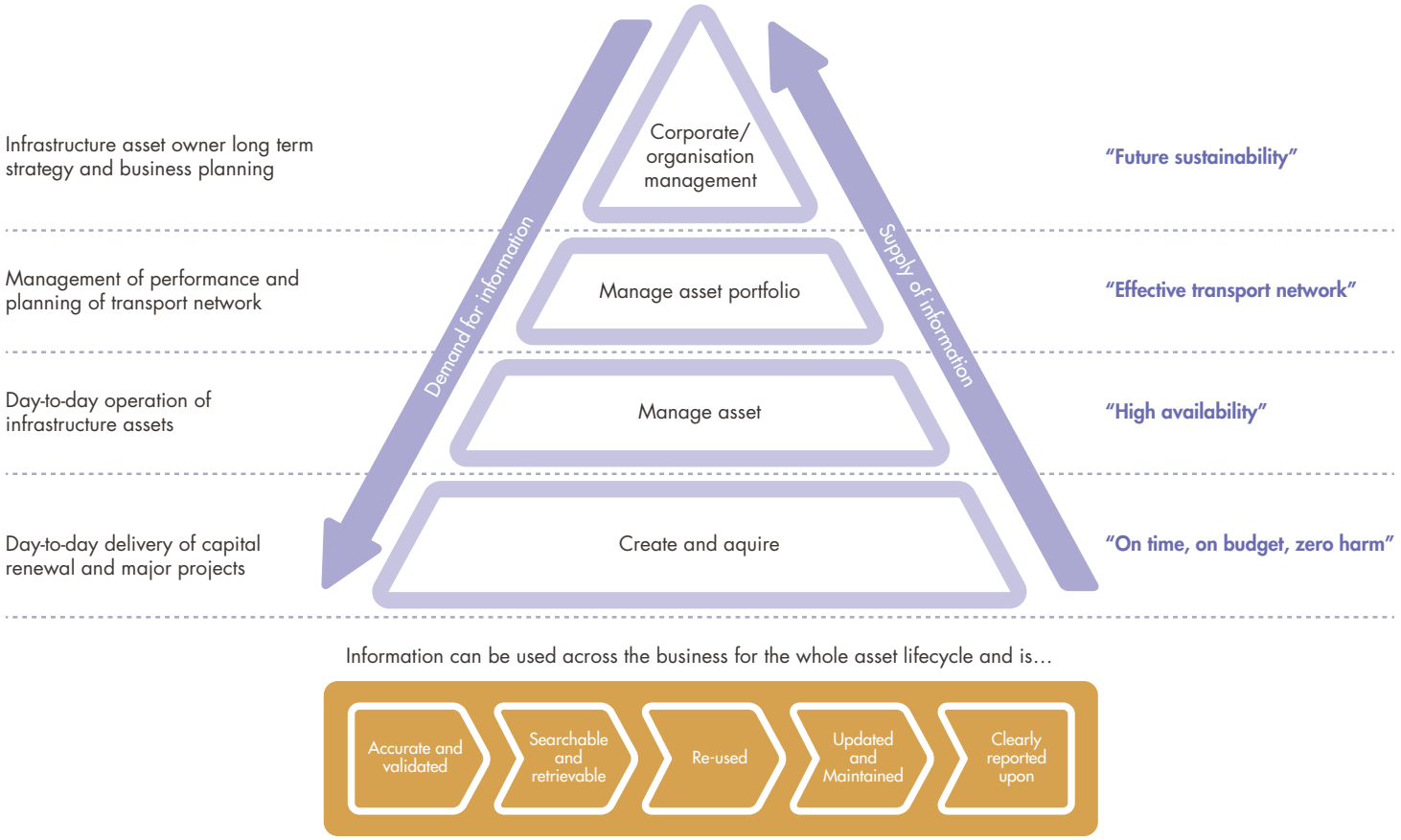


Figure 1.3 Overview of organisational information supply and demand, and benefits flowing from improved Information Management.

1.2 How to use this guide

Figure 1.4 shows the structure of this guidance document including the appendices which contain a number of 'pull-out' documents, such as check lists. These checklists can be used by individuals and in workshops for assessing what BIM means for your organisation. The figure also gives some points as to which sections of the guidance are more pertinent to the key BIM stakeholders within an organisation.

While this guidance has been tailored to asset owners, it is recommended they share and discuss it with advisors and suppliers before embarking upon their BIM journey. BIM is a large and complex subject and it is recommended that asset owners work together and possibly share or combine resources to avoid duplication of effort and to drive down BIM implementation costs.

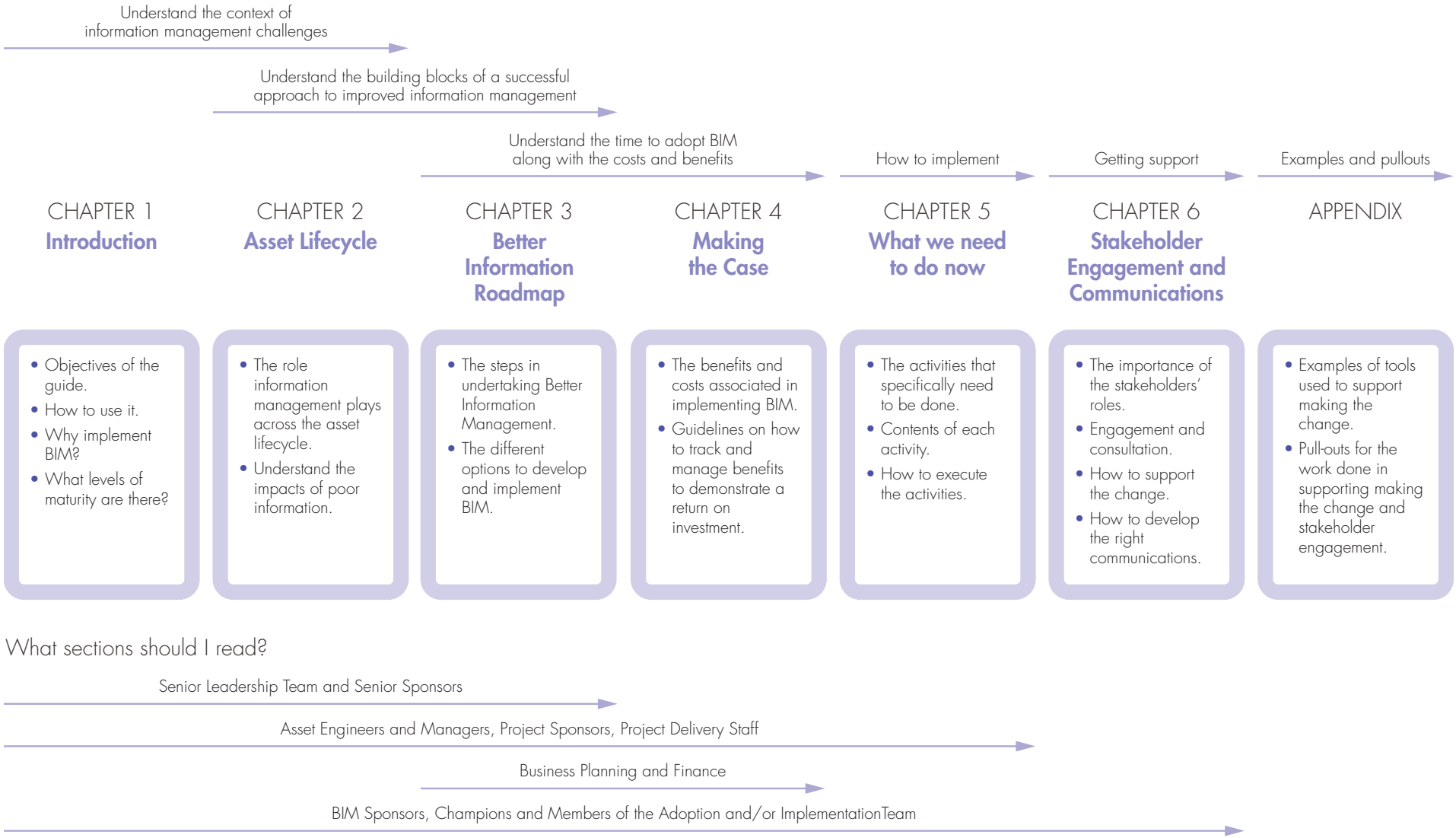


Figure 1.4 Document structure.

1.3 Why do we need to improve Information Management for infrastructure assets — what is BIM all about?

BIM means that we will be able to access the right information, at the right time and in the correct format, enabling better decision-making and delivering more efficient and effective asset activities, for example:

- Removing duplicate data collection and storage activities.
- Integrating and rationalising project and asset management information systems.
- Delivering better collaboration by enabling all stakeholders to readily share and work upon accurate and up-to-date information.
- Enabling opportunities to reduce capital and/or operational expenditure.
- Providing 3D and other visualisation tools that drive innovative approaches and enable risks to be identified and addressed pre-delivery.
- Reducing project lead times by streamlining sharing and workflow during feasibility and design.
- Providing remote access to asset information and removing the need for paper based documentation.
- Building a database of quality asset data (costs, interventions, materials and more) to inform optimum asset strategies and plans.
- Reducing supply chain risk because they can have greater confidence in the asset data.
- Reduced costs as a result of the automated transfer of accurate, complete and unambiguous information at asset handover and during transfer of operation from one service provider to another.
- Better awareness of liabilities and risk.
- Better awareness of the operational and maintenance needs of assets.
- Better decisions regarding operation and maintenance expenditure based on actual asset performance and status.
- Dynamic measurement and condition-sensing of assets enabling poor energy performance, faults and impending failure to be identified.
- Better organisational and strategic planning from more complete and accurate asset information.
- Better information quality as a result of automation, enabling an increased amount of verification.

1.4 Key requirements for BIM

Figure 1.5, right, illustrates some of the key requirements needed in order to successfully implement BIM in an organisation.

1.5 What does **Level 2 BIM** mean?

The Government's 2011 Construction Strategy, as discussed in Section 1.1, refers to the adoption of **Level 2 BIM**. Figure 1.6, over, describes the differences between the levels of BIM, as understood in the UK construction context. This graphic identifies the core components that make up **Level 2 BIM**. Depending upon the information challenges and targeted improvements being sought not all of the components may be applicable (denoted by an asterisk), such as cost and scheduling software. It may be appropriate to firstly achieve a **Level 1** capability rather than immediately targeting **Level 2**. If possible you should discuss this with organisations that have already started their BIM journey.

Strategy

The organisation needs to have a clear strategy of what is to be achieved from BIM defining the required capabilities and the benefits to be targeted.

Information Needs

Clear definition of information required and clear set of data and Information Standards to ensure consistent standards and interoperability of information.

Processes

What are the processes that need to be adopted to ensure BIM ?

People/Culture Change

Training and recruitment strategies.

Enabling Technology

What technologies are required to assist, and how will they be rolled out?

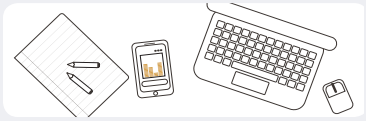
Transition to Business-as-Usual Process

Clearly defined benefits realisation plan.

Figure 1.5 Key requirements for BIM.

Level 0

Providing information in 2d drawings and documents



AUTHORING TOOLS

(for core data)

- Pen and paper
- Computer and 2d capable software

COLLABORATION TOOLS

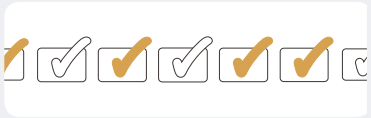
- Face-to-face
- File sharing through email

LIBRARIES

- Standard details and specifications

WAYS OF WORKING

- Isolated review and silo working



OUTPUT PRODUCED

- Paper drawings and documents
- Electronic drawings and documents
- Built asset information set

Figure 1.6 UK BIM Levels and what they involve.

Level 1

Providing information in 3d geometry models and documents

Computer and modelling

File sharing through website, e.g. FTP

Standard models, specifications, etc

3d geometry files

Level 2

Extracting and integrating data from model files

Cost/program software*

capable software

Controlled/automated collaborative online file management system

File-based and associated attributes, e.g. Parametrics

Business-wide engagement in defining client's requirements

Collaborative review of combined information and data sets

Semi-automated model validated and verified

Non-graphical data extracted and enhanced from models

Built asset information set and supporting data

Level 3

A database of the whole asset

Lifecycle/FM management software

Fabrication/manufacturing software

Online data management system

Standard graphical and non-graphical asset data from various models

Fully automated model validated and verified

Integrated graphical and non-graphical asset data from various models

Lifecycle data set and supporting information

2 Asset Lifecycle

The role Information Management plays across the asset lifecycle.

Understand the impacts of poor information.

2 Asset Lifecycle

Due to its origins within the construction industry BIM can often be viewed as **construction-specific** and something that is separate from the asset Lifecyle. In reality, BIM is applicable and can deliver benefits at all stages of the asset Lifecyle, from planning through delivery to operation, maintenance and asset decommission or renewal. BIM is not just for design teams it is for everyone involved in asset management.

BIM can enable things which are done today to be done more efficiently and effectively.

Example

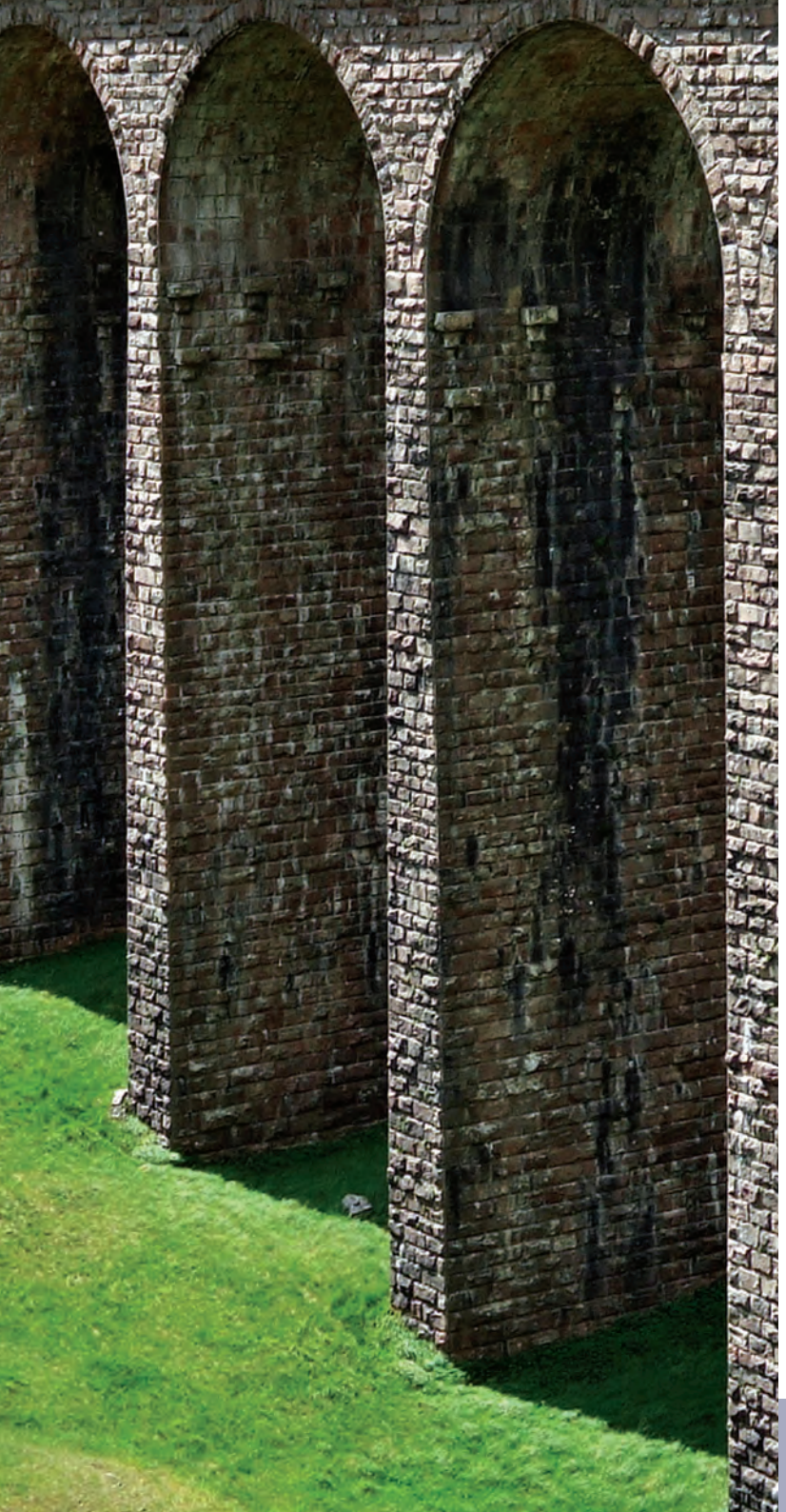
- First time finding of asset information and drawings making better use of staff time. In some instances this will also remove the need for a new survey of the asset.

BIM can also enable businesses to do things that they may find very difficult to do today more simply.

Example

- Bringing together data about underground assets such as services, with ground conditions, burst and leak history and weather conditions to gain insight in to how the assets are likely to degrade over time — this insight can be used to inform maintenance regimes and future capital investment needs.

There are clear and tangible, and frequently quoted. Benefits from BIM during the delivery phases of a project, however, many believe the far greater benefits lie in the asset Lifecyle. This is attributed to new assets and infrastructure being delivered through projects which have a defined and often short life, whereas the assets they deliver can be in use for hundreds of years and ongoing decisions made about them on a regular basis to ensure that they still perform their function.



2.1 Asset Management Process

To put this in to context, Figure 2.1 shows an example of a generic workflow for an Asset Management Process. This model represents both the strategic and tactical aspects of Asset Management and shows three core roles of Asset Owner, Asset Manager and Service Provider. The Service Provider in this context is either the in-house or supply chain asset maintainer. The accountabilities of each within the process can be simplified to Directing (Asset Owner), Planning (Asset Manager) and Doing (Service Provider).

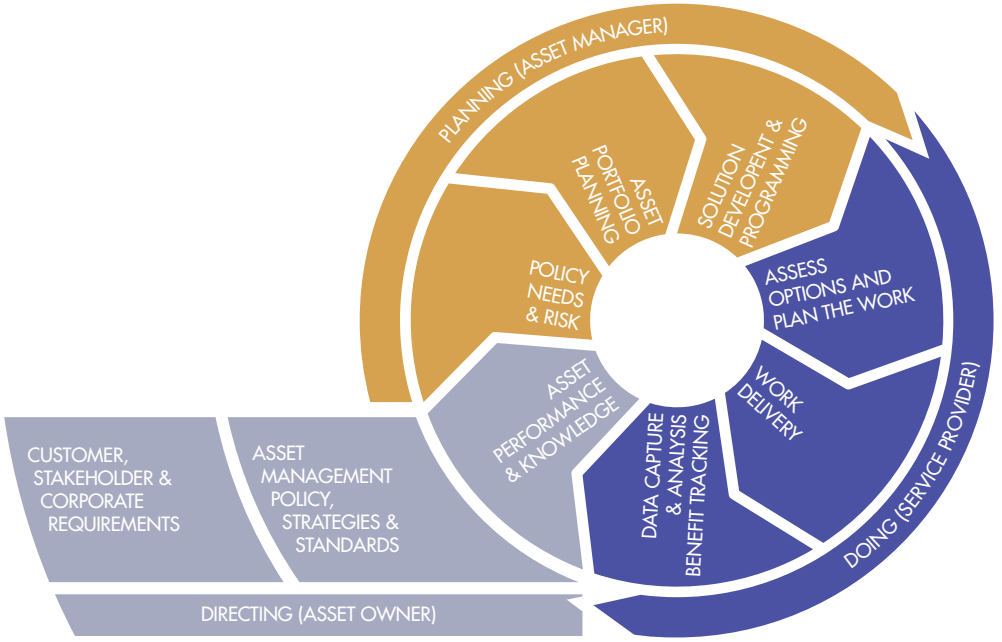


Figure 2.1 Example of a generic workflow for an Asset Management Process.

The accountabilities for each role are broadly as follows:

Directing — The Asset Owner

This role is accountable for understanding the corporate vision, desires and objectives and translating these into asset related objectives and performance requirements and using this to create Asset Management Policy, Strategy and Standards.

Planning — The Asset Manager Role

This role is accountable for understanding what the Asset Owner needs its assets to do, understanding and assessing the risks associated with current assets and identifying their specific needs for the future. From this, options are identified and investment plans prioritised and optimised to get the best value option for the business. As part of this, the Asset Manager is accountable for defining the work that will be done, whether this is to be a capex project or an opex funded maintenance activity. BIM processes and tools can be fully integrated with Asset Management Information Systems, delivering better quality data to the Asset Manager to support their planning and decision-making.

Doing — The Service Provider

This role(s) is/are accountable for delivery of work and activity in the Asset Management Plan. This may be day-to-day maintenance of assets to ensure they continue to perform at the required level, or large capital investment projects and programmes to introduce new or renew assets and infrastructure.

Within this process model the traditional world of BIM and construction falls within the service provider phase of the process, yet both the asset owner and asset manager roles require information about assets to enable them to formulate appropriate strategies and plans for the business. For this reason BIM is designed for the full lifecyle of an asset in that when everyone within the process uses the same language to describe assets and infrastructure and shares and manages information in a standard way life becomes much simpler.

So, the question for the asset owner and asset manager roles should be "What information do I need to know about the existing assets and infrastructure to enable me to perform my role effectively?" A secondary question would then be "Where does the information that I need get created and how do I know I can trust it?".

Take the example of an asset manager who has limited budget for renewing or refurbishing their infrastructure. How do they know where to invest that money to get the best return for their business? Being able to answer the following questions in Table 2.1 below will inform the asset manager, yet the information they need to do this comes from both the asset owner and the service providers.

What	Who
Which assets are critical to my business objectives? e.g. delivering great customer service	Asset Owner creates this information.
How many do I have?	Service Delivery Provider creates this information as part of projects.
Where are they?	Service Delivery Provider creates this information as part of projects.
What is an acceptable condition?	Asset Manager agrees the definition.
What condition are they in now?	Service Delivery Provider e.g. Operator/Maintenance Manager measures this.
How are they likely to degrade over time?	Manufacturers' literature from the Project Delivery Service Provider contains the design life, actual degradation over time is measured by the Operations and Maintenance Service Provider, and forecast demand over time is decided by the Asset Owner.
How much did they cost?	Service Delivery Provider creates this information as part of projects.
How much do they cost to maintain?	Service Delivery Provider, e.g. Operator/Maintenance Manager, measures this.

Table 2.1 Questions that will inform the asset manager.

BIM allows the information needed to answer questions, such as "If I have £1 to spend where should I spend it?", to be accessed easily from all of these different sources and for the recipient to know the degree to which it can be relied upon for decision-making.

2.2 Suppliers of information

To make Information Management work around the lifecyle the key is to understand who the creators and the users of information are and to encourage individuals to think of these as customer/supplier relationships. In asset organisations encouraging asset managers and asset owners to demand that the information they need is delivered as part of a project delivery process is a healthy step forwards. As described in Section 2.1, the asset management planning team could be the customers of information about the current condition of assets (which would be measured by the operations and maintenance team) as this would help them to make decisions about which assets should be replaced and when. The outcome of this decision would then inform a project to replace/renew certain assets, e.g. part of road pavement. This concept of interdependence between customer and suppliers of information is crucial.

2.3 Impacts of poor Information Management

Current business and asset working practices mean that asset owners and managers are likely to experience many data and information challenges. Table 2.2 provides some examples of the challenges that BIM can help to address are as follows.

Problem	Impact
Historic information is not available to support forward planning.	• Forward plans are based upon estimates and assumptions rather than accurate and up-to-date data, which results in plans which are not optimised. • Plans are difficult to substantiate when challenged.
The asset owner has not clearly defined the information that they need and in the format that they need it.	• The asset owner is not able to make informed decision. • The asset owner spends time and money gathering data to fill gaps. • The asset owner spends time and money converting information from one format to another.
The asset owner does not have visibility of information delivery and as a result does not have confidence that they will get what's needed.	• If information delivery is not planned then asset owner resources may not be available to validate and approve deliverables. • If information is delayed until the end of a project, there may be no time available to review information and some of it may not materialise at all.
Information is not captured consistently	• Information quality deteriorates. • Information/data cannot be transferred into downstream systems (without the need for cleansing) as it does not meet quality criteria. • Users find the information difficult to consume as the variations are distracting.
Information is not handed over smoothly from the Project to the Operations and Maintenance (O&M) team.	• Without the information, the O&M team may refuse to accept the assets resulting in additional costs and time for the project. • If information is delivered in large volumes, the O&M team may not have time to review and accept it. • The O&M team may work on assets delivered by the project without full knowledge and may open themselves up to Health and Safety risks.
Asset information, e.g. asset condition is not available to support risk-based maintenance planning.	• Maintenance planning resorts to traditional methods, e.g. time based maintenance, which results in unnecessary interventions. • Maintenance activities are carried out too early resulting in higher costs. • Maintenance activities are carried out too late resulting in increased risk to asset performance and service delivery.
Teams do not share information	• Individuals duplicate work as they do not know that something already exists. • Knowledge is not shared and different teams learn the same lessons at different times. • Third parties can receive conflicting information and this affects the confidence that they have in the infrastructure body and ultimately its reputation.

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Problem	Impact
Individuals don't know whether they can trust the information that exists	• Time and money are spent validating the information to understand how good it is. • Individuals keep their own copies of information, as they believe that they can trust this because it is under their control. • Individuals factor the uncertainty in information quality into their decision-making which leads to inflated costs and timescales for proposals. • Data is recollected.
Information is not available in a timely manner to allow decisions to be made.	• Poorly informed decisions are made. • Decisions are delayed whilst more information is gathered.
Inadequate information is delivered by suppliers	• The asset owner does not have the information needed to operate, maintain and develop assets. • The asset owner remains dependent upon the supplier when issues arise (as they have the knowledge) which results in increased costs. • If the asset owner does not have the information from the supplier, it can be difficult to change suppliers in the future.
IT prevents staff from being able to efficiently coordinate and exchange data and information with the supply chain.	• Information is not shared which leads to poorly coordinated designs and impacts negatively upon cost, time and quality of delivery. • Individuals find alternative methods for collaborating and sharing information, which are uncontrolled and may represent an information security risk.
Lack of ownership of information and data	• Because the data is not owned it is difficult to hold anyone accountable for it and hence drive quality improvement.
Data and information is stored in disparate disconnected systems and structured differently	• Time taken to search and retrieve key information from different systems. • Where data exists it is difficult to pull together as it is structured and described differently in the different systems
The information which is held does not meet legislative or regulatory requirements.	• Unable to pass information on to those who need it. • Potential prosecutions and fines.
Lack of understanding of the need to protect, and limit access to, sensitive built asset data and information	• Poor understanding and management of information about the location and/or properties of sensitive assets and systems, including those owned by third parties, can lead to information being revealed to people or organisations who do not do have a legitimate need-to-know, potentially compromising safety, security and resilience.

Table 2.2 Examples of the challenges that BIM can help to address.

To overcome these challenges information should become an integral part of the stages of the asset lifecycle. BIM supports the processes reflected in Figure 2.1 by ensuring that all relevant data and information flows within and across the different stages and amongst all parties are clearly defined, supported and governed. The parties involved define the data and information required and these requirements constitute the inputs used and the outputs produced in the relevant processes. Asset owners and asset managers, as with all other parties involved in asset management, need to define the information they need to deliver their processes. BIM enables the continuous and consistent tracking of this information, feeding decision-making throughout the asset lifecycle.

Indicative examples of integrated ways of working across the asset lifecycle are listed below.

- Holistic definition of data and information requirements: In establishing a project brief a holistic set of data and information requirements are defined which get reviewed and updated at key stages of a project. This includes ensuring that the asset manager defines the data and information requirements and standards required at end of the project.
- Sharing information across stages: Defined data and information is produced to defined standards and stored in a digital collaboration tool which can be accessed by the asset owners and asset managers as well as the project team providing continuous visibility of specific information required for the ongoing operation of the asset, e.g. possession planning.
- Asset managers input to the design process: The asset manager has an input to the design at key stages, using 3D models to ensure that engineering solution addresses the operation and maintenance requirements. Required design changes are resolved when the cost to change is low rather than identifying changes during the detailed design stage or during construction when the cost to change is high.
- Preserving information within a stage: As part of the concept design works for a new bridge, a decision is made around the selection of a specific type of suspension cable. The data and information around this decision is digitally preserved and is searchable to inform further detailed design works for the particular asset. Where defects and faults occur during the operation and maintenance an asset owner should not be required to rely on the knowledge of staff and searching through archive boxes to retrieve historic information. BIM practices mean that an asset owner will be able to digitally search for and retrieve data, information and decisions made about the entire lifecycle of an asset enabling quicker and better decision-making.
- Transferring information across stages: The defined data and information is progressively collected and assured during the delivery of the project. At the completion of construction delivery works and close out of a project there is a digital rather than an analogue (paper file) handover. The defined set of data and information, e.g. O&M Manual; H&S file, is handed over back to the asset owner and asset managers by the project managers. The data and information is provided in the prescribed format and can be uploaded into the asset management systems rather than having to re-key in data.

Some of the benefits that can be delivered by working in this way include:

- Easier access to information produced at each stage, ensuring visibility to all relevant parties when needed which saves time and money recreating information or taking decisions based on incomplete or inaccurate information.
- Removal of duplication and reduction of the risk of costly errors and misunderstandings as a result of information being produced in a co-ordinated, coherent and integrated way throughout the asset lifecyle.
- Accelerated decision-making based on verified and reliable information.
- De-risked delivery of projects through better quality data, improved co-ordination and less variation.

2.4 Building bocks of a successful approach to Information Management

A key part of making any approach to Information Management successful is building the understanding and connectedness of individuals around the lifecyle (customer and supplier). This is why it is necessary that any business improvement approach for Information Management does not jump to technology as the answer but considers the four key building blocks of Information, Processes, Technology and People, as depicted in Figure 2.2. These aspects of making better information a reality are covered in the following chapters in more detail.

Organisations adopting BIM can enable a series of opportunities across all asset lifecycle stages. Chapter 4 provides a comprehensive view on these opportunities broken down into the key elements of Information, Processes, Technology and People.

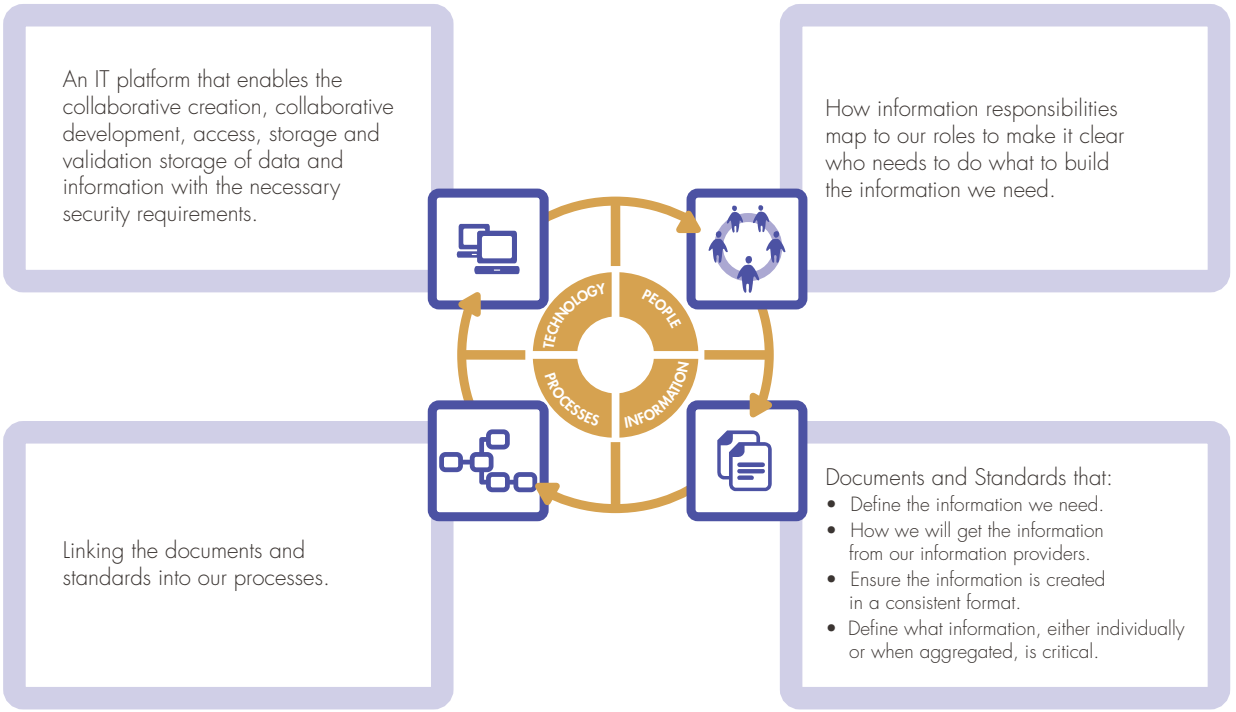


Figure 2.2 Building blocks of a successful approach to Information Management.


POTAIN

3 BIM Roadmap

The steps in undertaking BIM.

The different options to develop and implement BIM.

3 BIM Roadmap

In order to implement BIM practices, and any associated changes to business processes, procedures and systems that may be required, a logical programme of work needs to be undertaken.

By following a structured approach, the business challenges and needs will be clearly defined at the outset — against which solutions can be developed and implemented in order to achieve the required outcomes and deliver the benefits.

Figure 3.1, right, shows the typical steps taken by organisations when implementing a programme to deliver BIM.

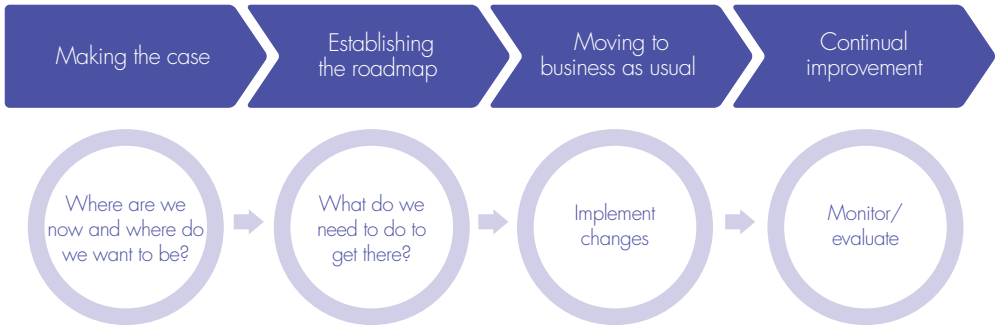


Figure 3.1 Steps typically followed in implementing BIM processes and technologies.

The following sections provide an explanation of each step of the programme.

3.1 Making the (Business) Case — where are we now and where do we want to be?

This stage is a discovery or information gathering phase. Its purpose is to identify the current information challenges and blockages that the organisation is experiencing and to identify how BIM can alleviate them.

Stakeholders across the organisation, and ideally across the supply chain, need to be engaged to identify and discuss the challenges and blockages. In order to do this, it is imperative to:

- Identify stakeholders and plan their engagement.
- Develop communication material so stakeholders get a consistent message regarding the overall vision, focusing upon the needs and targeted benefits.
- Consider the provision of awareness training on what is being undertaken and why.

Through focus interviews, workshops and questionnaires key points can be gathered about information challenges, risks and blockages throughout the asset lifecycle from planning, design, delivery and management and operation of the asset. Through analysing the information gathered themes of challenges can be identified and used in communications with stakeholders responding to real challenges and frustrations to support the case for change.

The findings from the stakeholder engagement should be well documented as it will be valuable reference material throughout BIM implementation, and it will inform the development of the vision (where do we want to be?) and the supporting business case.

Typically the business case is developed in stages, starting with feasibility stage as described under to identify the high level cost and benefits. On completion of concept design a detailed understanding of the implementation strategy, activities, costs and benefits should have been worked out to finalise and apply for approval of the programme business case. On approval of the business case and anticipated qualitative and quantitative benefits, development of the new tools and implementation can commence.

The next step is to identify where the organisation wants to be, in terms of improved efficiency and Information Management. What obstacles (identified in the initial discovery phase) need removing? What will the benefits to the organisation be, e.g. in terms of time and cost savings and improved staff morale and customer experience? This information can be used to create an initial business case to attract funding in order to undertake a feasibility study of the benefits of implementing BIM in the business. The business case would include a roadmap with an assessment of the costs, risks and monetised benefits to demonstrate a return on investment. Consideration should be given as to how benefits are going to be measured — how will the organisation know that the promised benefits have been achieved?

The following table provides a simple guide to assess your organisation's current maturity. The maturity may vary across asset groups and hence two columns have been provided, one for best practice within the organisation and one for general capability. All items will require a tick against them in order to confirm that the organisation is working at a particular level. Many asset owners are still at Level 0. A copy of this table along with a more detailed Level 2 BIM maturity assessment tool is provided in Appendix 1.

Level	Criteria	Requirements	Best practice within the organisation	General Capability
0	Design information produced in 2d drawings and documents	✔		
	Have documented Information Standards complying with BS 1192:2007 and BS 7000-4:2013	✔		
	Have a system to manage electronic documents and drawings with appropriate security controls in place	✔		
	Have a system to manage the exchange of information with appropriate security controls in place	✔		
	Staff and supply chain are trained and have a capability to achieve the Level 0 maturity requirements	✔		
1	Design information produced from 3d/2d (used where there is insufficient value in using 3d) models and documents. Drawings are produced from the models	✔		
	Asset data where specified is collated in documents as 3d/2d models do not have structured data	✔		
	Have documented Information Standards complying with BS 1192:2007 and BS 7000-4:2013	✔		
	Have a system to manage electronic documents and drawings with appropriate security controls in place	✔		
	Have a system to manage the exchange of information using file sharing systems with appropriate security controls in place	✔		
	Staff and supply chain are trained and have a capability to achieve the Level 1 maturity requirements	✔		

Level	Criteria	Requirements	Best practice within the organisation	General Capability
2	Business wide engagement in defining information requirements covering the whole asset lifecycle with Employers Information Requirements issued for projects and Asset Information Requirements issued for the operation and maintenance of assets	✔		
	Design information produced from 3d/2d (used where there is insufficient value in using 3d) models and documents. Models are produced using objects to which data is attributed in line with the information requirements. Drawings are produced from the models	✔		
	Non-graphical data is extracted and enhanced from models.	✔		
	Have documented Information Standards including model and data validation and verification complying with BS 1192:2007 and BS 7000-4:2013, PAS 1192-2, PAS 1192-3, BS 1192-4 and PAS 1192-5	✔		
	Have a system to manage electronic documents and drawings focused on a collaborative digital review of combined information and data sets with appropriate security controls in place	✔		
	Have a system to manage the exchange of information using a controlled collaborative online file management system with appropriate security controls in place	✔		
	Staff and supply chain are trained and have a capability to achieve the Level 2 maturity requirements	✔		

Table 3.1 Maturity Assessment Tool

Chapter 4 provides more information on how to develop the business case.

3.2 Establishing the Roadmap — what do we need to do to get there?

The purpose of this stage is to undertake enough work to develop a detailed implementation strategy. The key activities that we recommend are undertaken:

- Establish the required asset, project, organisational and security information requirements.
- Assess suitability of existing Information Standards.
- Assess the requirements in terms of enabling technology to support adopting BIM.
- Assess the impact of adopting BIM in terms of staff and suppliers.
- Maintain effective communications across the business to keep up awareness of the vision and targeted benefits.
- Deliver awareness training to stakeholders who need to be engaged in the development of the implementation strategy.
- Use findings about information challenges, blockages and opportunities to re-affirm the need for adopting BIM and incorporate these into communications material and the business case.

The activities above will form the basis of the implementation strategy.

At the end of the concept design the information gathered should allow the team to produce the business case and confirm the anticipated benefits and costs. Sufficient knowledge should have been gained to enable a detailed breakdown of costs and benefits along with a programme to enable the organisation to secure funding approval for the remainder of the programme. The business case should detail how the defined benefits are to be measured.

Sections 4 and 5 provide further details on how to develop the Business Case and create an implementation plan.

3.3 Moving towards Business-as-Usual — implementing changes

The purpose of this stage is to deliver all activities required to enable the adoption of the new ways of working. This includes:

- Production of Employer's Information Requirements template and the associated definitions of the Digital Plan of Work (dPoW).
- Production of, where appropriate, a Built Asset Security Strategy (BASS) and Built Asset Security Management Plan (BASMP).
- Production of Information Standards.
- Re-engineering of business processes.
- Procurement and delivery of the enabling technology.
- Amendments to roles and responsibilities.
- Production of training material.
- Amendments to procurement and commercial tools, processes and procedures.
- Amendments to contracts.

In line with the previous stages, it is important to maintain effective communications. Depending upon the size of the organisation, it may be appropriate to identify and engage a number of staff from across the business to become champions to support the drive and awareness of the project within their respective areas. Champions should receive early training so they have sufficient knowledge to engage with the programme and disseminate details to other staff. - 6 provides some guidance on Stakeholder Management and specifically the role of champions.

3.3.1 Early Adopters

To ensure the newly developed tools and ways of working are user-friendly, effective and deliver the anticipated outputs a period of testing should be introduced. This would typically include the consideration of using early adopter projects to validate the new methods of working and better understand the impact of implementation on business-as-usual. Lessons learned should be captured and addressed prior to rolling out BIM more widely. In selecting early adopter projects it is necessary to assess whether they will enable new ways of working to be tested within the durations required by the implementation plan. For example, if a one-year early adopter period is selected the projects must have at least one phase that starts and completes within the period — such as concept design.

In order to identify suitable projects, four main areas (as shown right) need to be considered, tested and confirmed, in order to ensure the correct projects are being selected for testing the tools and new ways of working.

Using Asset Class as a selection criteria will help ensure the selected projects are representative of the assets and varying levels of complexity in the organisation. A mix of Programme Types will ensure that the tools are being tested for a range of business processes, forms of contract and teams, while Project Gate ensures testing in different phases of a project or programme. It is pertinent to check how reliable the planned gates and milestones are at time of selection, as well as whether the project is likely to be able to deal with some level of disruption. The Contract Expiry date, will confirm whether a change of supplier is expected and when, where the Level of Spend will ensure a selection of small, medium and large projects.

An assessment is required to confirm which tools, new ways of working and other items require to be tested by early adopter projects. The broad categories, or workstreams, which most BIM products and deliverables can be grouped under are listed in Section 2 of Figure 3.2, right. Projects which represent an opportunity for testing a good sample of these products are preferable.

1 Selection criteria

Set criteria to choose the most appropriate early adopter projects:

- Asset class.
- Programme type (Capex, Opex, Capital Renewals).
- Stage Gate that a project is in.
- Contract expiry date.
- Level of spend of the project.

2 Products to be tested

BIM Workstreams that will develop and test products using the early adopters, for example:

- Information.
- Common Data Environment (CDE).
- Business Mobilisation.
- Process Change.
- Benefits Realisation.

3 Additional considerations

Should be considered for each project:

- Number of people in early adopter team.
- Pace of project moving through gates.
- Impact on benefits.
- Level of engagement into BIM.
- Number of suppliers involved.

4 Assumptions

Basic assumptions:

- Implementation plan timelines should align with early adopter project.
- Confirm availability of CDE supporting technology.
- Confirm duration of testing period of the CDE.

Figure 3.2 Tool to select early adopter projects

There are other considerations to take into account when assessing which projects will provide a good testing environment and provide valuable feedback. Teams of projects should not be too small and incorporate a good representation of different roles, to ensure a comprehensive mix of feedback within the testing period. It is essential that the projects can evidence some of the anticipated benefits the programme is looking to deliver, this will support and give confidence in the business case. Success is often dependent upon the commitment and awareness of all stakeholders, to support this we suggest confining early testing to areas that will actively champion BIM. Testing should also include the supply chain, possibly inviting them to engage with the development of the tools to test if the new processes and tools work for them.

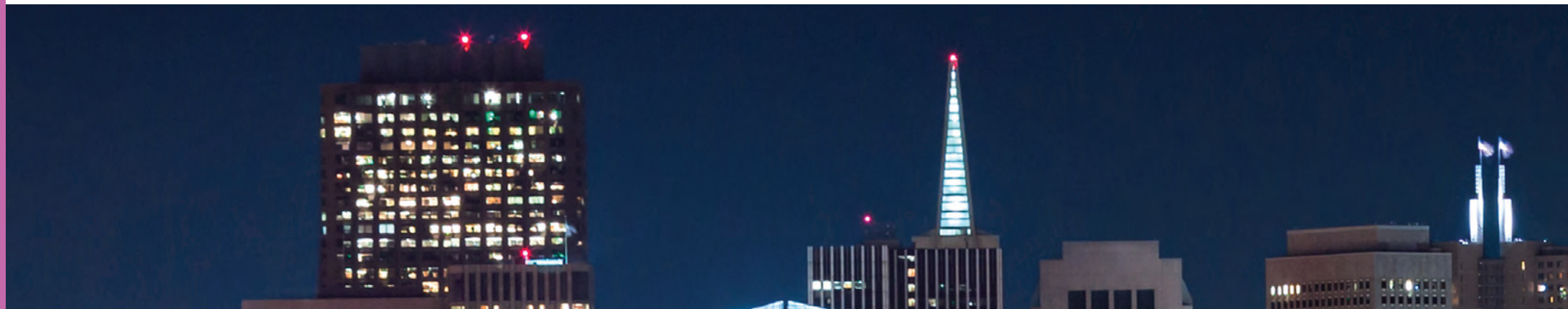
The fourth area in Figure 3.2, Assumptions, ensures that the plans align and timescales work. Continuous checking of the selected schemes is necessary as they may encounter delays or acceleration, which might mean the preferred projects are no-longer suitable.

3.3.2 Wider business implementation

The wider implementation of BIM builds upon the work undertaken on the early adopter projects. Depending upon the size of organisation and complexity of the supply chain, the implementation is likely to be undertaken in a phased approach, for example by discipline such as highways or structures. For a smaller organisation, it may be feasible to require all new projects to be undertaken in accordance with the new methods of working from a set date. As these projects are completed and the assets are handed over to operation and maintenance BIM may then be implemented to the asset management activities.

Prior to commencing implementation, it is important that all of the enabling technology is fully available so that there is a single training programme and that staff, along with suppliers, can quickly see the benefits of the new way of working. This will reinforce the adoption of BIM.

Where an external organisation has been used to support the delivery of the programme it is key that there is a team of individuals who will take over the ownership of the standards, templates and training materials and who are capable of providing support during the implementation stage. This is to ensure that governance is applied to ensure compliance with the new ways of working along with providing support and driving a programme of continual improvement.



3.4 Benefits realisation and continual improvement — monitoring and evaluating

This phase includes activities related to embedding BIM so that it becomes business-as-usual and that support structures are in place to ensure that the new ways of working are followed. A programme of lessons learned, commenced during the early adopter projects, should be continued so that challenges that arise to the new ways of working are addressed.

As the new ways of working become business-as-usual, a programme of measurement of the required benefits needs to be undertaken, not only to justify the programme expenditure but also to drive continual improvement. Chapter 4 provides guidance on establishing the business case for a BIM programme.

3.5 Example Roadmaps

The following are three roadmap options that an asset owner could undertake. More detail can be seen in Figures 3.3 and 3.4.

Option 1 Use Level 2 on early adopter project(s) to explore the benefits and challenges of adopting Level 2 ways of working. This will provide the business with insight and understanding of the effort involved, appetite of the people and start to build organisational capability for wider implementation across the business.

Option 2 Achieve Level 1 capability first, capture learning before looking to make the case of progressing to Level 2 ways of working.

Option 3 Achieve Level 2 capability — if option 3 is being considered the asset owner should firstly engage with industry peers to capture learning from their adoption of Level 2 ways of working.

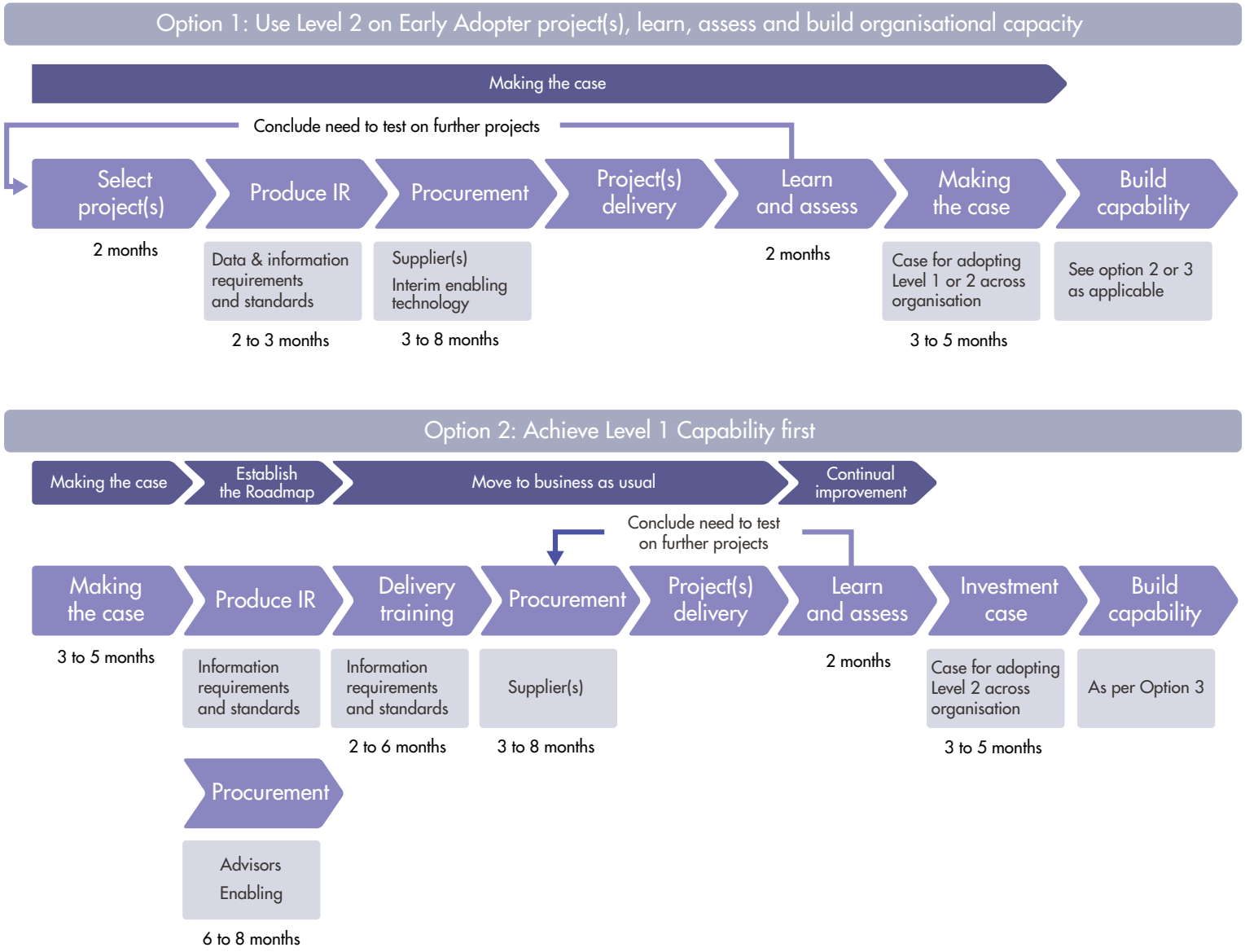


Figure 3.3 Option 1 and 2 Roadmaps

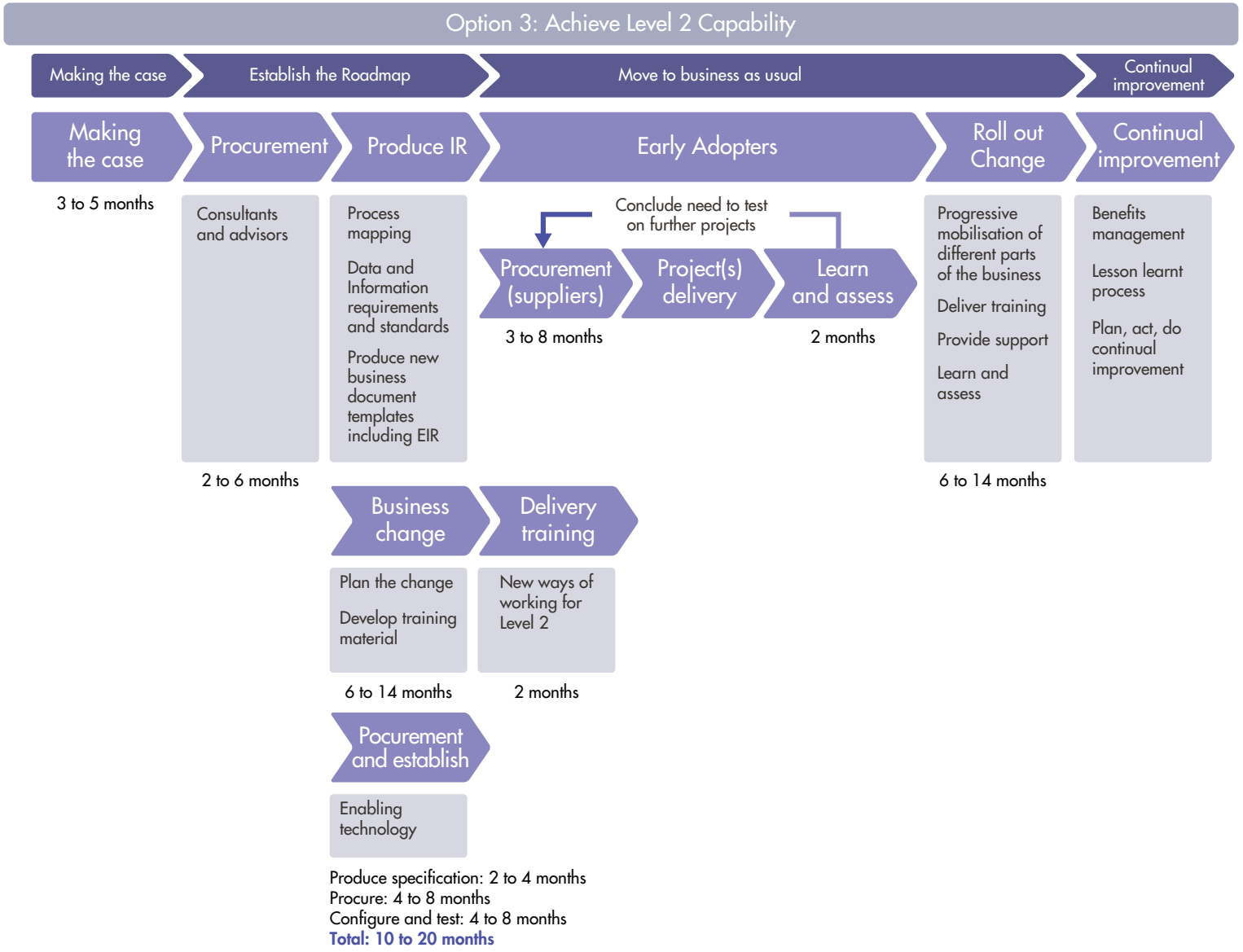


Figure 3.4 Option 3 Roadmap


MIND THE GAP

4 Making the Case

The benefits and costs associated in implementing BIM.

Guidelines on how to track and manage benefits to demonstrate a return on investment.

4 Making the Case

The following chapter explains the methods of assessing the challenges associated with BIM adoption and mitigating the impact and maximising the opportunity associated with the programme. It provides examples of the methods to mobilise the organisation and relevant stakeholders and build support for the change internally.

The chapter also provides a context for the business case and Benefits Management strategy. The business case will validate the investment in the adoption of BIM and determine the means of assessing the options available and the costs, benefits and risks associated with each.

4.1 Assessing the current challenges and determining opportunities

As discussed in Section 3.1, the first step towards adopting BIM is the discovery phase (where are we now?) where information challenges and blockages are identified. Alongside the information challenges and blockages identified, as part of the discovery phase, the organisation should identify the opportunities that BIM could yield. This includes opportunities across Information, People, Processes and Technology elements of the organisation. The specific opportunities identified will constitute the objectives forming part of the initial business case. Some of the typical challenges, impacts and opportunities that can arise in Information Management are listed in Table 4.1.

	Challenges/Hurdles	Impact	Opportunity
Information	Lack of definition of information requirements for asset management and projects.	Over or under procurement of information to a defined level of detail. Decisions need to be made on potential and incomplete information set.	• Clearly defined information requirements including when and how information will be provided in order to improve confidence that data provided is complete and accurate. • Clear demonstration of how the asset owner's requirements have been met navigating through digital models.
	Lack of understanding of the need to protect, and limit access to, sensitive built asset data and information.	Poor understanding and management of information about the location and/or properties of sensitive assets and systems, including those owned by third parties, can lead to information being revealed to people or organisations who do not have a legitimate need-to-know, potentially compromising safety, security and resilience.	• Appropriate and proportionate security information requirements will help to protect the safety and security of: users of the built asset and its services; the built asset itself; asset information; and the benefits the built asset seeks to deliver. • Measures can also help to protect intellectual property and commercial information.
	Differing Information Standards exist across the business.	Information cannot be searched for and/or re-used.	• Better commercial information recorded (costs, risks, supplier data) to assist with project forward planning will enable better decision-making.
	Failure to clearly communicate the information requirements internally either within a business unit or across the business and/or externally to the supply chain.	Business does not create and/or receive the information required to make effective and informed decisions regarding assets and projects.	• Up-to-date asset data based upon regular inspections. • Correct and complete data received at project close and hand-over to asset owner. • Improved operational plans and forecasts.
People	Team work in silos.	Inefficiencies partly due to duplication in effort.	• Collaboration, early stakeholder engagement and clear/ concise outcomes agreed. • Improved accountability for information collection and accuracy.
	Organisational structures, IT systems and/ or commercial arrangements do not support collaborative working.	Inefficiencies partly due to duplication in effort.	• Effective utilisation of resources.

Table 4.1 A structured approach helps to identify the addressable costs for the quantifiable benefits

	Challenges/Hurdles	Impact	Opportunity
Processes	Lack of processes and/or resources to check completeness of information when delivered by the supply chain.	Additional cost and time to collect missing information. Business does not have validated and verified information to operate assets and manage projects. If information is not trusted further expense is incurred to recollect data.	Integrated and coherent processes to enable information flow among all relevant parties throughout asset lifecycle. Ensure using information and lessons learned from previous projects are a clear requirement at the outset. Enable more targeted business cases due to better scope based on information available.
	Lack of clear roles and responsibilities with regards to information production, receipt, storage and use.	Additional cost and time to collect missing information. Sensitive information may be accessible by those without a genuine need to know and/or not accessible to those most in need of the information.	Redefine roles and responsibilities of staff and suppliers with regards to information production, receipt, storage and use.
Technology	No common place to store asset and/or project information.	Information cannot be searched for/located so is recreated.	Common Data Environment established which complies with BS 1192 and ensures a management of Information Standards, version control, security control and workflow Data is searchable and retrievable across different assets.
	Network drives are not managed.	Version history not maintained. Quality of stored information difficult to verify so may not be trusted. Information cannot be located.	An auditable and tracked record of file history and source information is available to the organisation.
	Information exchange is via email, USB sticks, DVDs, etc.	Information potentially not stored. No quality procedures deployed to validate, verify and, where appropriate, secure information.	Technology is used to exchange information in a managed and controlled way.

An example of the challenges and opportunities identified during TfL's BIM programme has been included in Appendix 2 of this document.

4.2 Building the Case

Example roadmaps were presented in Section 3.5. Having selected and/or developed a roadmap that suits the needs of the organisation, when developing the business case, it's important to take a two-way approach.

1 Top-down approach — achieving the **big picture**

It is important to have an overall picture, or vision, of where the organisation wants to go, and how BIM can assist in realising that vision. To create this, it can help to research into what comparable organisations and industries approach and activities. Also give due consideration to the organisation's strategic goals and drivers and the ways that BIM can help achieve these. This approach can also provide benchmark rates on costs, benefits and risks and the methods to measure the return on investment. Having a clear vision for the BIM programme will be very helpful when communicating to employees.

2 Bottom-up approach — engaging at all levels

The bottom-up approach involves identifying the existing arrangements and business needs within the organisation and building up goodwill towards the BIM programme at all staff levels.

One of the primary aims of this approach is to understand the current position in terms of Information Management. This typically involves working with the team(s) to identify the challenges and opportunities they face relating to Information Management. This can be completed, for example, through interviews and/or task observation.

Typical activities at this stage include:

- Identifying consistent or high-impact issues, or opportunities to derive major business benefits.
- Assessing the level of Information Management maturity across the organisation to determine gaps for improvement.
- Utilising the information to develop a core set of business needs and wider business case.

The development of the business case will generate a list of constraints, dependencies and assumptions made. These need to be clearly captured, defined and tracked throughout the adoption of BIM practices. It is important to communicate these to stakeholders across the organisation.

4.3 Mobilising the organisation

Adopting better information practices usually require changes in the existing ways of working and across all levels of an organisation. Consideration should be given to an effective mobilisation process which includes early engagement of stakeholders. By involving stakeholders early in the mobilisation process, the opportunity to persuade them that BIM is required and demonstrate that it will lead to better outcomes for all helps to gain momentum and support. This is more persuasive than relying purely upon the presentation of a solid business case.

Ways of working that are typically amended and improved when implementing BIM include:

- Processes: see Section 5.1.6.
- Using new Information Standards: see Section 5.1.7.
- Using new technology: see Section 5.2.
- Commercial and legal: see Section 5.3.3.

Extensive consultation across the organisation, its supply chain and external stakeholders is required. It is important to use this opportunity to build a community of champions, who will support the case for adopting BIM practices. This approach can prove highly successful not only for embedding BIM but also sustaining it. Consideration should be given to the identification of the right stakeholders to lead this process, i.e. people in the areas where the programme impacts, who are influential both within the business as well as to external stakeholders, who are willing to test and help grow support for the new ways of working and help in the early identification of resistance. These champions will help to manage the inevitable ambiguity and uncertainty associated with implementing new ways of working. The champions identified can have a powerful emotional and political impact on generating buy-in across the organisation at an early stage.

Maintaining momentum during long periods of implementation is one of the greatest challenges in adopting BIM. This requires consistent energy and enthusiasm, and regularly reminding stakeholders across the organisation of the benefits that lie ahead. Setting up a robust communications plan aligned to the successes, benefits and milestones of adopting BIM can contribute to effective engagement and mobilisation.

4.4 BIM Business Case and Benefits

The business case articulates the justification for investment in the project. It evaluates the benefits, costs and risks of the various project options, and provides a recommendation of and rationale for the preferred solution. The purpose of the business case is to obtain approval and gain management commitment for the project and the investment. The business case is owned by the project sponsor. It is a live document and should be updated at key project milestones, such as approval gateways, and in response to project changes.

Alongside the justification and the strategic rationale for the project, the business case provides a framework for informed decision-making. It enables improved planning and management of the project and the subsequent Benefits Management strategy. The business case is an evidence-based evaluation of the benefits, costs and risks of a solution to a need, problem or opportunity identified by the sponsor and approved by the funding organisation.

Given the level of innovation and business change required to deliver BIM, it is important that the Benefits Management strategy, including an outline plan for the realisation of benefits, is defined within the business case. The business case must clearly articulate the balance between the benefits sought and the costs and risks of achieving those benefits. The benefits should relate to the level of risk and the cost of the project that the organisation is willing to accept.

It is envisaged that each organisation will have a template business case, or approval paper, that will need to be adopted.

4.4.1 Business Case example

For a business case to be effective and for it to prove useful beyond the approved solution and funding of the investment it should seek to address a number of topics. A recommended BIM business case contains the following sections:

- A high level description of the project scope.
- Context — the rationale and need for the project.
- Scope of the BIM programme and range of options.
- Constraints and dependencies.
- Benefits Management strategy and plan for realisation.
- Risks.
- The estimated capital and operating costs.
- An evaluation of options, including the 'do nothing' option.
- The target schedule.
- Investment appraisal.
- Key assumptions used.
- Dependencies and constraints affecting the project.
- Project success criteria including Key Performance Indicators (KPIs).
- The impact of the project on business-as-usual operations.

In order to demonstrate value for money and the continuing viability of the business case, it is good practice to evaluate more than one viable alternative solution and compare the benefits forecast to be delivered by each solution. This information should run through the business case, with the alternative options defined in the 'Scope of the BIM programme' and evaluated in the 'An evaluation of options, including the 'do-nothing' option. Investment appraisal techniques such as payback, internal rate of return (IRR), discounted cash flow (DCF) and net present value (NPV) may be used within this evaluation process to provide a like-for-like comparison of options.

4.4.2 Costs

The costs that need to be considered and presented in the business case include:

- Capital costs
  - Internal project staff costs including internal implementation team used within the project phase.
  - External consultancy costs.
  - Capital cost of enabling technology and any integration with existing systems.
  - Overhead costs such as office space for project team.
- Operational costs
  - Ongoing internal staff costs for implementation team to drive and support the update of the new ways of working and also lead the continual improvement programme.
  - Ongoing enabling technology costs.
  - Technology refresh costs typically 5 year cycles.

4.4.3 Constraints and Dependencies

Constraints are likely to include:

- Time to procure, implement, test and deliver a programme of training for the Common Data Environment (CDE).
- Capability of the supply chain.
- Timing of other internal initiatives and/or projects such as IT upgrades and enhancements.

A typical BIM adoption programme could take up to 3 years to fully implement. The CDE, as an example component of the programme, is likely to take up to 18 months to procure, implement, test and then roll out a programme of training for the CDE. If an open dialogue with tenderers is the preferred procurement route then this activity is likely to take up to 24 months. The provision of the CDE is one of the enablers required to support the new ways of working and hence impacts on the timing of implementation and the start of the realisation of the benefits.

The design of a programme of work to deliver BIM is important. It needs to identify the critical path which is likely to run through the information requirements and standards workstreams. These workstreams provide an input to the technology requirements and will therefore determine the start date and process of procuring the enabling technology. A further constraint on the procurement activities and start dates will be the organisations project gateway process.

An additional constraint will be the capability of the supply chain. This has an impact on the level of cost to train and up-skill the supply chain. It also has an impact on the assessment of when benefits will start to be realised and when the BIM maturity level is achieved.

It is important that the business case identifies where there are dependencies on other internal initiatives and projects and how the dependencies are to be managed and reported. For example the technology solution may be dependent upon another IT project delivery to enable it to deliver the full capabilities and benefits for the business.

4.4.4 Benefits

A key task in developing the business case is to build the Benefits Management strategy and plan for realisation. This is likely to include a blend of qualitative and quantitative benefits. Figure 4.1, right, shows a process which can be used to identify the benefit themes. A number of the benefit themes can be derived from assessments of the current status of Information Management, blockages, time lost through poor access to information or inadequate information, etc. A risk assessment should also be carried out as part of a cost/benefit analysis.

In defining benefits, it is useful to bear in mind the SMART mnemonic. Benefits should be:

- **Specific** (What is to be achieved, and who is responsible for achieving it?).
- **Measurable** (How will we know it has been achieved/how will we measure it?).
- **Attainable** (It must be achievable, within the time limits set.).
- **Realistic.** (Remembering the change is likely to be achieved in gradual steps rather than wholesale.).
- **Timely** (It is usually best to set both shorter and longer timeframe goals for improvement, e.g. 1-year, 2-year, 5+ year.).

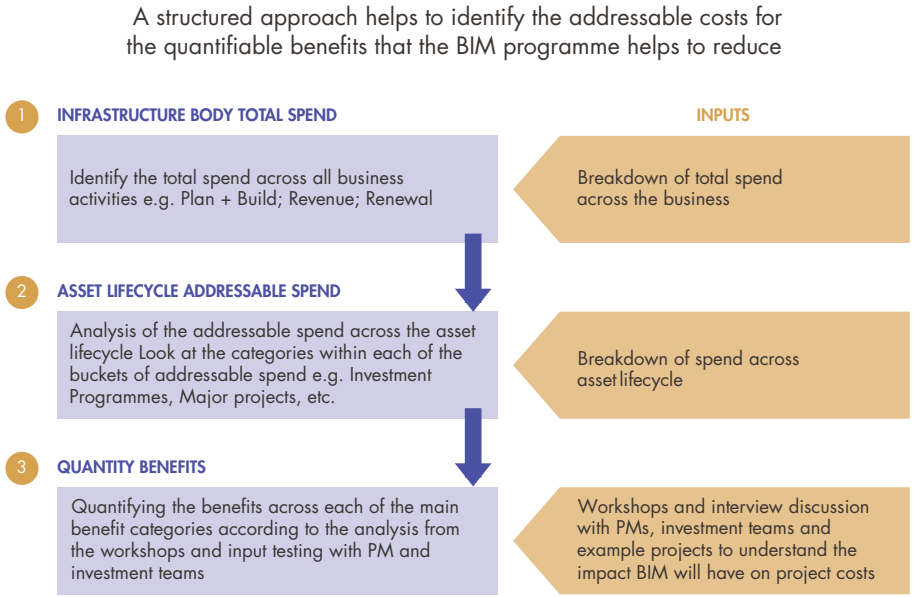


Figure 4.1 A structured approach helps to identify the addressable costs for the quantifiable benefits.

Using the process shown in Figure 4.1, the following table provides potential benefit themes and outcomes that may be considered in developing the business case.

Benefit Theme	Outcome
Reduce capital project risks	• Improved surety over programmes and reduced design iterations. • Enhanced ability to identify clashes pre-construction reduces risks and avoids unnecessary costs or delays. • Reduced level of project risk and contingency can release funds for use by the business (deliver 'more for the same'). • Greater ability for asset teams to review and validate design decisions.
Reduce the length of delivery programmes	• Reduced risk of delay at project gates and approval points. • Less disruption to the network and customers during the delivery of construction projects. • A shorter programme timeframe will reduce projects costs.
Improved supply chain management	• Greater leverage of supply chain data management capabilities. • Greater transparency on works progress and supply chain performance. • More effective scheme closure and handover.
Improve asset data quality	• Improved asset knowledge and reporting. • Routine updating of asset data throughout asset lifecycle. • A more accurate evidence base to support design and operational decisions.
Improve information and data security	• Reduced risk of loss or disclosure of sensitive information which could impact on asset safety, security and resilience. • Reduced risk of the loss, theft or disclosure of commercial information and intellectual property. • Reduced risk of incidents which lead to reputational damage and associated costs as well as disruption of day-to-day activities.
Reduce the whole life costs of asset data management	• Removal of waste and rework, for example, by data being automatically transferred from one system to another at transfer and handover points. • Removal of data duplication or recollection costs.
Improve information sharing and collaboration	• Common standards, format and requirements relating to data collection and storage. • Reduction of data silos within the business. • Lessons learned transferred more easily to future projects. • Improved decision-making at internal touch points. • Improved decision-making at external touch points.
Improve assurance	• Data linked to H&S, legal and regulatory obligations is defined and robustly collected. • Reduced reputational risk. • Reduced risk of disputes or claims relating to data and information supplied by the business.
Reduce operational risks	• Appropriate transfer of responsibility and accountability to contractors. • Data requirements from supply chain consistently met.

Benefit Theme	Outcome
Improve operational processes	• Robust 'As-Built' vs. 'As-Designed' information put in place. • Asset inventory, condition and performance data routinely created and updated. • Asset data updated during business-as-usual activity (inspections, maintenance, renewal, etc).
Reduce operational costs	• Improved condition and performance data available to support operational decisions. • More efficient inspection and maintenance scheduling. • Reduced frequency and impact of emergency interventions.
Improve customer experience	• Customer service information linked to assets/locations. • Improved capability to respond to customer feedback and greater ability to use this information to inform design, maintenance and renewal decisions.

Table 4.2 Benefit Themes

An example benefits map from TfL Surface's programme is provided in Appendix 3.

Financial benefits are typically assessed in terms of percentage savings against:

- Cost of capital renewal works.
- Cost of capital projects.
- Cost of operational costs.

The investment and operational costs need to be assessed over the lifetime of the project which is likely to be 5-10 years following the implementation of the new ways of working.

Figure 4.2, right, provides an indication of how the savings percentages can be assessed for different components that form the cost of capital projects. Having identified the cost components which will deliver the savings an overall percentage saving can be assessed for different types of projects. These percentage savings can then be used to build a commercial model of the cost versus savings which would typically include a net present value assessment.

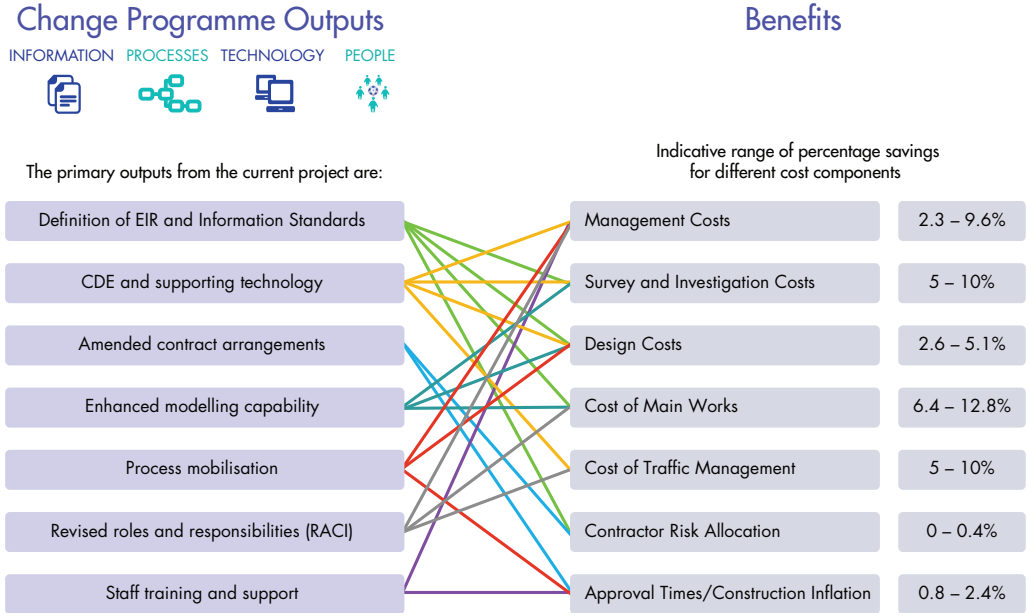


Figure 4.2 Indication of how the savings percentages can be assessed for different components that inform the cost of capital projects.

4.4.5 Benefits Management

Benefits Management is the process of organising, managing and supporting the delivery of real benefits resulting from an investment and doing so as early and fully as possible. Benefits realisation is one element of Benefits Management. Being able to see real, quantifiable benefits being achieved will help to convince any 'doubters' in the organisation of the value of the programme, and will assist in securing resources for further improvements.

Benefits Management is a continuous process running through the whole change lifecycle. With its rigorous processes, techniques and templates, the process is a vital control, providing information required for validating the business case, justifying the original investment and showing ongoing value for money. This is because the most important element of a successful project is that it delivers against its intended outcomes. Whilst minimising cost and delivery time are essential goals of project delivery, if the project fails to deliver what it planned it cannot be considered successful, no matter how cheap or fast it was.

A Benefits Management team should focus on supporting the delivery of all benefits contained within a business case. In addition there should be delivery requirements against each detailed benefit and the benefits realisation strategy should be embedded early in the project and evolve over time.

A strong Benefits Management strategy will have a plan and determined process for identifying and quantifying the benefits, a means to which they can be valued and appraised, a plan for implementation, realisation, and evaluation/review. The benefits realisation element includes a detailed benefits map, a benefits tracker (with metrics and KPIs) and other tools. It should encompass the project risk register, and design performance/departmental management frameworks. There should be a clear list of benefits owners (accountable against each benefit), including business changes, enablers and activities that are required to ensure the benefit is delivered.

Benefits are both quantitative and qualitative and should be related to the outputs and drivers of the project. The primary quantifiable benefits are likely to include reductions in the time, resource and cost of the development, design, management and delivery of projects and schemes. The means and methods of recording the benefits, reviewing progress and evaluation should be tailored to the individual benefits and compared against forecasts and expectations which may have been amended and updated during the project.

It is important to remember to keep all stakeholders informed during this phase of the project and to incorporate a feedback loop so that any problems that arise can be addressed quickly.

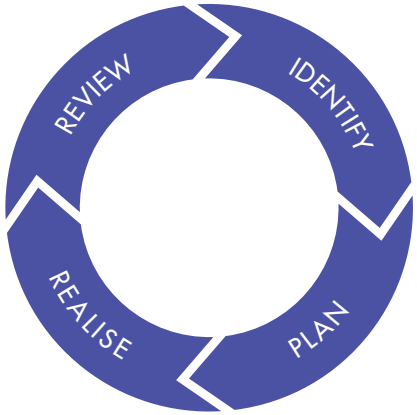


Figure 4.3 A demonstration of the Benefits Management cycle.

4.4.6 BIM Benefits Management

It is important on a BIM adoption programme to define the objective of the Benefits Management strategy at the outset. The organisation may wish to use the Benefits Management strategy to drive deliverables, demonstrate a return on investment or the success of the overall BIM programme, or provide examples of the improvements in capability within the organisation and with suppliers. It may wish to use the Benefits Management strategy to track performance and impact of BIM adoption and define a number of key areas where they expect improved performance. A successful BIM Benefits Management strategy will include a blend of quantitative and qualitative benefits and will build a number of measurements and metrics around each of these.

An example of the benefits includes:

- Reduced Capital Spend.
- Improved supplier engagement, management and relationship.
- Improved operational processes and reduced operational expenditure.
- Improved employee and/or customer feedback.

In any Benefits Management strategy it is important to establish a baseline and relevant benchmarks. To demonstrate the realisation of the benefits within the organisation the baseline and benchmarks may be based upon internal historical, live and future data and/or external comparisons. Where possible, the assessment against the baseline and benchmarks should be an objective process.

The organisation should seek to establish metrics, including KPIs, against the benefits they seek to realise. In relation to some of the benefits provided above, an example of KPIs or relevant metrics are shown below. These KPIs may be further supported by more detailed performance indicators and benefit levers.

Reduced Capital Spend — reduced management and design costs, shorter programme duration, a reduction in risk allocated to projects, a reduction in errors, delays, compensation events associated to projects.

- Improved supplier engagement, management and relationship — increased number of tenderers/suppliers per tender, procurement resource and duration required per tender, transparency of work in progress, supply chain performance, accuracy of tenders, improved capability of supply chain.

The organisation will need to build a method of capturing the relevant information, tracking the realisation of each benefit and assessing performance.

The benefits, baseline and benchmarks, and metrics for measuring realisation and performance will be bespoke to each organisation. They should be tailored to suit the objective of the Benefits Management strategy and the organisation's business case and vision for the BIM programme.

5 What we need to do

The activities that specifically need to be done.

Contents of each activity.

How to execute the activities.

5 What we need to do

In Chapter 5 we detail the activities that we need to undertake to adopt better information practices, covering information, processes, technology and people - as introduced in the earlier chapters. Specifically, what needs doing, the context of each activity and guidance about how to execute the activities.

In Section 5.1 we cover activities required to establish data and information requirements covering the lifecycle of assets along with data and Information Standards. BIM provides an excellent opportunity to gain a fresh understanding of the information needed to support strategic activities, whole life asset management, and compliance with legislative assessments and reporting, rather than starting with current custom and practice. We offer a practical guide on the value of establishing a clear set of data and information requirements along with how to set up and document these. The purpose of having defined data and information requirements is to make sure that organisations procure and are supplied with verified data and information to the right Level of Detail. Information requirements can also inform governance gateways - defined as decisions points where key questions require answering to enable approval. We refer to these as Plain Language Questions (PLQ). Establishing what the PLQ are is a key activity to define your data and information requirements. Each PLQ is likely to have further more detailed questions below it and the information that answers these questions form the information requirements.

Standards are, by definition, a consistent way of creating, structuring and sharing complex data sets in a co-ordinated manner, to a common set of agreed rules and guidelines. The key benefit of these standards is the development of confidence in the asset data. In particular having confidence in the origin, structure and accuracy of this knowledge bank. This extends to having confidence in the re-use and re-purposing of data and information in the form of design models along with other asset related documentation. This translates into the re-use of the data by core delivery teams and the ability to evolve the Level of Detail of data and information throughout the asset lifecycle. We introduce the different types of standards and the applicable suite of British Standards (BS) and the Publicly Available Standards (PAS). We provide guidance, following best practice in the BS and PAS, to establish standards that meet the specific requirements of the asset owners activities taking cognisance of existing standards such as business rules for asset management systems/

In the final part of Section 5.1, we provide a methodology for mapping business processes. To truly understand the need for and purpose of information within an organisation it is necessary to understand the business processes that the information supports. Mapping both the current (As-Is) and proposed (To-Be) processes enables discussion and debate around how the organisation works and wants to work in the future, what data and information is required to support these activities and provides a common reference point for further business improvement activities.

In Section 5.2, we cover the enabling technology to support the adoption of better Information Management practices. Collaborative working is a key element of better information practices where data and information is shared and re-used. Opening up access to data and information requires information security to be carefully considered. In this section we provide an introduction to the PAS 1192-5:2015 which has been developed to assist employers and asset managers to address any vulnerability in the management of their asset data.

A Common Data Environment (CDE) is a collaborative digital environment that everyone on a project can access, in accordance with the guidance given in BS/PAS 1192 and is a core enabler. Building on the guidance contained with PAS 1192 Part 2, we describe the key capabilities that CDE requires and provide an example system architecture diagram. We also provide guidance on how to establish a high level system architecture diagram based on your existing IT infrastructure.

In the final element of Section 5.2 we introduce digital engineering tools covering the creation and use of BIM models in an office environment and out on site. Please note, as this guidance document has been sponsored by a public sector organisation we are unable to name or provide examples of proprietary software.

In Section 5.3 we cover the activities to undertake when mobilising BIM adoption internally and within the supply chain. Firstly we identify the need for clear roles and responsibilities. Secondly we cover the activities required to ensure that staff and your supply chain have the skills and knowledge required to enable them to confidently adopt the new methods of working defined in Sections 5.1 and 5.2. In the final section we cover contract change both for existing contracts, such as framework agreements as well as new contracts. Contract change is required to ensure that your supply chain comply with all of your BIM requirements both during asset management as well as delivering capital projects. The Government's BIM Task Group working in conjunction with the Construction Industry Council has established a protocol document that can be adopted for the different standard forms of contract used in the UK infrastructure market.

5.1 Information Requirements and Standards

Physical assets have a value to their organisation and have associated costs. These costs include maintenance and renewal activities that are required over time to enable them to continue providing value. It is helpful to think of digital asset information as an asset in its own right, in that having good information can add value by informing decisions. However, there is a cost to collecting and maintaining this information to make sure it is available and remains fit for purpose. For every piece of information it is worthwhile understanding the cost : benefit equation, i.e. how much does it cost to collect and maintain it, and what benefit does it bring? For example, better access to information may:

- Enable informed decision-making.
- Assist in providing evidence to the regulator.
- Demonstrate compliance with legislation.

Fundamental to developing BIM practices within an organisation is understanding what information is required throughout the asset lifecycle. A typical example of an information requirement would be to know what type of pavement material has been used on a highway. Materials perform differently over time, so knowing what has been used (and where) helps support maintenance and investment planning.

When the value of information is understood and information requirements have been identified, standards provide a method of documenting what good practice looks like. For instance, the standards might require information to be supplied in a certain format to enable its use within the business without the need for conversion/translation, and that the information should be of a certain level of accuracy/tolerance, e.g. +/- 5 mm. Having set standards makes assessing information quality and completeness much easier. Standards also aid in the retrieval of information and inform quality management activities, which in turn increase the likelihood of information being re-used.

The following sections outline an approach for identifying information needs and defining and agreeing Information Standards.

5.1.1 Understanding Information Needs

As described in the previous chapters of this guide, it is critical to first gain an understanding of the organisational needs and requirements before embarking on a BIM programme.

Essentially, this requires answering three questions:

1. Why is BIM needed?
2. What do we want to achieve through BIM implementation?
3. What information does the organisation need to perform successfully?

To help answer these questions, the standard PAS 1192 (Parts 2, 3 and 5) adopts a top-down approach to developing information requirements from the organisational (strategic) level down to the asset and project-specific level (as illustrated in Figure 5.1 and Figure 5.2). A top-down approach is advised as businesses can often lose knowledge of the purpose for collecting information and continue to collect information long after it is required. Starting afresh and working out exactly what is required (in terms of information and processes) can deliver early benefits by removing redundant information collection and management activities. After strategic information needs have been identified, validation can then be carried out against what is currently delivered from existing processes. This will help identify data gaps and enable plans to be put in place to close them.

The first step is to understand the information needs by establishing the flow of information. Demand for data and information comes down from the corporate organisation, through the business, with each layer of the pyramid having different consumers of information.

Data supply comes from the lower tiers of the pyramid, and in order for it to easily flow up the pyramid, the following needs to be in place:

1. A clear definition of what data and information is required.
2. Common data and Information Standards established.
3. The supporting data transaction processes within each level of the pyramid and between layers of the pyramid need to be understood.

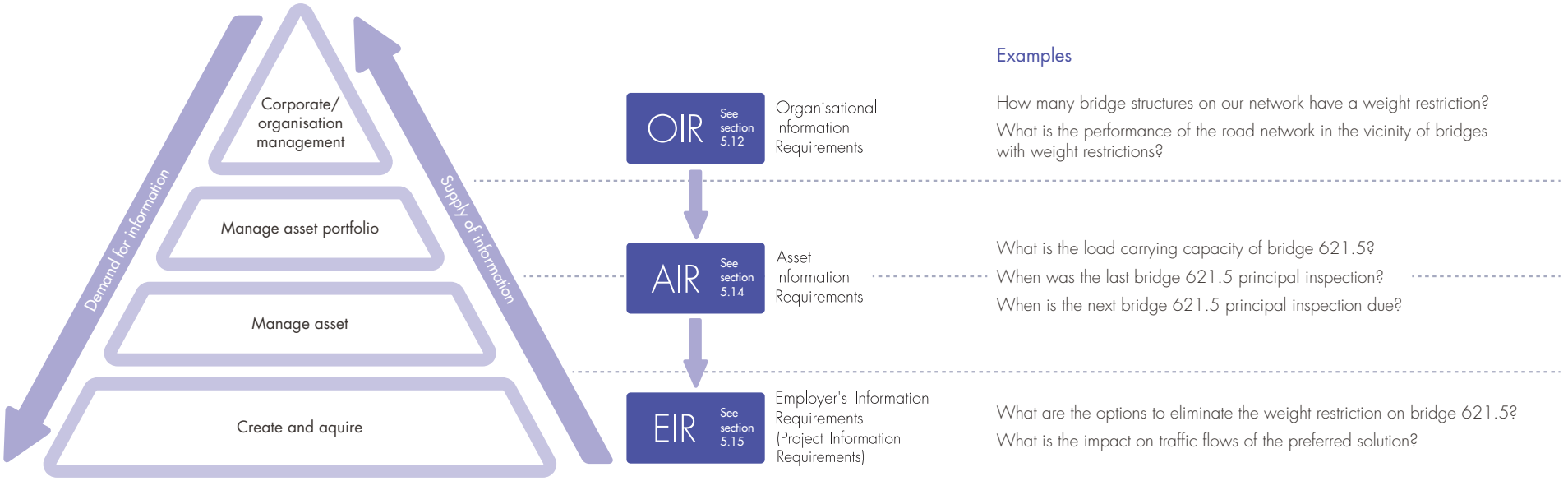


Figure 5.1 The Information Requirements Hierarchy, as defined in PAS 1192 (Parts 2 and 3).

The enabling technology that supports BIM generally uses an open data structure. An asset owner may have multiple asset management systems that have different data structures and business rules which conflict with having a common set of data and Information Standards. In assessing challenges and opportunities, an organisation may decide to rationalise and/or change its asset management systems as part of the BIM programme. Where there is not a business case to rationalise or change systems, then technology can be deployed to enable data to be pushed and pulled from legacy systems. In this situation, it is encouraged to seek specialist advice so that cost and time implications can be fully considered.

In establishing new ways of working with common data and Information Standards across all tiers of the pyramid, there will be a significant amount of legacy data and information which will not conform to the standards. It is not recommended that legacy data and information is updated to conform to the new standards unless there is value in doing so. Typically an organisation will establish an archive area within a new information store (Common Data Environment — see Section 5.2.2) where core metadata is applied as groups of files are loaded to support searching and retrieval.

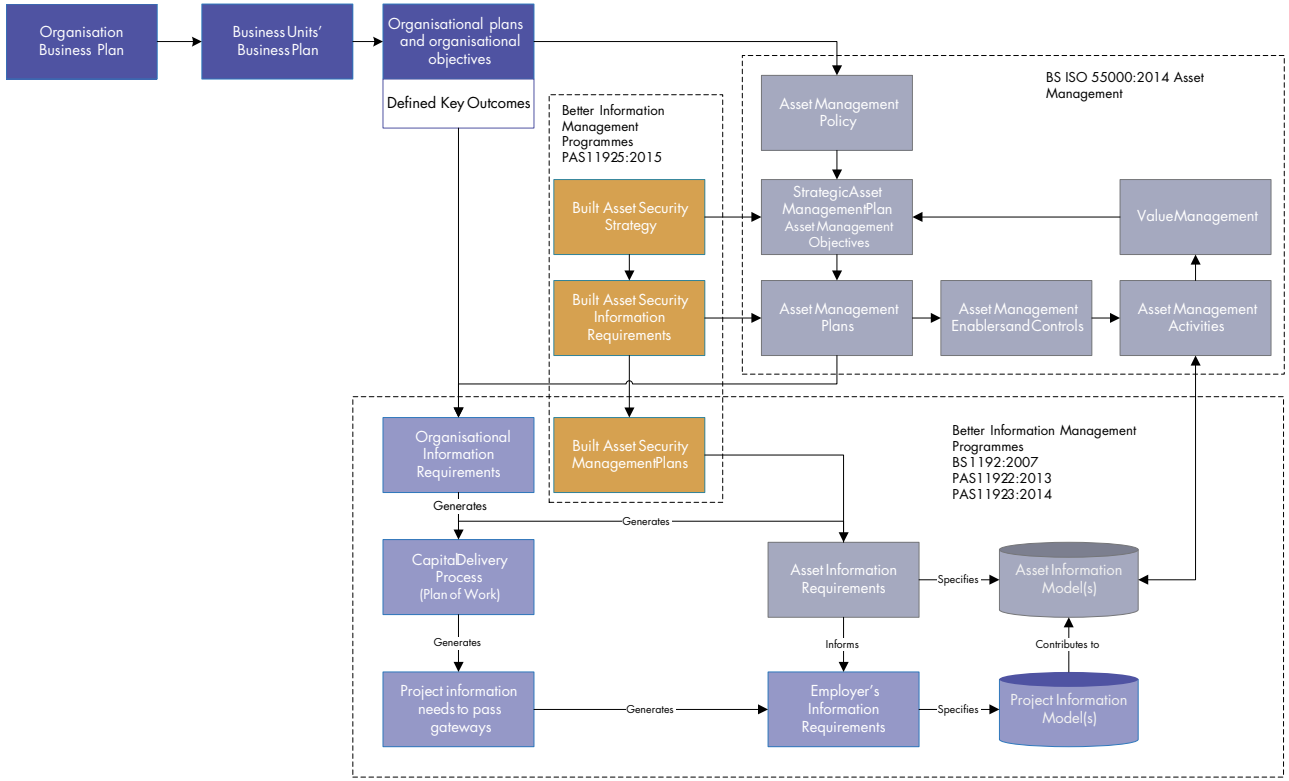


Figure 5.2 Link between information requirements referred to in the BIM standards and an organisation's business plan and asset management activities as described in ISO 55000.

5.1.2 Organisational Information Requirements

The Organisational Information Requirements (OIR) identify the information an organisation needs to know about its assets in order to operate its business and achieve its strategic goals. A typical business question that would drive an OIR might be "what is the operational and financial impact of unavailability/failure of a particular section of pavement?" To answer this question the business would need information about the pavement itself, in addition to information about utilisation and context. Taking closure of the Forth Road Bridge as an example — what costs were borne by the authority in having to close the bridge, conduct emergency repairs and deal with brand/political damage? This information could be used to answer the business question and could also be used to evaluate the relative benefits of different options for mitigating the associated risks to the organisation.

When the strategic questions have been determined, the next stage involves working out what information is needed to answer them. The output from this stage is what we document in the OIR.

5.1.3 Built Asset Security Information Requirements

Built Asset Security Information Requirements (BASIR) detail the specific information requirements around any sensitive assets and systems, in particular the arrangements for, and overseeing of, the secure capture, handling, dissemination, storage, access and use of all data and information pertaining to these. The nature and extent of the BASIR will depend on the specific security risks, or combinations of risks, identified and the mitigation measures to be applied.

As the operational lifecycle of built assets as a whole often far exceed the period during which design and construction occur, it is essential that the BASIR informs asset Information Management to ensure the security of this information is maintained.

Where a BASIR has been developed in line with PAS 1192-5, it should be used to inform production of both the AIR and EIR.

5.1.4 Asset Information Requirements

The Asset Information Requirements (AIR) specify what information is required about specific infrastructure assets in order to answer the OIRs. For example, to effectively manage a section of highway over time and understand when interventions may be required, it is important to know the type of material used, its design life, planned utilisation, what is an acceptable condition, and given the above, how this is likely to degrade over time. When this information is combined with actual degradation rates a decision can then be made about optimum replacement times.

Referring back to the question asked in the Section 5.1.2 Organisational Information Requirements, if the optimum replacement time is known, then the wider information set could be used to quantify the risk of delaying the replacement. As an example, if planned replacement time of a pavement is optimum plus one year, then the likelihood of failure would be increased. Moreover, the consequence of failure could be severe as no suitable detour routes are available within that area. Therefore the organisation's strategy for pavement in that area, may be to replace or renew far earlier than actually required to mitigate this risk.

PAS 1192-Part 3:2014 provides a specification for Information Management for the operational phase of assets using digital engineering information. The PAS makes reference to triggers — a planned or unplanned event that changes an asset or its status and requires information to be gathered, verified, stored and disseminated.

PAS 1192-Part 3:2014 uses trigger events to identify the need for asset information. Example triggers include:

- Performance evaluation of an asset, including failure trends from similar components used elsewhere and experience-based learning and feedback from asset performance — such as a principal bridge inspection for example.
- Maintenance work on an asset, whether planned or reactive.
- Minor works on an asset, such as minor repairs, component replacements or minor upgrades.
- Major works on an asset such as major repairs, refurbishments or major upgrades.
- Asset replacement.

As well as defining the data and information requirements for different trigger events, it is imperative that there are established standards and business rules covering the creation, maintenance and use of data for the lifecycle of an asset. This can be achieved through establishing an AIR that is built from the contents of the Employer's Information Requirements as detailed in the following section.

5.1.5 Employer's Information Requirements

The Employer's Information Requirements (EIR), developed by the asset owner (or their advisor), set out the information to be delivered and the standards and processes to be adopted by suppliers in delivering a project. It is called Employer's Information Requirements rather than 'asset owners' or 'clients' information requirements as the document is meant to be used through all tiers/layers of a project, so anybody required to submit information to another party on the project has to adhere to the EIR.

The EIR should cover the following three areas:

- **Technical information**: For example, to what Level of Detail (both graphical and non-graphical) is the information to be supplied? This should be considered carefully so that the client receives the right type and amount of data to run their business effectively and does not have to pay for the creation of data they don't need. Software platforms (including asset management systems) used should be detailed, as well as data and file formats required.
- **Management information**: What processes and procedures are going to be adopted to manage information flow on the project?
- **Commercial**: What are the deliverables? i.e. What models are required? When are the data drops to be carried out? What is the information to be used for?

The organisational information requirements (OIR) and asset information requirements (AIR) inform the EIR, with the addition of the data needs to support interim decision-making. All organisations, particularly those in the public sector, should advocate the use of open standards for exchanging data, e.g. IFC, COBie, BCF.

The EIR should include:

- Levels of Detail (both in terms of geometry and also associated data): these need to be considered carefully as there should be enough detail for the intended use at each project stage, but onerous requirements can slow down projects and ultimately result in unnecessary cost and delay.
- Training requirements.
- Any security requirements.
- Work planning and data segregation, naming conventions, etc.
- Details of coordination and clash detection requirements.
- Requirements for collaboration and collaborative working practices.
- Any specific information that needs to be excluded or included from models or associated data.
- Any technical constraints such as model file or attachment sizes, versions, filetypes.
- Compliance plan.
- Any coordinate systems to be used and site origin coordinates.
- Software formats and version numbers.

- Information exchanges — aligned with work stages, purpose and formats required.
- Client's strategic purposes for information required.
- An initial Responsibility Matrix.
- Details of any changes to the standard roles, responsibilities, authorities and competences set out in the contract.
- Competence assessment details.

5.1.6 Mapping Business Processes

To truly understand the needs for and purpose of information within a business it is necessary to understand the business processes the information supports. Mapping both the current (As-Is) and proposed (To-Be) processes enables discussion and debate around how the organisation works and wants to work in the future. The data and information required to support these activities, as well as providing a common reference point for further business improvement activities. Mapping processes also enables debate about the timing of information delivery, as high accuracy information delivered earlier than required can become redundant and be expensive, while useful information delivered too late can mean poorly informed decisions are made or decisions are delayed. The mapping of processes and associated data and information requirements are key inputs to the configuration of a Common Data Environment (see Section 5.2.2).

In order to identify the changes to the processes, the steps on Figure 5.3 (overleaf) should be taken

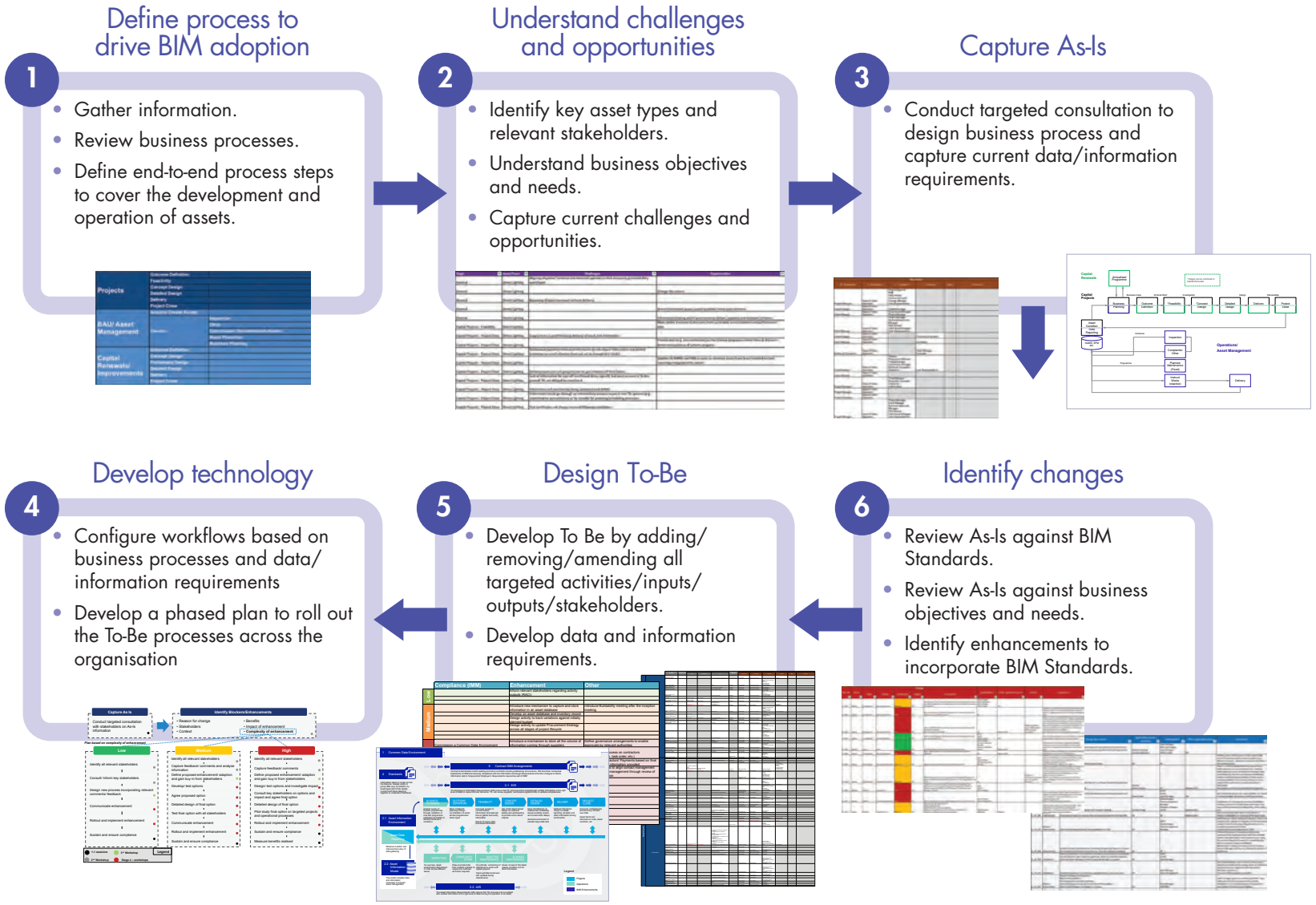


Figure 5.3 Steps to be followed to identify changes to the processes.

When establishing process diagrams, it is beneficial to allocate a reference number system that uniquely identifies each task and each deliverable/group of deliverables. Referencing supports review of the process diagrams and enables the process to be scheduled in a spreadsheet, where it is easier to apply a responsibility assignment matrix (a tool used for identifying roles and responsibilities during a project, e.g. RACI: Responsible, Accountable, Consulted, Informed). Referencing also aids in identifying activities to be managed by the Common Data Environment. Fields commonly used in the spreadsheet are:

- Process, e.g. Capital Project Process.
- Process stage, e.g. Definition.
- Unique activity reference number.
- Activity/product, e.g. Issue and execute contract.
- Input: this could be a product, e.g. Award letter and/or input from a system such as a Contract Management System.
- Output: this could be a product, e.g. a Contract and/or input in to the Contract Management system.
- Against each activity and product line a RACI can then be prepared identifying which role rather than which individual is Responsible, Accountable, Consulted and Informed.

A simple reference number system is shown in Figure 5.4 right. The reference system can indicate whether a process activity refers to producing information, e.g. P21: Produce Contract Award Recommendation) or a business activity; A21: Evaluate Tenders. Differentiating between business activities that don't produce information/data and others that entail the production of documents, etc could help the technology provider in the development of the respective workflows. A similar rationale/approach could be extended to inputs and documents, etc.

Ref. No.	Activities/Products	Outputs
		Products
A21	Evaluate tenders	N/A
P21	Contract Award Recommendation	Contract Award Recommendation
P22	Award Contract	Award Letter Rejection Letters
P23	Issue and execute Contract	Contract
P113	Produce contract management matrix	Contract management matrix
A22	Raise shopping cart	N/A

Figure 5.4 A simple reference number system.

When designing the process maps, consideration should be given to the final purpose of these outputs — which is the development of workflows. These workflows will be used to design and configure the necessary technology solution.

Organisations will have varying definitions of different levels of process mapping. Figure 5.5 depicts an example process mapping hierarchy.

An example of a Level 2 process would be the stages in the Network Rail Guide to Rail Investment Process (GRIP). An example of a Level 3 process is provided in Figure 5.6. This is the Ministry of Justice (an early adopter project for the BIM Task Group) end-to-end process diagram. An example Level 4 process diagram is provided in Appendix 4.

In an asset-intensive business, looking through the lens of ISO 55000 and creating a clear line-of-sight from the objectives of the business down to the role of the assets in achieving these objectives, can provide valuable insight into information requirements. Examples of business processes, which would provide insight once mapped, include:

- Developing Asset Management Policy and Strategy.
- Investment planning and optimising Asset Plans.
- Developing the Asset Systems Strategy.
- Activities for maintaining and operating infrastructure assets.
- Delivering and integrating new infrastructure.
- Reviewing performance and improvement.

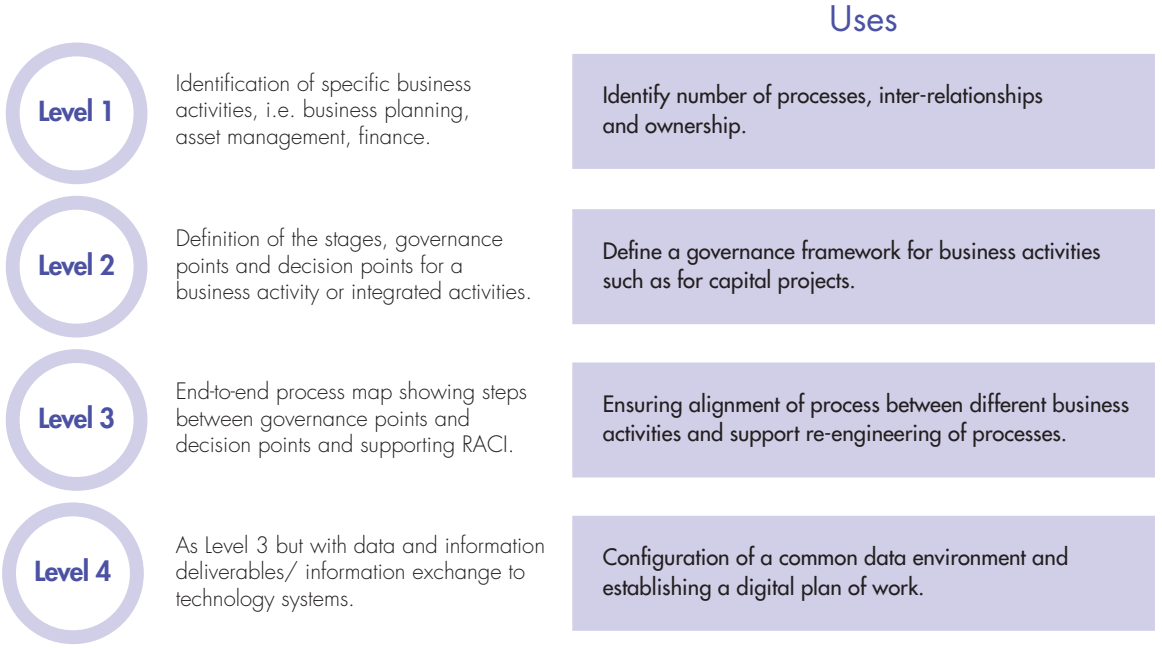


Figure 5.5 Example of a hierarchy of different levels of process mapping.

Key stages and decision points within these processes and the associated governance requirements create a pull for information. For example, within 'Delivering and integrating new assets' it is likely that the organisation would need to identify the costs, timescales and risks associated with a chosen project solution and compare this to other investment options. To support this, information would be needed on current infrastructure assets, e.g. performance and cost, and predicted information about the benefits that the other options could bring. This would enable a decision to be made on whether the business case is viable, affordable and achievable. In regulated businesses this is particularly relevant, as regulators look for evidence to support decision-making.

5.1.6.1 A practical approach to establishing the overarching business Level 3 processes

The following steps represent a structured approach to mapping business processes. Whilst the work involved in each step may vary depending on the organisation, it is good practice to follow all of the steps to the appropriate level to ensure that everyone involved has a common understanding and nothing gets missed. Some organisations are more process-driven than others and may already have well-documented processes in place, however re-engaging stakeholders around a single process document can prompt discussion and identify opportunities for improving current ways of working.

Step 1 Establish an understanding of the organisation, how it works and the information it holds (including any sensitive information) through a review of existing Information Management systems and a series of structured interviews with key stakeholders to identify organisation structure, vision, strategy, funding routes, etc. This would include collating the Levels 1 and 2 processes which together define the framework for end-to-end delivery. This is represented in the top portion of Figure 5.4.

Step 2 Collate existing departmental level 3 processes where they exist and add them to the end-to-end process diagram to start to produce a single linear process.

Step 3 Hold departmental workshops to review the end-to-end process diagram and identify key departmental processes and issues, e.g. delivery, technical standards and commercial.

Step 4 Update the end-to-end process diagram so that it depicts each of the core business processes, e.g. delivering and integrating new assets. When engaging with project stakeholders it is important to map internal processes for managing projects between approval gates/decision points as this will highlight the activities that are undertaken to generate information.

Step 5 Hold workshops with key stakeholders from different parts of the organisation, e.g. operations and project delivery, to gain agreement across the business on:

- How business is carried out, e.g. how projects are delivered.
- Key governance requirements, including security requirements.
- Questions (that are easily understood by the target audience) that need to be addressed at each strategic decision.
- Key points at which information is required to support the process.
- Definitions of the level of information required at each stage.

Lean Six Sigma techniques can be used to document the As-Is processes and establish a complete end-to-end To-Be delivery process with identified improvement opportunities. Figure 5.6 is the end-to-end process developed for the Ministry of Justice. Each decision point, identified as red diamonds, has an associated data drop comprising Native BIM models, Structured data and 2D drawings (produced from models) and other document deliverables.

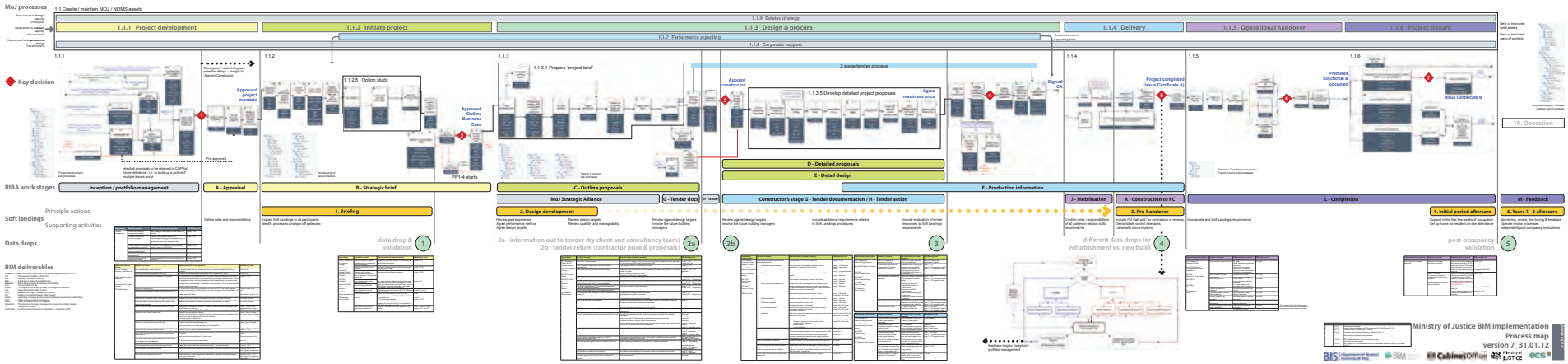


Figure 5.6 Ministry of Justice end-to-end process diagram — example of a Level 3 process map.

5.1.6.2 Detailed Process Mapping

Having established the level 3 process map, detailed level 4 process mapping can be undertaken to fully document the activities and deliverables for different asset types. Outputs from the detailed process mapping are used by the Common Data Environment provider to automate the workflow for a given activity or asset type. An example level 4 process diagram and supporting schedule is provided in appendix 4.

5.1.6.3 Process Change

The current processes (As-Is) are reviewed against the BIM standards and business needs to identify changes that need to be made to support BIM.

The Process change identifies the enhancements required to incorporate the BIM Standards (see Section 5.1.6) and identifies changes that need to be incorporated into these processes.

Several types of change should be considered,including:

- Products, e.g. documents.
- Process activities.
- Roles, e.g. Information Manager and, where appropriate, Built Asset Security Manager (BASM).
- Systems, e.g. Asset Management Systems, Corporate Systems.

When all changes have been identified, process change will reflect these in the proposed (To-Be) business processes. When establishing the To-Be process diagrams, it is worth colour coding any changes and affected areas of the current (As-Is) ways of working. This allows easier tracking and communication of the process changes to the end users. A schedule of information should be developed for each process activity, including:

- Inputs and Outputs, e.g. documents, data.
- Asset Management Information Systems.
- Roles and Responsibilities in the form of a RACI matrix (Responsible, Accountable, Consulted, Informed).

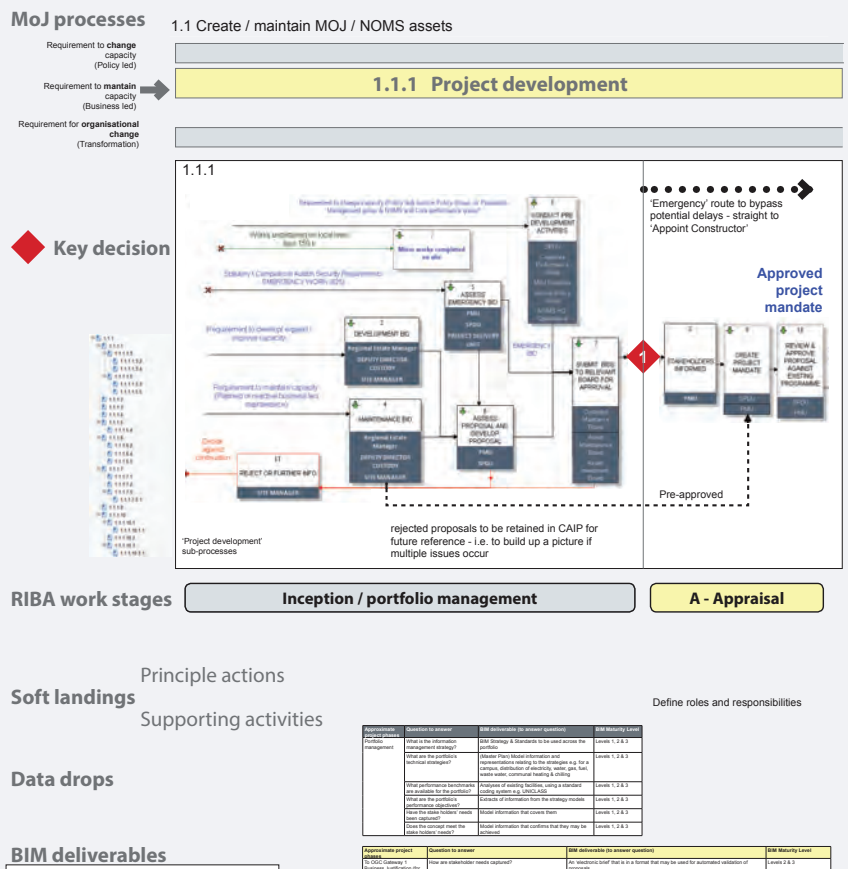


Figure 5.6(a) Enlargement of the Ministry of Justice end-to-end process diagram: example of a Level 3 process map

Process change should primarily focus on the Information Management changes, however consideration should also be given to applying Lean Six Sigma principles to make the To-Be process efficient. This helps to ensure that all Information Management changes are incorporated in an integrated activity. The challenge in applying Lean Six Sigma principles in conjunction with BIM is that end-users may find it difficult to fully understand and embrace the new ways of working.

The RACI matrix should reflect any changes applicable to end-users' activities, and will feed into the roles and responsibilities (see Section 5.3.1) alongside the business processes.

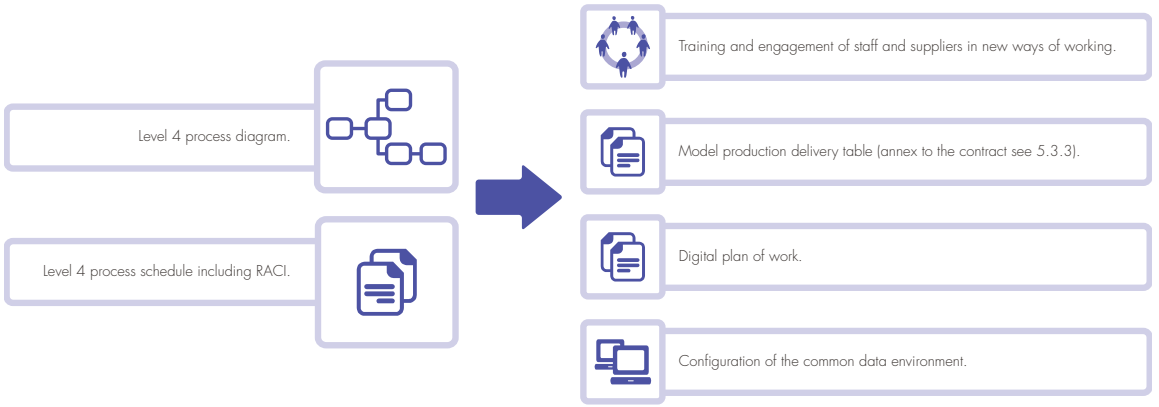


Figure 5.7 Graphical representation of the uses of the level 4 processes.

The proposed (To-Be) process maps should capture a sufficient Level of Detail to reflect the flow of information from the start to the end of the process and amongst the relevant stakeholders. To help the technology provider develop the workflows, a supplementary manual guide can be developed to provide a picture of how the process map aligns to the schedule of information discussed above. An example of how this manual guide could look is shown below in Figure 5.8. Process activity diagrams are linked with the respective process activities listed in the schedule of information.

The 'A' process map shows those responsible for carrying out activities and producing information while the 'B' information shows other roles involved information creation or update.

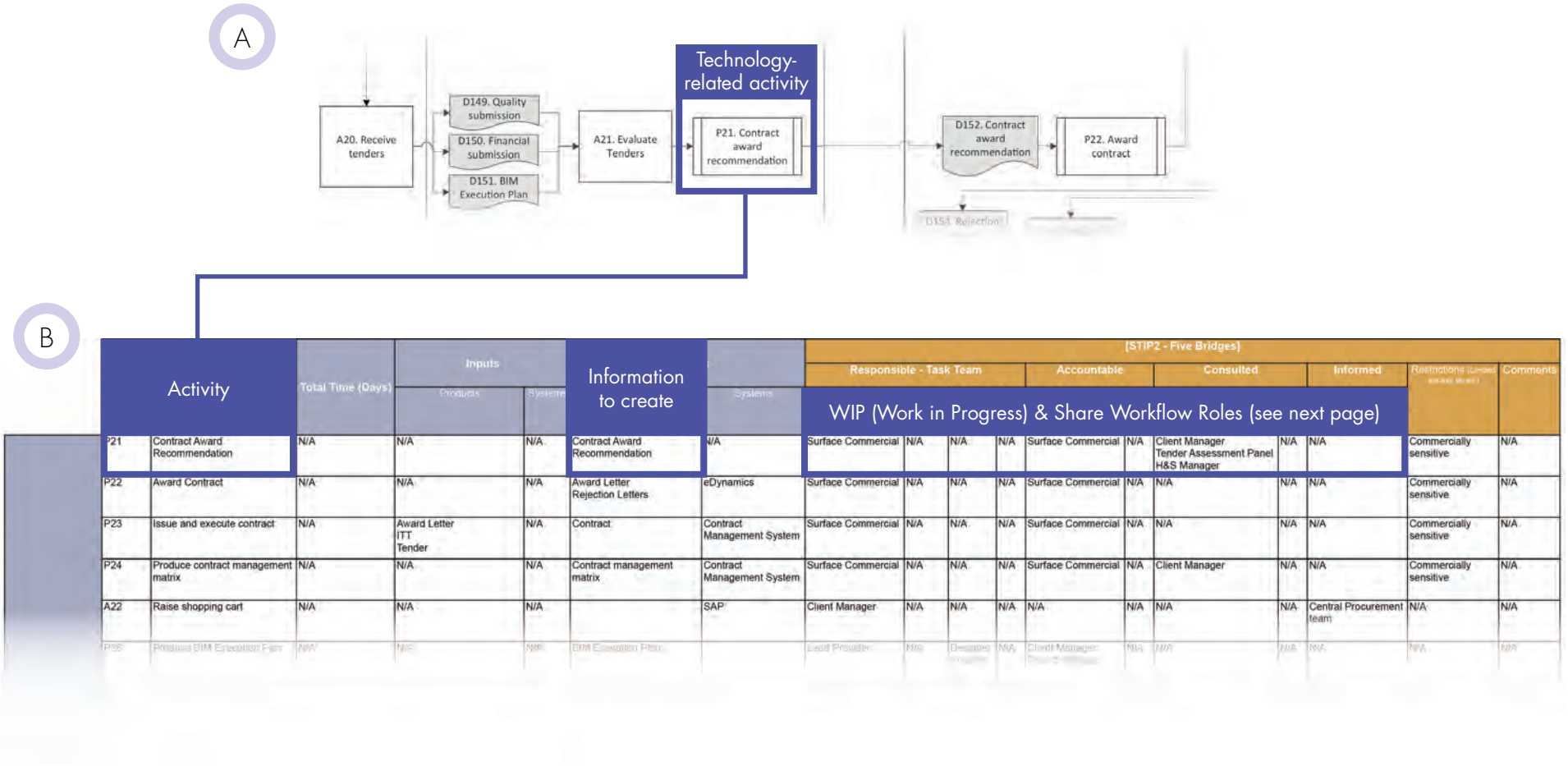


Figure 5.8 Key elements of a process diagram and linkage to the schedule of information for inputs/output, systems, RACI.

Changes identified can be grouped as shown in Table 5.1.

Type of change	Description	Indicative examples
BIM core changes	Changes instructed directly by BIM Standards (see 5.1.7) aiming to ensure compliance with BIM Level 2 requirements.	• Develop BIM Execution Plan. • Commission a Common Data Environment. • Define Employer's Information Requirements. • Establish a common asset classification and object library. • Define new roles and responsibilities.
BIM enabled changes	Changes identified as by-products of the BIM core changes aiming to address challenges and enable opportunities.	• Develop RACI matrix. • Share asset and location specific information. • Design an information assurance process.

Table 5.1: Process changes.

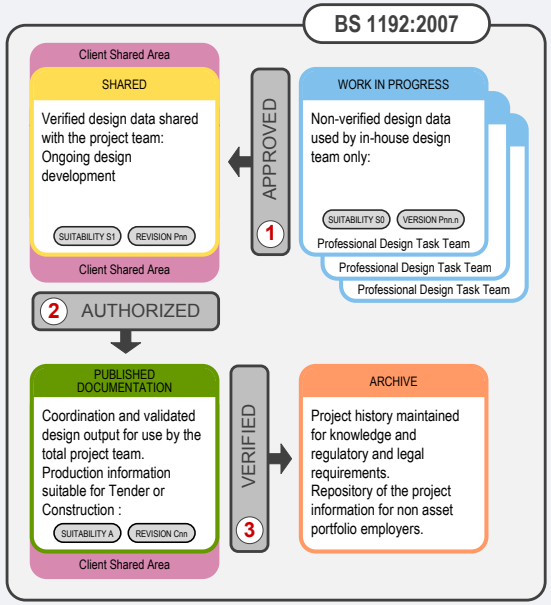


Figure 5.9 BS 1192:2007 Common Data Environment information delivery cycle.

All BIM core changes are mandatory and should be implemented as part of the programme. The infrastructure body can make a decision as to whether they want to proceed or not with all or some of the BIM enabled changes depending upon the challenges and opportunities identified.

5.1.6.4 Information Delivery Cycle

In preparing detailed To-Be process maps it is vital that participants contributing to their development understand the information delivery cycle that all information should follow. The cycle, shown in Figure 5.9, begins with work in progress, then flows to shared, published and archive as introduced in BS 1192 and detailed in Section 9.2 of PAS 1192:Part 2 — 2013 and Section 5 of PAS 1192-Part 3 2014.

All information that forms part of the asset and project information models should follow the BS 1192:2007 information delivery cycle.

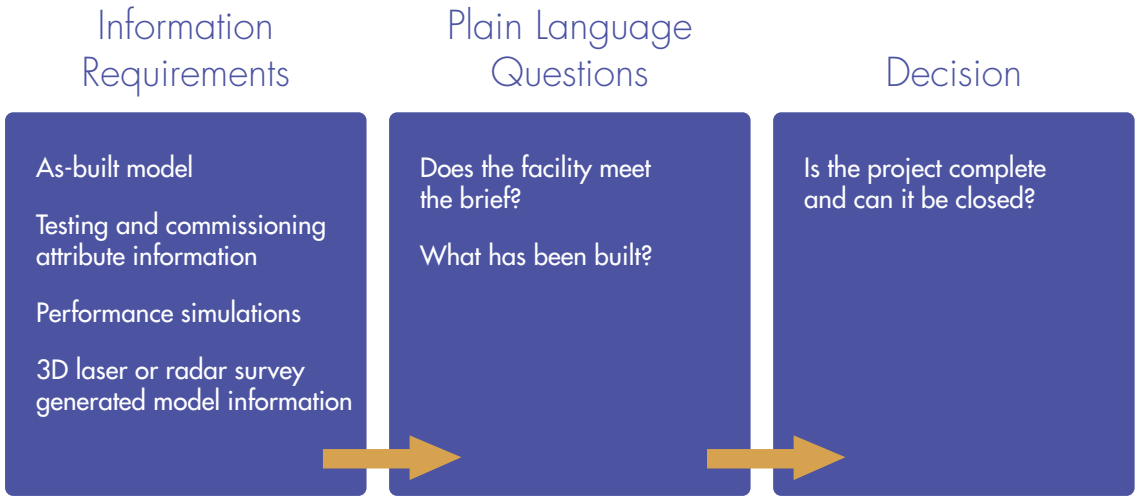


Figure 5.10 Example showing link between PLQs and defined information requirements.

Gathering and Agreeing Information Requirements

The purpose of having defined information requirements is to ensure that organisations procure and are supplied with verified, appropriately controlled information to the right Level of Detail. Information requirements can also inform governance gateways (decisions points where key questions need to be answered to enable approval). These questions are referred to as Plain Language Questions (PLQ). Each PLQ is likely to be supported by more detailed questions, with the answers forming the information requirements (Figure 5.10).

The benefits of adopting the use of PLQ are:

1. Organisations can clearly articulate digital data requirements aligned with business need.
2. Data is only produced when needed — eliminating waste.
3. The definition process secures business-wide buy-in to the data requirement.

To help establish information requirements, it is good practice to engage with a diverse range of stakeholders. This can also lead to situations where individuals see themselves as customers of the same pieces of information (although they may have very different purposes for these), which could enable a constructive discussion about information quality, i.e. how good is good enough? In other cases, individuals may not see that they require the same information, so getting cross-functional groups together can be valuable in providing learning for individuals about how interdependent they are or could be, e.g. "I never knew that information already existed, I pay someone to survey that every year!"

As part of step 4 of the process mapping approach in Section 5.1.6, an initial set of PLQ can be identified and used to develop spreadsheets against the identified decision points. These spreadsheets can provide a platform for engaging with stakeholders to identify further PLQ and secondary questions against which the information requirements will be defined, i.e. the information required to enable the question to be answered. Fields commonly used in the spreadsheet are:

- Key decisions and plain language questions.
- Information required.
- Information type, e.g. document.
- Whether there are any security requirements around the information Level of Detail.
- Responsibility, e.g. role responsible for creating and managing this information.
- Assurance, e.g. role responsible for providing assurance regarding the quality of the information.
- Information User.
- File Format, e.g. PDF.

An example of an information requirement spreadsheet is provided in Appendix 5. Where PAS 1192-5 is being implemented, as a minimum, the PLQ available on the Centre of the Protection of National Infrastructure (CPNI) website should be reviewed and included as appropriate.

Organisational Information Requirements (OIR) (see Section 5.1.2), which are the output of this approach, principally relate to the information which is required to produce and deliver an organisation's investment programme and manage the portfolio of assets. As such, the OIR drives both the Opex and Capex information requirements.

Every organisation will start from a different place with regard to their current understanding of information requirements. If asset information requirements are already well understood, these can be tested and recorded against the PLQ, which may identify additional PLQ and/or identify that too much asset information is being specified and collected in some instances. It is likely that there will be a core set of information which is standard across all asset types and projects, and other information which will be specific to individual assets or projects.

A spreadsheet of the capital projects PLQ can be used to engage with stakeholders to discuss and record capital projects information requirements. It is important to ensure that information requirements at the handover from projects to operations are accurately reflected in the project information requirements and it is good practice to develop a first draft of the information requirements with a small group and then test with a wider group of stakeholders. Where process maps exist which document the activities between approval gates/decision points, the spreadsheet can be transferred to the process diagrams to enable the output to be tested back with the stakeholders prior to a final requirements sign-off workshop.

5.1.7 Understanding the Importance of developing Information Standards

Whilst the information requirements for each area of a business will vary to some degree, we recommend that a defined set of Information Standards is established that can be applied across the organisation and its supply chain.

The purpose of defined Information Standards is to make sure that information is recorded and produced in a standard way so that it can be easily managed, retrieved and used within the Common Data Environment (CDE).

By having a defined set of standards embedded internally and within the supply chain, asset organisations obtain the required information to enable quality to be assessed and improved, and create a documented baseline which allows standards to be re-used and developed over time to facilitate learning.

To support BIM, standards are required for the following areas and each one delivers benefits in its own right:

- File naming, including metadata.
- Modelling — CAD as opposed to financial modelling, etc.
- Asset naming and classification.

Standard	Purpose	Outcomes	Benefit
File Naming Convention	A robust file naming standard will: • Help make sure all project documentation is named in accordance with an agreed set of rules and guidelines. • Underpin the document and file management strategy and establish a framework to support a smooth integrated document management workflow. • Provide a consistent approach to creating and locating content and help avoid lost files and duplication of effort. • Introduce industry best practice if aligned with BS 1192. • Help the user to categorise the document in terms of content type. • Have defined metadata requirements including revision and suitability codes. • Support introduction of an Electronic Document Management System (EDMS) as well as a Common Data Environment (CDE). These systems facilitate co-ordinated, appropriate sharing of data, together with a revision framework and referencing facilities, and provide a clear audit trail for quality purposes.	• Unique file naming and prescribed metadata. • Suitability code (metadata) provides a clear consistent statement of how the information can be used.	• Less time spent searching for files. • Consistency in approach.

Standard	Purpose	Outcomes	Benefit
Modelling Standards	An approved set of Modelling Standards will: • Facilitate a consistent approach to data creation from projects across the organisation. • Help to establish industry best practice and enable data sharing and re-use during the project and asset lifecycle. • Provide a framework to create models and drawings in a structured format, improving confidence in the quality and accuracy of outputs. • Enable models to be federated together to ensure designs are fully integrated and clash free. • Help make sure that models adhere to a common set of guidelines in areas such as categorisation, naming, Level of Detail and the way the content is linked.	• Means to co-ordinate design. • Ability to obtain accurate schedules of materials to support analysis of cost. • Ability to carry out virtual construction sequencing (4D modelling). • Development of library components and classifications, which are usable across projects.	• Reduced design cost. • Design data can be re-used over the life of the asset. • Design should be clash free. • Schedules of materials accurately produced digitally from models. • Risks are identified and treated. • Construction sequence is optimised. • Cost of future design is further reduced through the use of library objects. • Project knowledge and asset libraries evolve to meet project lifecycle needs. • Encourages the re-use and sharing of asset models as well as the embedded data and linked metadata.
Asset naming and Classification	• Sets out the standard for uniquely identifying assets. • Provided a common reference for the build-up of associated intelligence and supporting the tracking and evolution of the asset over its life • Identifies the asset type and may be linked to Asset Information Management Systems (AIMS)	Assets are uniquely identified which enables information to be tagged and linked to the asset.	Effective information retrieval regarding an asset and groups of assets enables informed decisions to be made.

Table 5.2: Overview of the purpose and benefit of the different types of Information Standards

5.1.7.1 Establishing Information Standards

It is recommended that Information Standards should be developed in line with the guidance provided in BS 1192:2007 and PAS 1192 Part 2: 2013. Adopting common industry standards across asset owners was a key driver for the adoption of Level 2 BIM by central government to enable information to be shared but also enable the supply chain to have a standard way of working for all Government departments.

During the gathering of the PLQ, stakeholders may identify existing Information Standards within an organisation. Reviewing internal standards alongside external standards will enable an As-Is assessment to be made which will identify commonality, variance and gaps. Once this is complete, a strategy can be put in place to establish a single integrated set of standards which align with industry standards.

External standards

Standard reference	Title
BS1192:2007	Collaborative Production of AEC Information.
BIP2207	Standard Framework and Guide to BS1192:2007.
PAS1192-2:2013	Specification for Information Management for the capital/delivery phase of construction projects using building information modelling.
PAS1192-3:2014	Specification for Information Management for the operational phase of assets using building information modelling.
BS1192:4	Collaborative production of information — Part 4: Fulfilling employer's information exchange requirements using COBie — Code of practice.
PAS 1192-5: 2015	Specification for security-minded building information modelling, digital built environments and smart asset management.
BS8541-1:2012	Library objects for architecture, engineering and construction Part 1: Identification and classification — Code of practice.
BS8541-2:2011	Library objects for architecture, engineering and construction — Part 2: Recommended 2D symbols of building elements for use in building information modelling.
BS8541-3:2012	Library objects for architecture, engineering and construction — Part 3: Shape and measurement — Code of practice.
BS8541-4:2012	Library objects for architecture, engineering and construction — Part 4: Attributes for specification and assessment — Code of practice.
BS7000-4:2013	Design management systems. Guide to managing design in construction.
BS80000-1:2013	Quantities and units.

Table 5.3 Schedule of key BIM standards.

In addition to BS 1192:2007, Highways England has published Interim Advice Note 184/14, which is a first step to defining the governance needed for the implementation of BS1192:2007 and PAS1192-2. It will enable the supply chain to configure their systems and Common Data Environments to produce and receive information in a consistent manner on behalf of Highways England.

5.1.7.2 File naming

The benefits of Information Standard Management include confidence in the organisations ability to easily create, track and locate files as well as establishing essential relationships between disparate silos of data. File naming supports the classification of asset data as well as helping to ensure that there is one single source of truth.

BS1192:2007 was published in January 2008 and has become embedded throughout the supply chain and within the wider construction industry. The document is a code of practice for the collaborative production of architectural, engineering and construction information. It provides details of the standards and processes that should be adopted to enable a consistent, structured, efficient and accurate information exchange. In developing a file naming standard, it is advised that it should adhere to BS1192:2007 wherever possible. Capturing the principles is vital, i.e. the number, name and type of divisions that make up the code.

BS 1192:2007 provides the following file naming structure:

- **Project or asset code**: standard needs to detail how the unique project or asset code is established and controlled.
- **Originator**: codes need to cover internal departments along with external organisations such as your supply chain (standard needs to detail how new originators are provided with an identifying code).
- **Asset group**: unique code required for each asset type, this may require additional codes not covered by BS1192. Exception codes are used to identify files relating to all asset groups, multiple asset groups and no asset groups as appropriate.
- **Location**: The location code should reflect how the asset organisation manages locations such as Councils and Parish Councils, etc and is likely to follow how asset information is currently recorded.
- **Filetype code**: The filetype codes needs to cover all document types — an engagement across the asset organisation is likely to be required to identify all filetypes.
- **Discipline role code**: The role code needs to cover both internal and external roles — an engagement across the asset organisation is likely to be required to identify all roles requiring a code.
- **Number**: standard needs to define how document numbers are to be generated, using a four-digit code enables logical groupings to be used such as the Design Manual for Roads and Bridges (DMRB).

							Core Metadata			
Project	Originator	Asset	Location	Type	Role	Number	Suitability	Revision	Version	Title
ST150030	PPD	TUN	03	MP	PM	0001	A	P01	P01.1	Tunnel Structural Report

Figure 5.11 Example of a full filename and divisions.

Number	Use	Number	Use	Number	Use	Number	Use
00XX	Introduction	08XX	Road Pavements — Unbo	15XX	Motorway Communication	22XX	Not Used
01XX	Preliminaries	09XX	Road Pavements — Bitu	16XX	Piling and Embedded	23XX	Bridge Expansion Join
02XX	Site Clearance	10XX	Road Pavements — Conc	17XX	Structural Concrete	24XX	Brickwork, Blockwork
03XX	Fencing	11XX	Kerbs, Footways and Paths	18XX	Structural Steelwork	25XX	Special Structures
04XX	Road Restraint System	12XX	Traffic Signs and Road Mark	19XX	Protection of Steelwork	26XX	Miscellaneous
05XX	Drainage and Service	13XX	Road Lighting Columns	20XX	Waterproofing for Con	30XX	Landscape and Ecology
06XX	Earthworks	14XX	Electrical Work for Roads	21XX	Bridge Bearings	50XX	Maintenance Painting
07XX	Road Pavements General						

Table 5.4 Example DMRB methodology for building a framework for file numbers.

The suitability code is a key metadata field. BS 1192 places onus on the information author to define the suitability code as part of their own quality management system and that they will be held responsible for ensuring that the information is of the right quality in line with the selected code. Table 5.5 replicates the codes provided in BS 1192. Additional suitability codes will be required to cover asset management activities.

Stage	Code	Suitability
Work In Progress	S0	Initial non-contractual code.
Shared	S1	Fit for coordination
	S2	Fit for information
	S3	Fit for internal review and comment
	S4	Fit for approval
Documentation	D1	Fit for costing
	D2	Fit for tender
	D3	Fit for contractor design
	D4	Fit for manufacture/procurement
Sign Off	A	Fit for construction
	B	Fit for construction with comments
	C	Comprehensive revisions needed
Archive	AB	As-Built

Table 5.5 Standard document suitability codes [Note BIS codes are being extended to cover asset management activities].

5.1.7.3 Graphical modelling and structured data

It is common for asset owners not to have a defined modelling standard. In the absence of a defined standard, model authors (or the asset owner themselves) will be using their own organisation's or asset owner's standards and quality management system. The emphasis of Level 2 BIM is in the procurement of digital information for use through the asset lifecycle including project phases. As such, infrastructure bodies should have a defined standard.

Modelling standards provide clear and succinct guidance to internal teams and external delivery partners on the methodology for creating models to support the project lifecycle, including concept design, detailed design, construction and as-built records. The methodology should be equally applicable to small single team projects and large complex multi-disciplinary projects. It should cater for short-term and long-term projects and support defined project stages.

Model's need to include the following parameters:

Accuracy: Creation of accurate models using the capabilities and tolerances of modern BIM software.

Classification: Model content needs to be organised by layer or element and must be structured to an approved classification system. The naming must be to an agreed convention.

Federation: Models must be co-ordinated to ensure that they fit together in a spatial context. They should share common units, coordinates, grids and be drawn to true scale.

Knowledge: Models should be designed to store essential asset knowledge as metadata attributes and links to databases. This will allow development of an Asset Information Model (AIM), a specialist model which compiles data and information to support asset lifecycle management, including operation and maintenance of those assets, and in some cases their interdependencies.

A modelling standard would typically cover:

- Introduction and Context.
- Scope and Definition.
- Existing Guidance and Documentation.
- Relationship with other BIM guidance.
- Industry Standards and Best Practice.
- Objectives.
- Security requirements.
- Quality Control.
  - Automated Checking.
  - Templates.
  - Library.
- Model Naming.
- Parameters to enable model co-ordination.
  - Units.
  - Co-ordinates.
  - Scale.
  - Model Federation.
- Common Data Environment.
- Core Workflows.
  - Model Classification.
  - Model Sharing.
  - Model Delivery.
- Define rules for structured data.
- Data Integration, Exchange and Format.
- Sheet files.
- Metadata and Title blocks.
- Model Elements and Layers — (Naming).
- Annotation.

To drive quality control and reduce waste, it is recommended that a modelling template is produced for each authoring tool used. These templates are used as seed files by the CAD operators and can be used to validate models prior to publication.

The establishment of a modelling standard and associated templates is a specialist task which should be undertaken by a subject matter expert from within the asset organisation or from a suitably experienced consultancy. The modelling standard should adhere to BS1192:2007 wherever possible, which supports the reaching of consensus between internal design teams and any external designers. Given the potential variance in standards, it is advised that a working group is established to review sections of the standard as it is produced to minimise abortive work.

Level 2 BIM maturity requires models to be produced using graphical objects to which non-graphical data is attributed. Designers are required to produce models in accordance with the Level of Detail prescribed in the Employer's Information Requirements and, where appropriate, the Asset Information Requirements. Level of Detail comprises the following:

- **Level of Model (graphical) Detail**: the detail to which the physical characteristics of the asset(s) are represented (as graphical data) within model files.
- **Level of Information**: the type and amount of information (about the assets functional characteristics) which may be included as attributes (non-graphical data) within model files.

While the non-graphical data supports the asset owner's decision-making during a capital project, more importantly it delivers the data required for through life asset management. The authoring tools typically export data in an open format such as IFC or COBie. The IFC and COBie data schemas are large and only a portion of the schema may be required to supply the information for the asset management information system. However, the schema may not fully address all of the data requirements for an object which requires additional attributes to be defined. For data to be extracted from models in an open-data format and provisioned to these systems, the modelling standards must define the rules for non-graphical data.

It is essential to consider whether there are any security implications related to the Level of Detail required and where there are, to take appropriate and proportionate measures to protect sensitive information.

Not all asset management and computer-aided facility management systems will accept data using IFC or COBie. In such circumstances, the data rules will inform creation of a data dictionary which will be required for additional technology to be deployed to take open data from the Common Data Environment and push it to the target systems.

Table 5.6 shows an example of the non-graphical data required for a TfL feeder pillar using the COBie schema, identifying the extent of new attributes required for a single asset type.

Feeder pillar attribute	COBie attribute
Borough Name	Region
Identity Code	Component-Asset Identifier
Shell Size	New attribute required against component or type
Paved Working Area	New attribute required against component
Electricity Supplier	New attribute required against component
Cable Type	New attribute required against component
Cable Size	New attribute required against component
Cable Cores	New attribute required against component
Earth Electrode	New attribute required against component
Main Bond CPC	New attribute required against component
Supplementary Bond	New attribute required against component
Lockable Multiple Isolator Rating	New attribute required against component
Fuse Type	New attribute required against component

Feeder pillar attribute	COBie attribute
Fuse Rating	New attribute required against component
CB Type	New attribute required against component
Power Socket 13a	New attribute required against component
Has a Meter	New attribute required against component
MPAN (Meter Point Admin No)	New attribute required against component
Isolation Point	New attribute required against component
Isolation Type	New attribute required against component
Elect Test Cert Ref No	New attribute required against component
Installation Date	New attribute required against component
Installed Under Scheme ID	New attribute required against component
Last Modified Under Scheme ID	
Work Order ID	
Update Type	

Table 5.6 Example of the non-graphical data required for a TfL feeder pillar.

In assessing the level of effort required to establish modelling standards, it is recommended that asset owners engage with peer organisations who have already adopted or are in the process of adopting level 2 BIM to seek advice and support.

5.1.7.4 Classification

A classification system is a structured approach to organising asset information based on common characteristics. Uniclass2015 is a unified classification for the UK covering all construction sectors.

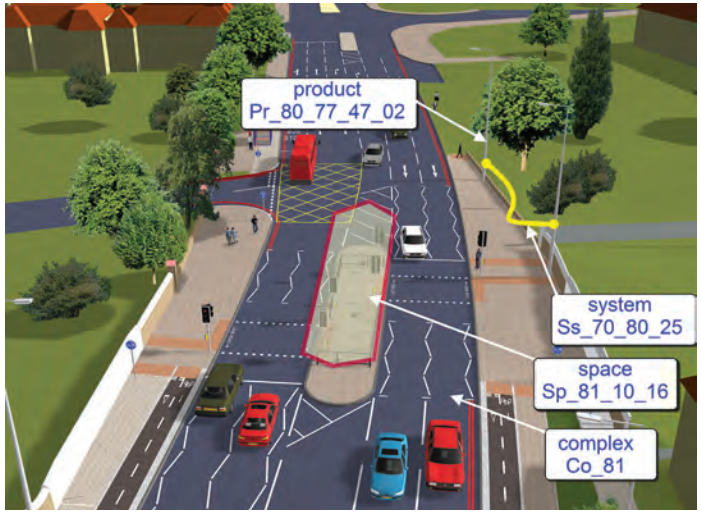


Figure 5.12 Example of Uniclass 2015 Classification application.

The UK BIM standards and publicly available specifications assume that Uniclass 2015 will be adopted as a unified approach to classification, ensuring that information is universally structured regardless of the author.

Whilst Uniclass 2015 is mature for building assets, it is still being developed for infrastructure. The NBS, along with a number of partners, has been contracted by the Government's Technology Strategy Board, now known as Innovate UK, to complete Uniclass 2015 for all asset types.

Highways England and the Environment Agency have been working with the NBS to map their assets to Uniclass 2015. To ensure alignment, Transport for London is using Highway England's Uniclass 2015 tables to complete the mapping of its highway assets. It is recommended that highway authorities should, through the Road Liaison Group, build on this common approach to ensure that Uniclass 2015 is adopted in a unified way.

Detailed descriptions of the Uniclass 2015 tables (shown in Figure 5.13) are included in the following paragraphs.

Complex (Co): A complex is at the top level of the hierarchy tree. It is essentially a spatial container and the area it covers will contain a large-scale collection of entities such as a road network. In a road network example it would need at least one junction entity and a section of carriageway. In many situations the project will define the boundary of the complex. Other examples of complexes will include canal systems, rail networks, hospitals and universities. Some of these are more critical than others, but each has the role of a container.

Entity (En): An entity is at the second level of the hierarchy. It is a discrete unit or independent construction. Examples include road junctions, the sections of carriageway that join these junctions, bridges, tunnels and buildings. Again, this is a spatial container and depending on its scale and complexity could be elevated to the status of a complex. An example of this complexity would be a large scale gyratory.

Element (Ee): An element is at the third element of the hierarchy and will form the 'building blocks' for entities. Examples include foundations, walls, retaining walls, kerbs and abutments. The construction of these elements will normally require the efforts of more than one discipline or trade. Similar Elements will collectively serve a common purpose such as the substructure of a building.

System (Ss): A system is a series of connected products (see below) which unite to form a common purpose. A good example is a network of lighting columns, feeder posts and the cables that connect to form a lighting system. Typically they are designed by a specialist team and may sit on or within the elements mentioned above. Drainage which relies on pre-constructed elements, including trenches, inspection chambers and manholes, is an example of a system. Multiple systems will often reside alongside each other such as the infrastructure within trenches and draw pits. Systems will generally require regular maintenance and therefore their identification, location, labelling and access require careful consideration. Dedicated asset inventories will store this essential information to support the effective maintenance of these systems.

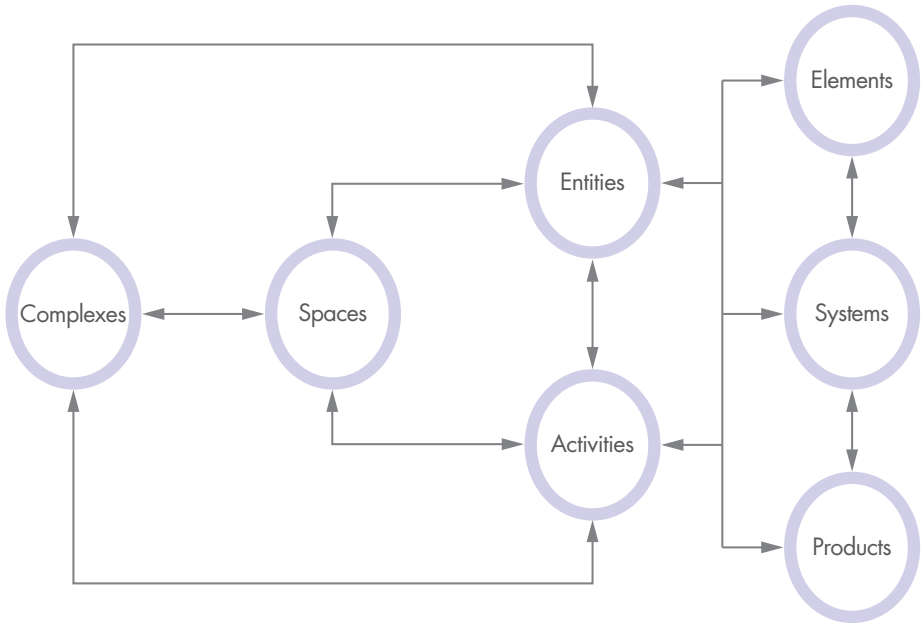


Figure 5.13 Uniclass 2015 tables.

Products (Pr): A product is at the lowest level of the hierarchy and will often be an off the shelf item with a unique manufacturers identification. They may be procured in bulk and delivered to site with specific installation instructions. The specific manufacturer has the greatest knowledge of the product and this information should be stored or linked to the asset inventory to assist in effective maintenance. Examples of products include lamp columns, gullies, railings and bridge bearings. Although not usually maintained, products such as concrete and steel reinforcement would also fit within this category and require specialist design guidance.

Spaces (Sp): Complexes and Entities are designed to serve specific purposes such as the transport of people and goods. To achieve these there needs to be dedicated 'spaces' to ensure that smooth and efficient journeys are achieved. These dedicated spaces will often be delineated by site boundaries, specific road markings and signage may be included to inform the users of these spaces. Systems may also be installed to improve or monitor the performance of these spaces, for example lighting and CCTV.

Activities (Ac): Whilst some spaces will be dedicated to a specific activity, other spaces will need to accommodate multiple activities. A prime example is a carriageway which will serve the needs of cyclists, cars, buses and heavy goods. At junctions and crossing points, pedestrians will also share this common space. Therefore, the spaces must be designed with these multiple activities in mind and additional 'systems' such as railings and signals must be installed to help segment the 'activities' and streamline their flow.

Further information on Uniclass 2015 can be found on the NBS website https://toolkit.thenbs.com/articles/classification.

5.2 Enabling Tools and Technology

5.2.1 Introduction to Enabling Technology

In terms of understanding enabling technologies, the successful transition to BIM can be seen as a journey — from tools, to platform to environment. Many first time adopters make the mistake of viewing BIM as just a 3D modelling software programme (or programmes) designed to carry out specific tasks for the design and construction sector. Later they start to understand BIM as a platform that can manage data input from different users, before moving in to the concept of BIM as an environment, e.g. the Common Data Environment — see Section 5.2.2. A BIM environment can support multiple platforms, assimilate and process data from different models, and can provide multiple representations of the environment.

It is important to understand that even the BIM tools used for design and coordination purposes are quite different to Computer Aided Design (CAD) tools that many readers may already be familiar with. The key difference is the data behind them. CAD tools are generally used as electronic versions of drawing boards, where collections of lines, shapes and text, with fixed geometry and properties, are represented on a screen and later printed out as 2D drawings. Thus CAD drawings are often referred to as 'dumb' drawings as they contain no real intelligence behind the lines.

However, the models in BIM environments represent data. The models can be thought of as visual representations of the databases behind them. Rules, behaviours and relationships can be built-in so that changes to one component are reflected in related components and across different views (known as parametric behaviour). We are also starting to see more use of automatic data validation, where models can automatically be checked against the brief, for example, for clashes or errors.

5.2.2 Common Data Environment Requirements and Solutions

A Common Data Environment (CDE) is a collaborative digital environment that everyone on a project can access, in accordance with the guidance given in BS/PAS 1192. A CDE provides a means to exchange and coordinate information with the entire supply chain/stakeholders thus forming a controlled information delivery cycle. It is about providing common information in a common environment. However, we recognise that in relation to sensitive assets and systems, access to some information may need to be restricted on a need-to-know basis in accordance with the guidance contained in PAS 1192-5. As the use of CDE matures, there is an increasing acceptance that a CDE can be comprised of a number of different information systems that are integrated together to form an integrated data environment.

The CDE has two key objectives.

1. To enable accurate, up-to-date and reliable information (structured data and documents) about the 'Operational State' of the infrastructure owner's assets to be held in a common and readily accessible format.

2. To support the management of the creation, assurance, sharing, dissemination and coordination of in 'Development State' information (structured data and documents) generated as part of major works, minor works and maintenance activities.

The CDE needs to control revisioning and indexing, and maintain an audit trail. The best way to handle this is through a software solution. This is an area which is developing rapidly and needs to be thoroughly investigated when considering a solution.

When defining requirements for and procuring a CDE, it is crucial to consider how it fits into the overall organisational strategy as well as the BIM strategy. In considering the requirements for a CDE, we recommend the following is considered.

- How will information be exchanged from a CDE to existing information systems such as asset management information systems? Which system will hold master information and which will be the slave?
- Is it capable of meeting the organisation's specific security requirements?
- In terms of existing systems the following needs to be considered:
  - Retention and replacement plan for existing information systems.
  - Do existing systems support push or pull data?
  - Do they use open data?
  - Does the existing IT architecture include an Enterprise Service Bus that can be deployed to push data from the CDE to the other systems and pull data back?
- Retention of current local/network drives for producing information before it is ready for sharing.
- How the Infrastructure organisation wishes to work with the supply chain:
  - Fully collaboratively (provide a CDE to meet the needs of all).
  - Intelligent lean client organisations where the key interest is in the information required at data drops and asset management trigger events (provide a CDE that only provides employer's shared, published and archive).
- Treatment of correspondence.
- Requirement for additional functionality such as a NEC3 contract management tool.
- Information security and retention policies, including Firewall configuration regarding access to third party applications and external users.
- Capability — capacity and subject matter expert knowledge of internal IT resource.
- Capability of your existing and potential future supply chain in terms of BIM and supporting technology.
- Performance of existing internet connections.
- Performance of existing hardware, i.e. is a hardware refresh required to support the use of a CDE?.
- Restrictions on procurement of technology, i.e. maximum duration of contracts for Software as a Service and future data migration strategy.

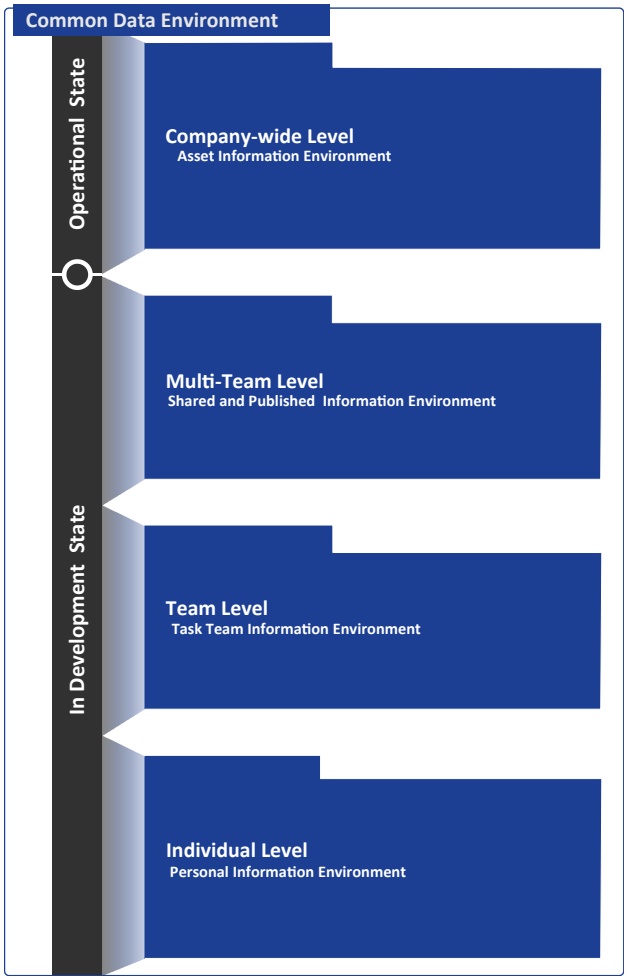


Figure 5.14 Transport for London has defined their CDE as having four levels.

Figure 5.14 shows how Transport for London has defined the CDE in for different levels:

- Company-Wide: Asset Information Environment. Dedicated to asset information in 'Operational State'.
- Multi-Team: Shared and Published Information Environment. Dedicated to managing in 'Development State' information that is shared amongst multiple Task Teams (Major works, Minor Works and Maintenance).
- Task Team: Work in Progress Information Environment. Dedicated to managing in 'Development State' information that is shared amongst a single Task Team (Major Works, Minor Works and Maintenance).
- Individual Level (Personal Information Environment).

5.2.2.1 Example CDE architecture diagram

Figure 5.15 is the CDE architecture diagram created by Transport for London as part of their technology strategy to define the enabling technologies to support their BIM change programme. It identifies the key capabilities that are required at each level of the CDE.

Company-wide — Asset Information Environment

At Company-Wide level, the proposed architecture building blocks create an Asset Information Environment, which simplifies the collection, validation, presentation and re-use of the asset owner's asset data and information, in a way that is compliant with the organisation's security requirements. The Asset Information Environment will primarily support the information processes identified in PAS1192-Part 3, and provide a view of data and documents which are not necessarily collated into the Asset Information Environment itself. Through data integration and virtualisation techniques ,it will be possible to view and analyse data that is maintained and stored within the existing asset management information systems.

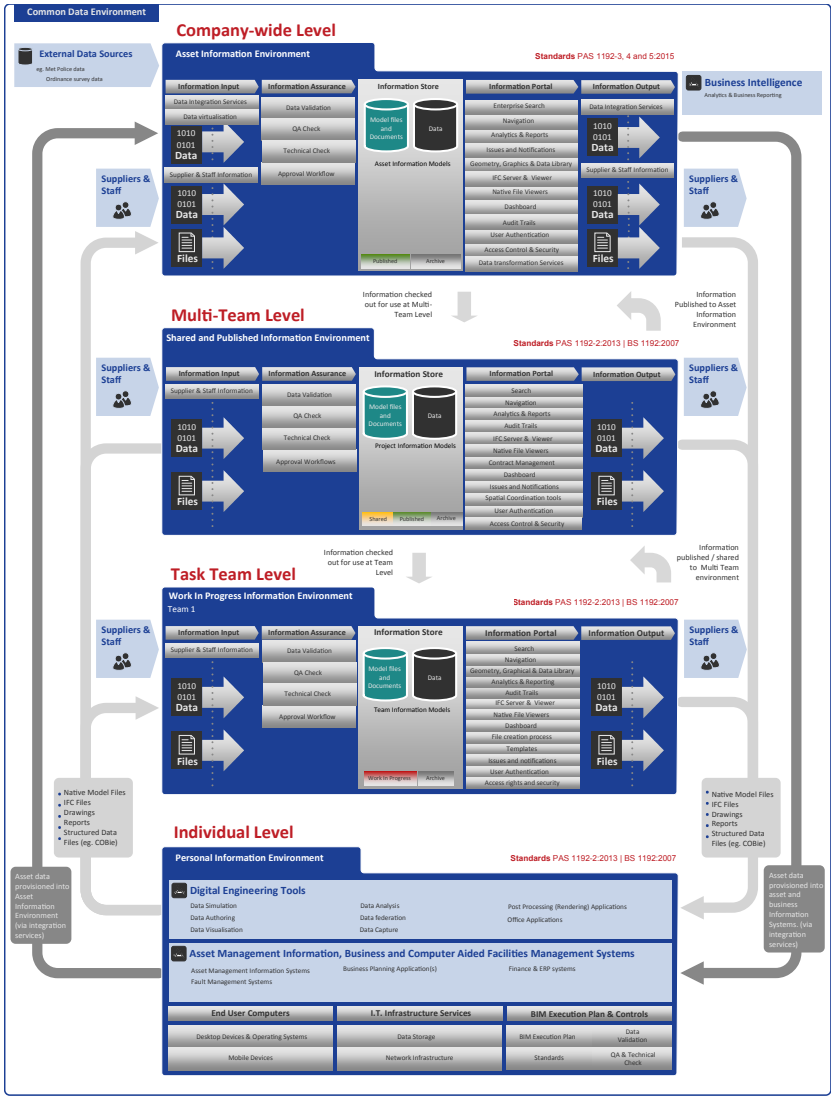


Figure 5.15 Transport for London CDE architecture diagram.

The single source of approved validated information related to an asset is known as the Asset Information Model (AIM). The Asset Information Environment will host discrete AIMs of documents and data that represent the operational state of assets.

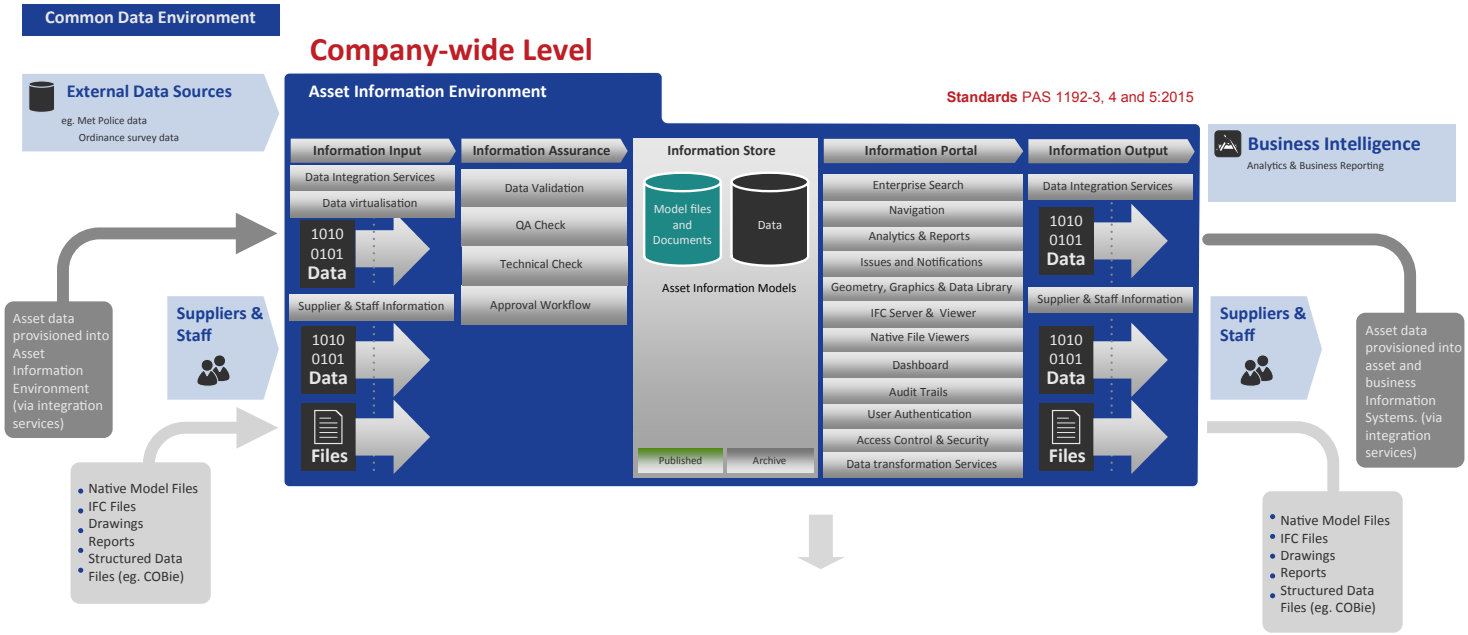


Figure 5.16 Transport for London Asset Information Environment.

Multi-team — Shared and Published Information Environment

At the Multi-Team level, the primary architectural building blocks make up a Shared and Published Information Environment. This provides staff and suppliers with the capability to manage the coordination and dissemination of native format and IFC models, datafiles and documentation, in a way that is compliant with the organisation's security requirements. It will also provide integration with Pathway, allowing document checklist creation and auto-generated file referencing. The system would be configured to enable the collaborative processes and procedures described in BS1192:2007 and PAS 1192 — Part 2 and serve as a project collaboration platform for staff and suppliers to share, coordinate control and manage multi-task team data and information. The Shared and Published Information Environment will be capable of managing the iterative development of native format and IFC format models, documents and datafiles required to achieve spatial coordination and meet design requirements.

The 'Shared and Published' environment will also include Contract Management workflow tools to help manage the key commercial processes with your suppliers.

Task Team Level — Work in Progress Information Environment

At the Task Team level, the primary architectural building blocks will deliver a Work in Progress Information Environment to help with the control and coordination of information at a task level. This environment will enable each Team to share and coordinate their own data and information prior to sharing it with other internal and supplier Teams. Compliance with the organisation's security requirements will therefore still be important.

The primary objective is to bring control and assurance to information creation and coordination processes at Team level. This type of environment will foster greater levels of collaboration within Task Teams by allowing them to efficiently share and coordinate 'work in progress' native format and IFC models, datafiles and documentation. For smaller organisations there may only be one task team depending on the level of adoption of BIM practices within the business.

The Work in Progress Information Environment must be able to connect geographically dispersed teams and will need to facilitate work-sharing, content re-use, review and provide approval capabilities in a managed environment. It will also need to enable Task Teams to manage information productivity effectively through the use of applications and workflows.

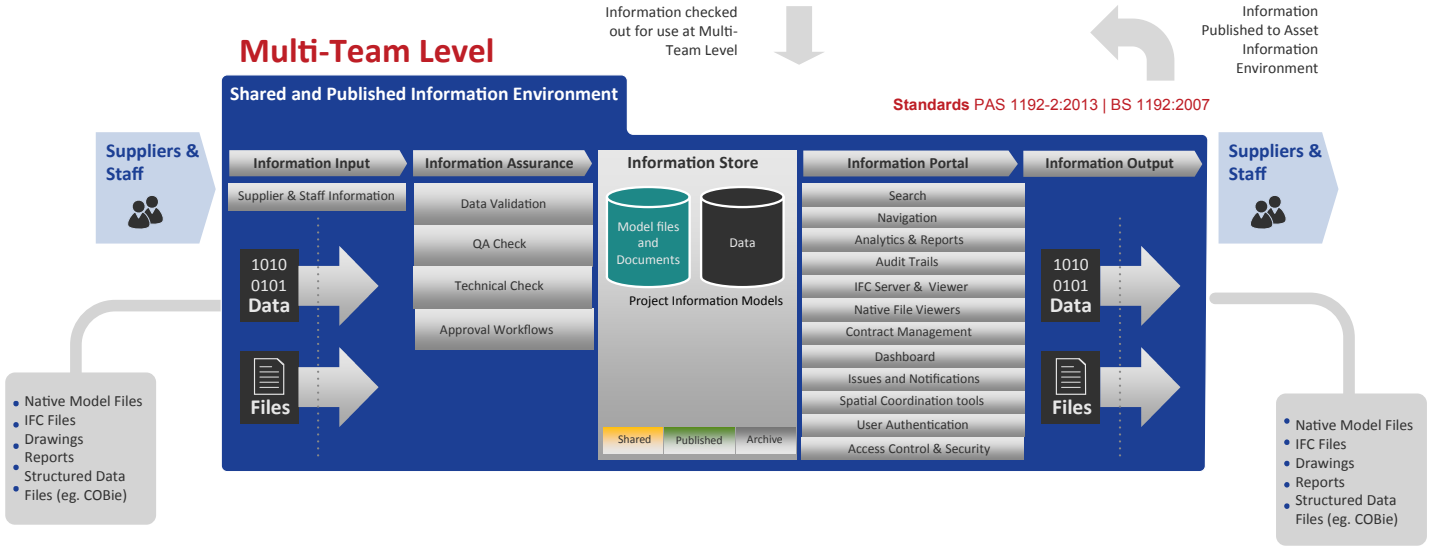


Figure 5.17 Transport for London Shared and Published Information Environment.

Individual Level — Personal Information Environment

At Individual level, the primary architectural building blocks create a Personal Information Environment or end user computer environment which delivers the necessary digital engineering applications.

The Personal Information Environment will need to use the IT services including digital engineering applications that facilitate data authoring, data capture, data analysis, data visualisation and data simulation. It is primarily concerned with activities related to the development of the data and information and is reliant on the performance of the underlying network and hardware infrastructure.

The primary objective is to provide a stable platform upon which data and information can be created and used efficiently, using the appropriate tools for the activities being carried out by staff.

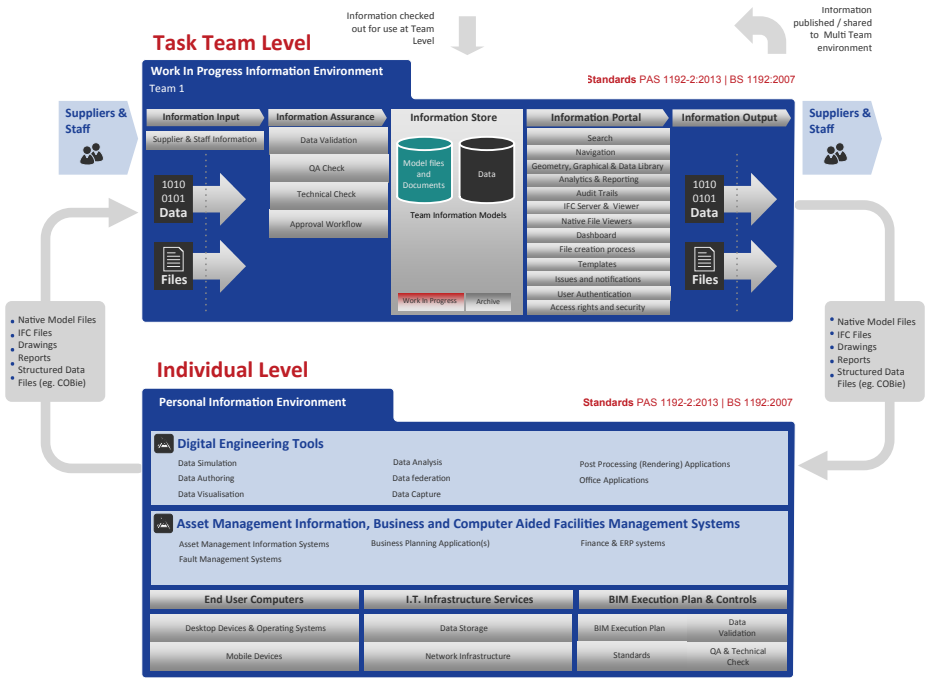


Figure 5.18 Transport for London Task Team and individual Work in Progress Information Environment.

5.2.2.2 Developing a CDE architecture diagram

A CDE has two key environments:

- The Project Information Model (PIM) which provides a single source of approved validated information relating to projects.
- The Asset Information Model (AIM) which provides a single source of approved validated information relating to assets.

In reviewing the As-Is IT system architecture and assessing the potential To-Be IT system architecture, the capability of existing asset management and computer aided facility management systems need to be considered. Asset maintainers and operators will typically be interfacing with these systems on a day-to-day basis and hence these systems typically form a key part of the AIM. Figure 5.19 identifies a series of steps to ascertain how the AIM should be established.

In completing these steps, Figure 5.20 provides four options as to how the high level system architecture can be configured:

- **Option 1**: CDE vendor provides the PIM and AIM and provides the functionality to push and pull data to the existing information systems.
- **Option 2**: CDE vendor provides the PIM and AIM. The asset owner provides the functionality to push and pull data to the existing information systems.
- **Option 3**: CDE vendor provides the PIM and provides the functionality to push and pull data to the existing information systems. Existing information systems provide the full AIM functionality.
- **Option 4**: CDE vendor provides the PIM. Existing information systems provide the full AIM functionality. The asset owner provides the functionality to push and pull data to the existing information systems.

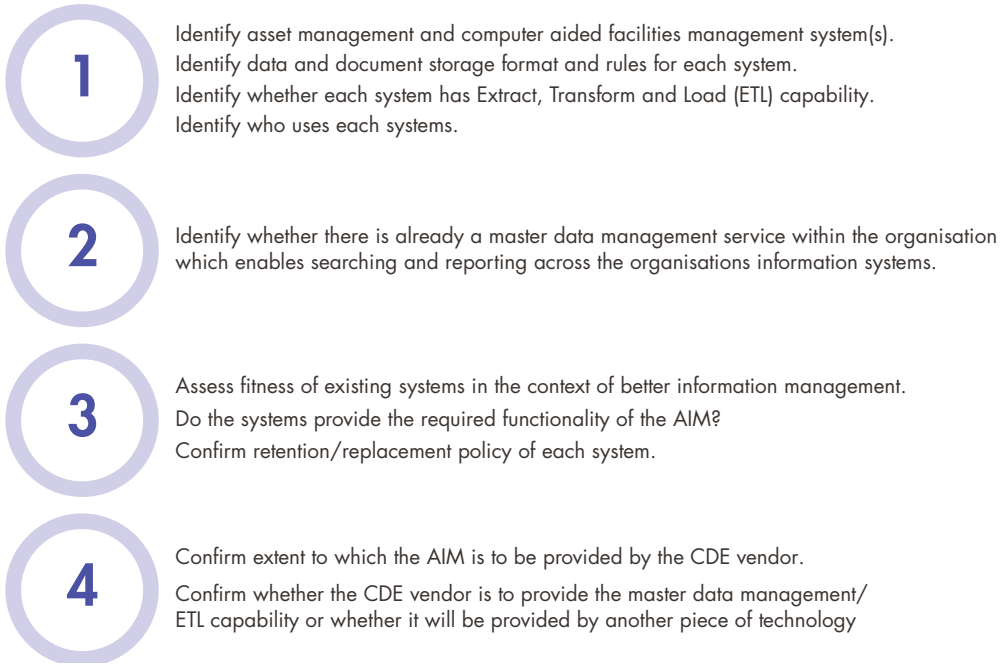


Figure 5.19 Key steps to follow to ascertain how the AIM should be established.

In adopting BIM, the procurement of a CDE is likely to be one of the longest activities on your programme and needs to be in place to support the business mobilisation activities detailed in Section 5.3. The following are indicative times:

- Prepare functional specifications and user requirements — 4 to 6 months.
- Procurement — 6 months.
- Configure and test — 6 months.
- Roll out across the Infrastructure organisation and the supply chain — 3 to 6 months depending upon the number of people.

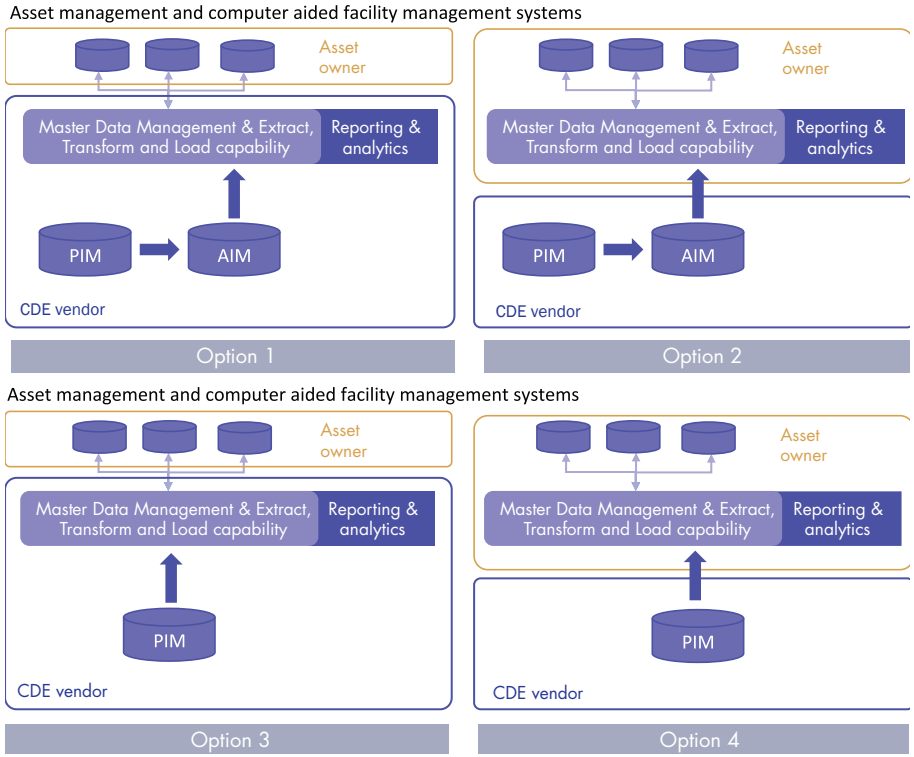


Figure 5.20 Graphical representation of the four options with provision of the AIM and the pushing and pulling of data to information systems.

Many IT systems are protected by firewalls which block collaborative working with the supply chain and other stakeholders. Procuring the CDE as a software service using web technology, which can be accessed securely from offices and mobile devices, is one way of enabling authorised users to access it easily. However, where the CDE will be holding sensitive data and/or information, further advice should be sought on appropriate CDE solutions (see PAS 1192-5 and current guidance on cloud-based services available on the CPNI website).

5.2.3 Digital Engineering Tools

The range of software tools available to support digital engineering is rapidly expanding. When selecting a tool, or tools, it is important to consider whether they suit the tasks they are to be used for, and how interoperable they are with the systems used by other stakeholders on a project. In terms of interoperability, open standard file formats should be supported. BuildingSMART is the international non-profit industry body responsible for developing and promoting the use of open standards for sharing BIM data.

The most widely used open file formats are:

- Industry Foundation Classes (IFC), supporting transfer of 3D information models
- COBie (a 2D spreadsheet format) for transferring asset data (a requirement of PAS 1192)
- BIM Collaboration Format (BCF), which is an open XML format supporting workflow communication in BIM projects

Many people confuse BIM with 3D graphical modelling. However, a 3D model is only a small component of many BIM projects, particularly in the asset management and infrastructure sectors.

The major digital engineering tools can be separated by the types of tasks they are used for, as follows:

- Creation of graphical objects and building models, including data about the objects and their behaviour.
- Model Co-ordination and Clash Checking.
- Management of associated 4D (scheduling) and 5D (cost) data.
- File Sharing and Collaboration Tools.
- Data validation tools.
- Discipline-specific tools, e.g. structural or MEP analysis tools.
- Specialist 3D visualisation/navigation tools.

The choice of tools that an organisation requires will depend on internal capabilities. In many instances free to use tools may be sufficient. The following table provides guidance on the tools that may be required to support different capabilities:

	Digital tools				
Capability	Engineering modelling software	Model federation/ checking software	Free Model viewing software	4D scheduling software	5D cost modelling software
CAD teams	Required	Required	Required		
GIS teams		Required	Required		
Design Managers/Coordinators		Required	Required		
Engineers/Technical Approval staff		Required	Required		
Maintenance and operations			Required		
Project Managers			Required	Optional — 4D scheduling software provides benefits on complex, not necessarily large, projects.	
Planners			Required	Optional — 4D scheduling software provides benefits on complex, not necessarily large, projects.	
Commercial/Estimators			Required		Optional — software enables quantities to be taken directly from models.

Table 5.7 Guidance of what tools may be required to support different capabilities.

5.2.4 Mobile BIM and data capture

Mobile data capture is extensively used within existing asset management and computer aided facilities management systems to distribute work instructions, log the completion of tasks and update asset information. Most of the BIM tools have evolved as desktop applications for use in an office. Many CDE vendors' web-enabled products work on tablets as well as laptops/desktop computers. However, most vendors are now working on expanding their use to construction sites and other field-based applications, e.g. access to the digital models and associated data for operations and maintenance. Other vendors are creating applications to make use of and push data to a CDE.

These tools tend to rely on the power of cloud computing, enabling the use of mobile devices such as tablets and smartphones to view and update BIM data. The tools can run in lightweight apps, with processing handled by the cloud. Portions of models can be checked out when users have internet access, and taken to site (where there may be no internet access). Then the device can scan, for example, a QR code or other bar code, locate their position in the model, take pictures with the device and make notes. When internet access is next available, all of this information can be uploaded and the model updated automatically. The apps used can be customised to resemble current manual systems, e.g. checklists, to ease transition to the new way of working.

The ability to access the latest published information on-site is a valuable benefit to both project and asset management teams. Being able to access and use up to date models in the field enables augmented reality to be used. Augmented reality is where the handheld device superimposes an image from the device's camera upon which an element of the BIM model can be superimposed to enable on-site planning and interface management activities to be undertaken at the point at which the work is to be undertaken. The tool also provides the ability to check that element of work.

Similar to mobile data capture used by asset management and computer aided facilities management systems, the following are mobile BIM applications that support project activities:

- Surveillances and Inspection & Test Plans (ITPs).
- Clean Up Notices, Non Conformance Reports.
- Requests For Information.
- Technical Queries.
- Early Warning Notices.
- Change Requests.
- Site Plant Checks.
- Confirmation of verbal Instruction (CVIs).
- Site Inspections.
- Permits to Work.
- Health and Safety Accident and Incident Reports.
- Safety Improvement Notices.
- Site Diary and Daily Record Application.
- Site Photo records.
- Snagging.
- Waste and disposal tracking.

Where mobile technology is not currently deployed, the above mobile BIM applications could be used to support asset management activities as well as projects.

In assessing the need for in field tools, an assessment of the current in field technology currently deployed should be undertaken. This will allow the identification of gaps in capability along with the need for new capabilities, such as being able to view models in the field, which require new tools. Having identified a need, tools should be evaluated carefully, especially in relation to the organisation's security requirements, prior to adoption for particular asset management activities and projects.

5.2.5 Security-minded approach

The adoption of BIM promotes more transparent, open ways of working and the sharing and use of both detailed models and large amounts of digital information. However, for the trustworthiness and security of the resultant digital built assets to be delivered, inherent vulnerability issues need to be recognised and addressed. The adoption of a security-minded approach does not seek to undermine the collaborative approach which BIM promotes, rather it encourages the implementation of an appropriate, proportionate, need-to-know measure for the sharing and publication of information that could be exploited by those with hostile and malicious intent. The precise nature of the approach adopted will depend on the sensitivity of the assets and asset information in question, as well as the risk appetite of the organisation to which they belong.

A Publicly Available Standard (PAS) has been developed to assist employers and asset managers to address any vulnerability in the management of their asset data. This standard is PAS 1192-5:2015 and is more comprehensive than ISO 27001.

Information assurance (IA), which ISO 27000 seeks to deliver, includes protection of the integrity, availability, authenticity, non-repudiation and confidentiality of user data and information. However, it excludes key elements related to the asset information and the design and operation of computer-based systems in the built environment — namely safety, possession and utility. The ISO 27000 standards will therefore not be sufficient alone, even when applied in full, to ensure that asset information is secure throughout an asset's lifecycle.

PAS 1192-5:2015 requires the asset owner to consider not only certain information pertaining to sensitive assets and systems not otherwise generally visible directly or through other sources, but also that which when aggregated or associated with other data, could compromise the safe and secure operation of an asset.

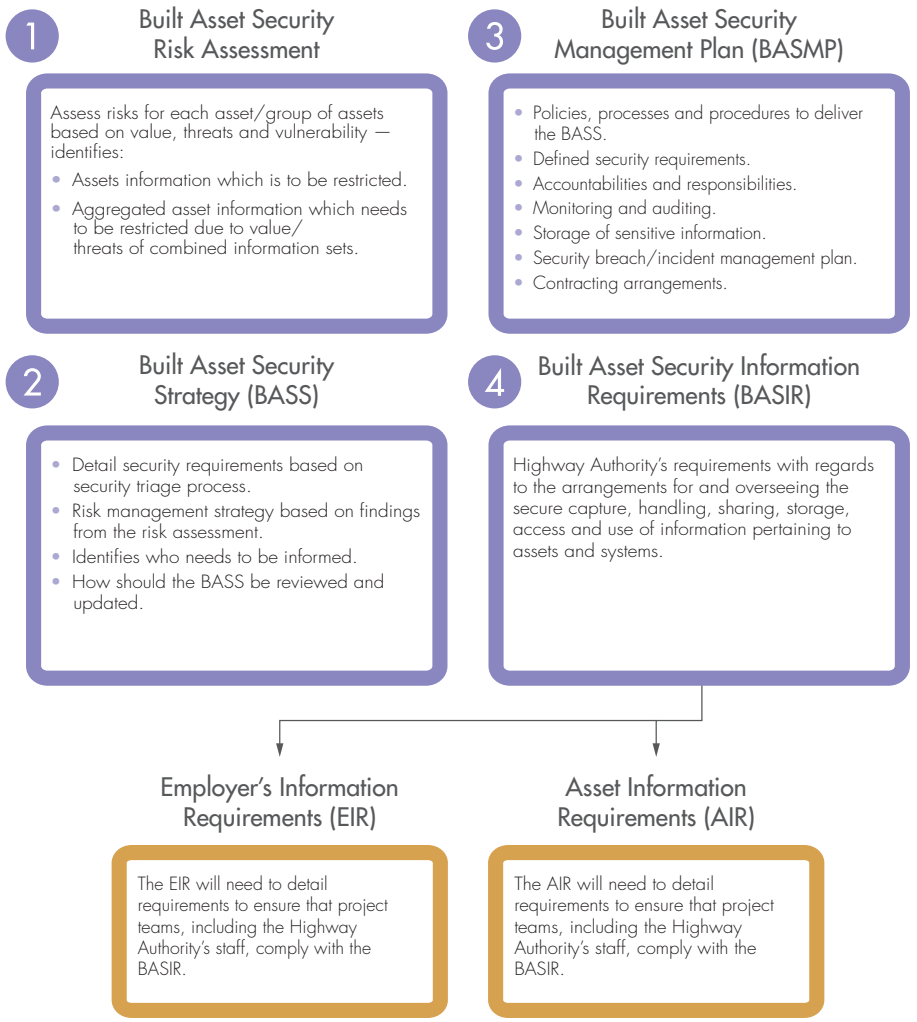


Figure 5.21 Summary of the key aspects of PAS 1192:5-2015 and how they feed into the EIR and AIR.

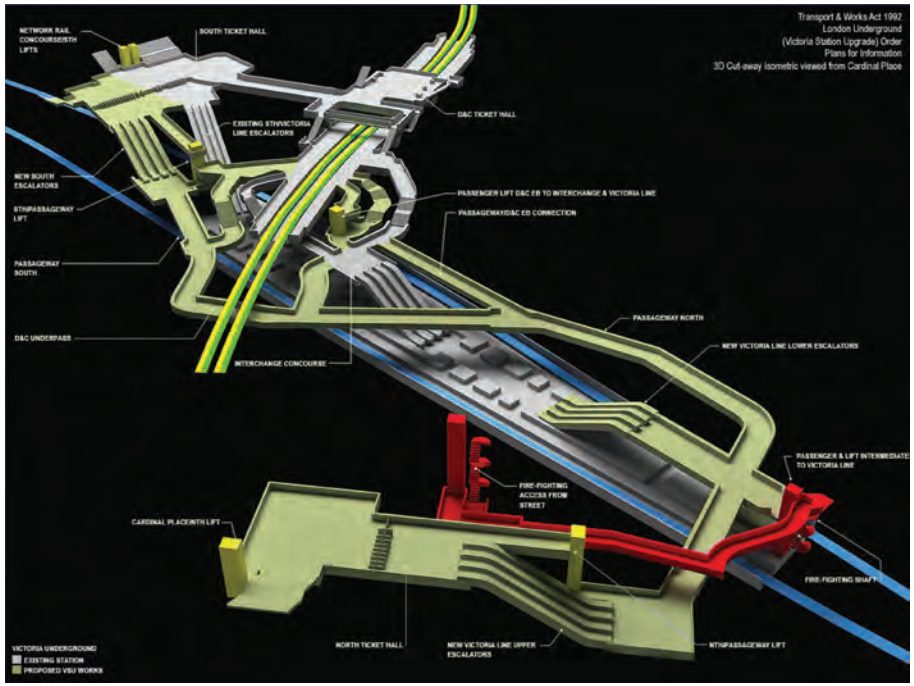


Figure 5.22 Victoria LU Station Upgrade Project example — a major passenger transport interchange.

Implementation of the measures outlined in the PAS can also be used to minimise the risk of loss, theft or disclosure of commercial information and intellectual property – incidents which can lead to significant reputational damage, cost, and disruption of operational activities. The key aspects of the PAS are detailed in Figure 5.21.

Figure 5.22 shows a 3D model of the Victoria LU station which has been extensively published in the press and is a great illustration of the challenges in this area.

While images such as these can demonstrate project complexity and benefits that BIM will bring, an assessment should first be carried out to determine whether they provide useful information, not otherwise generally visible directly through other sources, to those with malicious or hostile intent. It is important to remember that once information has been published, it is virtually impossible to delete, destroy, remove or secure all copies of it.

In terms of Highway Authorities, the security risks and threats often relate to structures and in particular tunnels and the tunnel system. Other threats may include traffic monitoring and control systems along with sensitive fibre optic cables installed in the verges, which may be owned by the Highway Authority or a third party.

When assessing the risks, consideration should be given to the nature of harm which could be caused to: personnel and other occupants or users of the built asset and its services; the built asset itself; asset information and/or the benefits the built asset seeks to deliver, be they societal, environmental and/or commercial.

The measures adopted to mitigate the identified risks should take into consideration people, process, physical and technological aspects of the built asset, asset-related systems and the associated asset information. They should therefore include:

- Built asset security policies, processes and procedures.
- User awareness and training in relation to security.
- Protection of the project and asset management technical infrastructure.
- Protection of asset systems and infrastructure.

The UK Government has started planning for BIM Level 3, which will involve greater integration of project teams and a move towards smart cities involving interconnected asset data. In parallel with this, industry bodies such as the Institution of Engineering and Technology (IET) have formed working groups to develop further guidance on cyber security.

5.3 Business Mobilisation

Implementing BIM successfully depends upon new ways of working that integrate people, information, technology and processes. To deliver these new ways of working and associated BIM benefits it needs to be targeted to the right individuals in organisations. Activities involved in business mobilisation include:

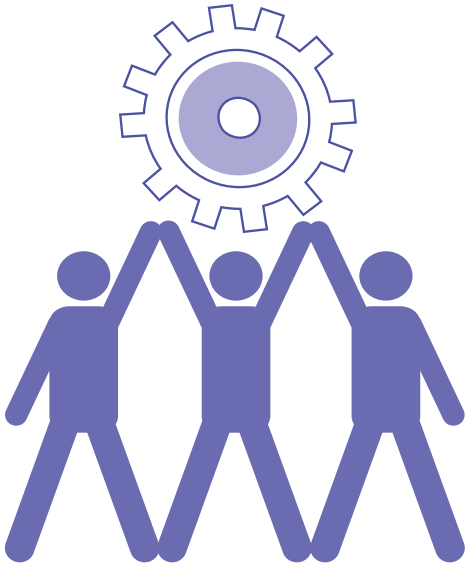
1. Process Change (see Section 5.1.6.2 and 5.1.6.3 above):
    - Understanding the current information production and management processes within the organisation and the challenges and opportunities, including the need for a security-minded approach, that BIM implementation should look to address.
    - Building the Information practices and protocols into a future information production and management process.
    - Using the future process and the overarching BIM strategy to understand the full picture of the activities and skillsets required within the business to successfully deliver to the new BIM ways of working.
2. Roles and Responsibilities
    - Evaluating the impact of these required activities and skillsets on existing roles and responsibilities.
    - Understanding whether additional roles or resources are required to respond to the defined activities and skillsets.
3. Skills and Training
    - Developing the required skills and behaviours within all roles (new and existing) to support these activities.
4. Contract Changes
    - Understanding the implications of the future strategy and process on the Supply Chain and undertaking the required Supply Chain training and contract change to respond to these.

Any organisation, that looks to implement BIM without undertaking the activities described, risks introducing practices, protocols, standards, models and technology that are not successfully embedded into business-as-usual and are therefore not taken up by the business. The following sub-sections focus upon the considerations and approach that we recommend are taken to ensure these critical components are delivered effectively.

5.3.1 Roles and Responsibilities

To understand what roles and responsibilities are required it is important to distinguish between implementing BIM versus BIM as business-as-usual. To implement BIM the roles and responsibilities will need to include programme management, change management as well as training. Whereas, for business-as-usual, these will include technical responsibilities such as the application of Information Standards.

Table 5.8 overleaf details indicative roles and responsibilities to implement BIM. Depending upon the size of the organisation, the level of BIM maturity in the organisation and resources available, these can be scaled accordingly.



Role	Typical Responsibilities	Why/when you need this
Project/Programme Leader	• Developing and managing the plan ensuring achievable outcomes and dates. • Control and manage the budget.	• Depending upon the level of change required a project manager will enable the organisation to deliver the change on time and within budget. • In particular if an organisation moves from level 0 to level 2, i.e. the level of change has a significant impact on people, processes, systems and ways of working.
Sponsor/Executive Leadership	• Represents the users requirements. • Ensuring desired outcomes are achieved. • Provides direction and removes (organisational) obstacles.	• To ensure executive leadership and buy-in.
Change Management Expert	• Communications. • Stakeholder Management. • Training material and train the trainer. • Engagement. • Dealing with resistance. • Skills assessment.	• No matter the level of change it is advisable to use change expertise in order to deal with resistance, obtain buy-in, engage with stakeholders, provide training and embedding the changes to business-as-usual.
Information Expert	• Information Standards. • Modelling. • Information Requirements. • Support to technology requirements and or procurement.	• To be in place prior to the roll-out of the new ways of working across the organisation. • To support the embedding of the change into the organisation and supply chain. • Lead continual improvement process for information. • Carry out compliance surveillance.
Built Asset Security Manager	• Providing a holistic view of the security issues and threats to be addressed. • Offering guidance and direction on the handling of the resultant risks. • Development and maintenance of the BASS, BASMP, Security Breach/ Incident Management Plan (SB/IMP) and BASIR. • Development and review of all other strategies, policies, documentation and procedures where security-minded content is required. • Promoting a security-minded culture.	• Where the Highway Authority has identified the need for a security-minded approach to be adopted, either in relation to some its own assets or because it holds sensitive information about neighbouring assets, it should nominate a suitably qualified and experienced individual to fulfil the role of Built Asset Security Manager. Within this type of organisation, it is likely to be a part-time function that can be fulfilled by an individual with other duties. The full details of the role are set out in Clause of PAS 1192-5.
Process Expert	• Analyse and document business processes and workflows. • Develop responsibility assignment matrices.	• To understand the gap between current (As Is) and future (To Be) ways of working. • To carry out works before implementation and roll-out of new ways of working.
Legal Expertise	• Contract changes.	• Applicable if the organisation decides to change their contractual arrangements with the supply chain.

Table 5.8: indicative roles and responsibilities to implement BIM

For business-as-usual roles and responsibilities the process mapping as described in Section 5.1.6.2 and 5.1.6.3 is a starting point to understand changes and additions to existing roles. In certain instances, new roles will need to be created to take on the responsibilities that come with BIM and in other instances people will need to change the way they do things. Some organisations might want to change and/or update relevant job descriptions as a result of the identified changes.

At the end of process mapping, a series of process maps and schedules of information will have been developed as described in Section 5.1.6.3. These outputs constitute the basis for role mapping. Role mapping defines how organisational roles are linked to process activities and which roles are connected to what products and people in the proposed (To-Be) processes. This will provide a picture of which roles will be affected by BIM adoption.

Role Mapping aims to assign BIM-related responsibilities and tasks to the employees that will adopt BIM. The asset owner needs to extract these responsibilities as designed in process mapping and assign them to specific roles across the organisation. Role Mapping shall involve a series of discussions with senior management (and Human Resources where appropriate) on the new responsibilities identified. This engagement will ensure that additional responsibilities align to the workload of the various roles. During this engagement process there might be a series of iterations required to ensure that feedback is incorporated in role mapping and consensus is reached. Where appropriate, redistribution of tasks and/or additional support roles may be required to help employees fill their duties.

An impact assessment of the additional responsibilities on existing roles could help facilitate this engagement process with senior management. Reviewing existing workload of the affected roles, and analysing the additional effort required to fill any BIM-related responsibilities, shall provide a picture around the extent of change expected in the various roles affected. Depending on the extent of the change this could result in the need to create and recruit for additional roles. This should be assessed as part of the business case development to ensure this is included and funding made available.

Please note that the asset owner can introduce appropriate controls to ensure the effective mitigation of any risks associated with change of roles. Senior management need to feel comfortable with both the additional responsibilities and what it means for the role as well as potential new roles.

Once agreed with senior management, role mapping outputs needs to be communicated with the wider business to ensure that all affected roles are fully aware and comfortable with their new responsibilities. An individual role mapping summary can be developed for all affected roles. This summary could include but is not limited to:

1. Overarching responsibility statement.
2. List of BIM-related activities/products.
3. Role's contribution to the adoption of BIM.
4. Areas of support provided by other parties.
5. Level of BIM capability expected.
6. Information related challenges/blockers addressed.
7. Other associated skills supporting the specific BIM-related responsibilities.

The output of the role mapping will provide an important input to the BIM training programmes as discussed in Section 5.3.2.3.

Examples of changes in roles

Role	Examples of new/updated responsibilities as a result of BIM	
Programme Manager	• Initial input into the information requirements for the projects in the form of the Employers Information Requirements. • Reviewing initial outcome definition documentation including – Stakeholder management plans. – Procurement strategies. – Business cases.	• Approval and review of core project delivery documentation including: – Project Execution Plans. – Consents Plans. – Cost Plans. – Lessons learned reports. – Risk draw downs. • Providing assurance at the review of financial close report stage.
Project Manager	• Allocate BIM roles within CDE at beginning of a project. • Ensure delivery of project deliverables according to BIM Protocol, i.e.: – Information deliverables meet requirements of the EIR. – Correct following of WIP and share process. – Correct document naming. – Information deliverables received within specified timeframes. – Information deliverables accurate/to correct Level of Detail, etc.	• Ensure project teams are clear on BIM responsibilities. • Approving core BIM deliverables including: – BIM Execution Plan. – Master Information Delivery Plan. • Identify BIM Process/Information/Technology/Training improvement opportunities based on experience of BIM within the project environment.
Designer	• Producing the relevant project management documentation according to the Employers Information Requirements and according to the specified Information Standards. • Project documentation includes: – Designer programmes. – Designer risk registers. – Cost plans. – Interpretive reports.	• Producing design information as required by the project including: – Whole life cost models. – Specifications. – Drawings. – Check certificates. – O&M plans, etc.

Table 5.9 Examples of changes in roles.

In addition and depending upon the scale of the organisation and the changes required, a dedicated BIM manager role(s) could be necessary. This could be a team of people or one individual who will be responsible for:

Ensuring the processes, ways of working, technologies, responsibilities, etc delivered by the programme are successfully adopted as part of business-as-usual.

- Ensuring continued governance of BIM.
- Providing expert advice and support.
- Maintaining and updating products and tools.
- Monitoring the long term realisation of the benefits of BIM.
- Identifying opportunities for continuous improvement of the approach to BIM within the business.
- Designing and implementing continuous improvement activities, i.e. how to move to level 3).
- Influencing the rest of the business to ensure continuous buy-in and prioritisation of BIM outcomes.

5.3.2 Skills and Training

5.3.2.1 Developing the Skills Framework

Delivering BIM requires a specific set of competencies to be developed within the organisation. The BIM Task Group have produced the "Initial BIM Learning Outcomes Framework" that provides guidance on what competencies to consider when developing and delivering training material. This framework can be found at http://www.bimtaskgroup.org/education-and-training/.

BIM capabilities or skills can be grouped at a high level into the following five categories:

- Strategic Alignment of BIM.
- Using BIM in the Asset Lifecycle.
- Enabling BIM through Information Practices and Technology.
- Support Functions for BIM.
- Maintaining and Improving BIM.

The competencies that sit within each of these five categories are listed in Table 5.10.

Competency Category	Overview	Relevant roles	Competencies Required
Strategic alignment of BIM	Competencies needed to make strategic decisions and drive long term BIM initiatives in line with the wider organisational strategy.	Heads of Information/ Data, Head of Asset Management/Head of Operations, etc.	• Providing leadership around BIM for the organisation: owning the BIM Strategy and aligning it with organisational strategies and objectives, communicating BIM benefits, engaging with key stakeholders and engaging with the industry. • Identifying opportunities to develop BIM capability. • Making strategic decisions, i.e. partnerships, changes to Supply Chain strategy, engagement of consultancies, in the continuous development of BIM capability. • Being accountable for security and, where appointed, have clear reporting lines from the Built Asset Security Manager.
Using BIM in the Asset Lifecycle	Competencies needed to manage and generate BIM deliverables for the design, construction, operation, maintenance, renewal, and disposal of assets.	Strategy and Planning roles, Project/Programme Sponsors, Project Managers, Designers, Operations/Maintenance Managers.	• Understand the information requirements for different stage gates. • Implement appropriate and proportionate security-minded policies, processes and procedures to protect sensitive information and systems. • Control the delivery of information deliverables on time and to the right quality. • Incorporate BIM risks and opportunities in risk management practices. • Use a CDE with defined processes and workflows. • Link together models or their components within the CDE, e.g. a 3D model to City Models or similar, or a financial model to a 3D model. • Use object-based software tools to capture and represent physical spaces and environments. • Use software tools to conduct various types of model-based simulations and estimations. • Use information from asset handovers to support the planning and delivery of maintenance and asset operations.
Enabling BIM through information practices and technology	Competencies needed to define, deliver and maintain the information practices and enabling technology for BIM.	Information Management teams/dedicated BIM teams, Internal technology teams.	• Introduce and manage the implementation of BIM tools, their processes, and protocols to enable the delivery of the BIM Strategy. • Manage and maintain the storage and sharing of data, documents, and models according to PAS1192 and COBie. • Ensure the introduction and effective functioning of a Common Data Environment. • Specify, recommend or procure computer hardware and equipment to enable BIM. • Agree and implement alignment of systems and training with partners and supply chains, e.g. aligning systems to minimise data loss during handovers. • Monitor technological progress and trends and understand and act upon implications for the organisation.

Table 5.10 BIM roles competencies.

Competency Category	Overview	Relevant roles	Competencies Required
Support functions for BIM	Identify, plan and manage people and contract change.	HR roles, Commercial/ Procurement/Legal roles.	• Establish, implement and monitor human resourcing and skills development policy to enable BIM. – Establish recruitment requirements and identify suitable candidates with specific competencies needed for BIM. – Design, maintain and develop the competency framework for BIM. – Monitor and develop learning and development for BIM – Develop, track and deliver a BIM Training Plan. – Understand the commercial and legal implications of BIM. – Establish, execute and develop arrangements for procurement in a BIM environment, including definition of requirements for supply chain. • Understand the impact of the BIM strategy on contractual elements of procurement and supply chain management including IP and recourse. – Establish, execute and develop arrangements for supply chain monitoring and management in a BIM environment, including performance management. – Understand the contractual interventions required to support BIM, particularly around Information Security, ownership of IP, risk, and recourse. – Identify, monitor and respond to further legal and regulatory requirements related to BIM.
Maintaining and Improving BIM	Competencies needed for the implementation and continuous improvement of BIM capability.	Internal change roles, Information Management roles, Head of Asset Management directorates.	• Develop best practice in BIM and the required BIM Strategy. – Monitor and understand progress in the industry to determine potential opportunities. – Understand improvement requirements based on industry specifications. – Assess systems, evaluate workflows and audit procedures for BIM. – Conduct Research and Development activities and develop BIM-specific R&D plans. – Define, maintain and develop a common BIM language and terminology. – Identify and act upon gaps and opportunities in current practices and competencies. – Identify, respond to, and learn from any security breaches or incidents which occur. – Develop and maintain an organisational BIM Strategy. • Implement the BIM Strategy. – Understand the implementation implications for the introduction of BIM on the organisation and supply chain, e.g. training, management processes and systems. – Lead, plan and implement BIM improvement. – Effectively mobilise and engage people in BIM improvement. – Programme manage the implementation, including benefits tracking and KPI monitoring.

An organisation implementing BIM must first assess which of these skillsets are required within each area or team– internal and external. Once the future BIM processes have been designed, these skillsets can then be mapped to the relevant roles within each team to define which skillsets must be held within each individual role.

5.3.2.2 Assessing Organisational Competency

Before commencing any detailed design of training strategies and materials, the current competencies within the organisation should be assessed against the desired levels of BIM maturity (as described in Section 3.1). This will allow for a targeted and appropriate training programme to be developed that meets the specific needs of the organisation. It will also allow for a baseline to be created which allows the organisation, through subsequent assessments, to track the progress of developing BIM capability and, importantly, monitor the success of the training programme.

In the early stages of BIM implementation, the assessment can be delivered at directorate/ team level. Once the processes have been designed and the roles and responsibilities agreed, the competency assessment should be designed to provide a role-level granularity to ensure all the critical BIM roles have the required competencies to deliver.

5.3.2.3 Designing BIM Training Programmes

In all BIM training programmes, the strategy should focus on the delivery of four key elements:

- Building a cross-organisational understanding and buy-in to BIM.
- Developing the organisational skills required to deliver BIM effectively and work within the new processes, protocols and technology environment, as defined by the skills framework.
- Providing suppliers with the knowledge and capability to deliver their required BIM activities.
- Developing the short-term skills required to deliver specific elements of BIM Implementation — pilot projects, technology testing, etc.

The training programme should therefore range from awareness to role-specific to technical training depending on the audience and their level of involvement in BIM. It should also reflect where the organisation is in relation to its BIM maturity and where it wants to go. Except for the Awareness Training the training should be delivered at the appropriate level depending upon the individual's role. For example, a project manager should be able to create and then apply an EIR whilst a client manager needs to be aware of what an EIR is and how it is used. Typically, the levels will range from Awareness ("I know of it"), to User ("I know how to use it"), to Creator ("I know how to create it and can train other people"). It is important to develop the training around these levels for people to get the right level of know-how and skills to do their job using BIM.

Table 5.11 shows an example of an outline training programme that can be adapted to the organisation needs in line with its maturity levels.

Training	Typical Audience	Purpose	Content	Options for delivery	Suitable for Maturity Levels
Awareness	Everybody in the organisation.	Provide a basic BIM foundation for all future training modules to build upon.	• Introduction to BIM in the context of the organisation as well as the industry. • Description of what is new in terms of People, Processes, Information and Technology. • Description of the business benefits that BIM can deliver. • Next steps (training roll-out).	• One hour, live training. Predominantly sides with some feedback and discussion. • Alternatively deliver as an e-module (self-taught).	Levels 0 and 1
Project Training	Project Teams.	Provide training that introduces BIM products and enhancement and how they are used and created across the lifecycle of a project and how this relates to individuals day-to-day activities.	• Introduction of BIM new ways of working and products. • Illustration of how the BIM products are created, used and matured over the lifecycle of a project to deliver a step change in Information Management. • Help individuals to have a working knowledge of their role and responsibilities in relation to the creation, development and management of information, including any security requirements. • Introduce the concept of WIP and share, why it is important for collaborative creation of information, and bring to life through a business game. • Train in the file naming convention, its role in Information Management, how file names are built and what this will mean for them in a CDE.	• Half-day, live training. Some slides but optimum delivery is based by using interactive business games.	All Levels
Role-specific Training	Delivered to each role separately, or group of roles where the depth of training is consistent.	Provide training to all individuals across the project team to the necessary depth for each aspect of BIM to enable them to fulfil their role in the creation, validation, maturation and maintenance of data and information.	• Depending upon the role there will be different levels of training for: – EIRs. – Information Standards, including any security requirements. – Supply Chain Assessment Forms. – BIM Execution Plans, etc.	• Classroom based, length to vary and not necessarily delivered on the same day. Can be tailored to meet the project timescales.	Levels 1 and 2.
CDE Training	Project Team	Provide training to all individuals across the project team to use the basic functionality of the interim CDE.	• This course is to be developed and delivered by the solution provider. • Support from the IT teams will be required.	• Classroom based (recommendation).	Levels 1 and 2

Table 5.11 Example of an outline of a training programme that can be adapted to the organisation needs.

Not every organisation will have the resources to develop and roll out an extensive training programme or indeed have the need to do so. It is recommended that for larger organisations a dedicated team is in place to develop the necessary materials. Smaller organisations should consider a train the trainer approach; where the BIM 'expert' works with either a specific project team or a specific group of asset users, to upskill them in the necessary BIM skills on a day-to-day basis, i.e. being part of the team providing on-the-job learning. Once the team is using BIM as business-as-usual, they can then become trainers to other teams and/or they can become a 'placement centre' whereby other people in the organisation join to carry out mini placements to learn on-the-job. We would like to encourage that asset peer groups work together when it comes to developing and sharing training materials, for example Transport for London Surface has developed an extensive training programme for their people and the Supply Chain which, in parts, could be shared if and when appropriate.

5.3.3 Contract Change

5.3.3.1 Overview of Contract Changes Required for Level 2 BIM

Level 2 BIM, as detailed in PAS 1192:2-2013 and PAS 1192:3-2014, is purposely designed to have minimal impact on existing contracting methods. To support the inclusion of BIM requirements into existing contracts the Construction Industry Council (CIC) drafted a BIM protocol. The BIM protocol provides a universal addendum to appointment documents and construction contracts that puts in place additional rights and obligations associated with BIM (http://cic.org.uk/download.php?f=the-bim-protocol.pdf).

The primary objective of the protocol is to define specific contractual obligations, rights and liabilities associated with BIM, including those pertaining to security, and to define the models that will be produced in connection with the contract. It provides clear direction to the supply chain regarding the Employer's expectations in terms of data delivery at the data drops. The early definition of this requirement is intended to encourage downstream collaboration of the supply chain to produce further benefits.

All parties involved in the use, production, or delivery of models, are required to have a BIM Protocol appended to their contracts. This will ensure that all parties producing and delivering models do so in accordance with the EIR and that all parties using the Models have a clear right to do so.

The asset organisation should consult its legal advisors to review the CIC BIM Protocol to ascertain the suitability of the protocol as drafted or whether amendments are required to align with the authority's requirements, such as owning intellectual property.

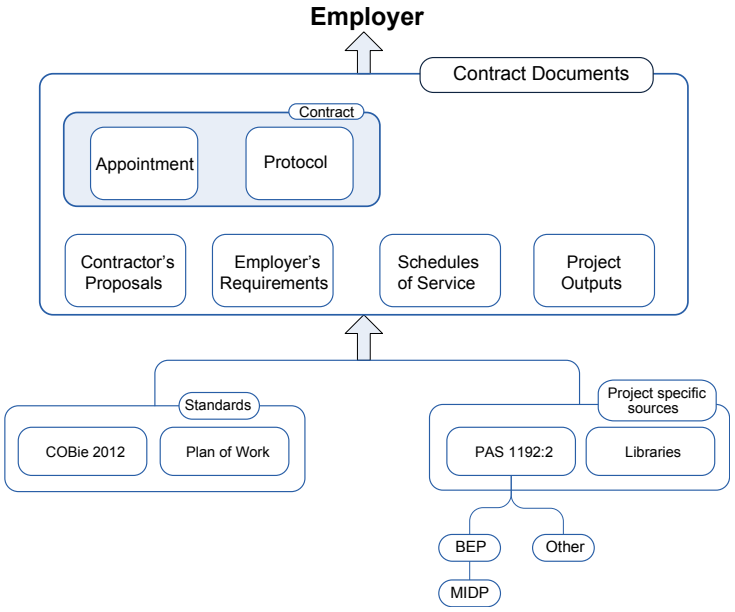


Figure 5.23 From PAS 1192-2 The relationships between the contract and the associated documents.

Figure 5.23 shows the relationship between the contract and the associated documents. Alongside the contract, the BIM Protocol creates a contractual link and defines the hierarchy of documents, including the EIR, between the contract, standards and project specific sources of information.

5.3.3.2 Procurement Documentation

Figure 5.24 shows the BIM documents that are to be produced during the prequalification, tender and contract phase of a project.

Where tier 1 contractors have tier 2 and tier 3 suppliers delivering BIM data, in issuing the supplier's BIM documentation they should be required to demonstrate BIM competence, resources and management at all applicable tiers of their supply chain. This is particularly important where the asset owner adopts a design and build procurement route for a project.

In order for Tier 1 suppliers to be able to prepare a BIM Execution Plan (BEP) that conveys their own as well as their supply chain capability to comply with the EIR, it is incumbent on the Tier 1 supplier to obtain the following from each applicable tier of their supply chain:

- BIM supplier capability and assessment forms.
- Project implementation plans that provide inputs to the BEP.
- Task team information delivery plans.

5.3.3.3 Key Contract Change Activities

Contract change aims to identify and implement any changes required to contractual arrangements with the supply chain (CapEx and OpEx) in order to adopt Level 2 BIM.

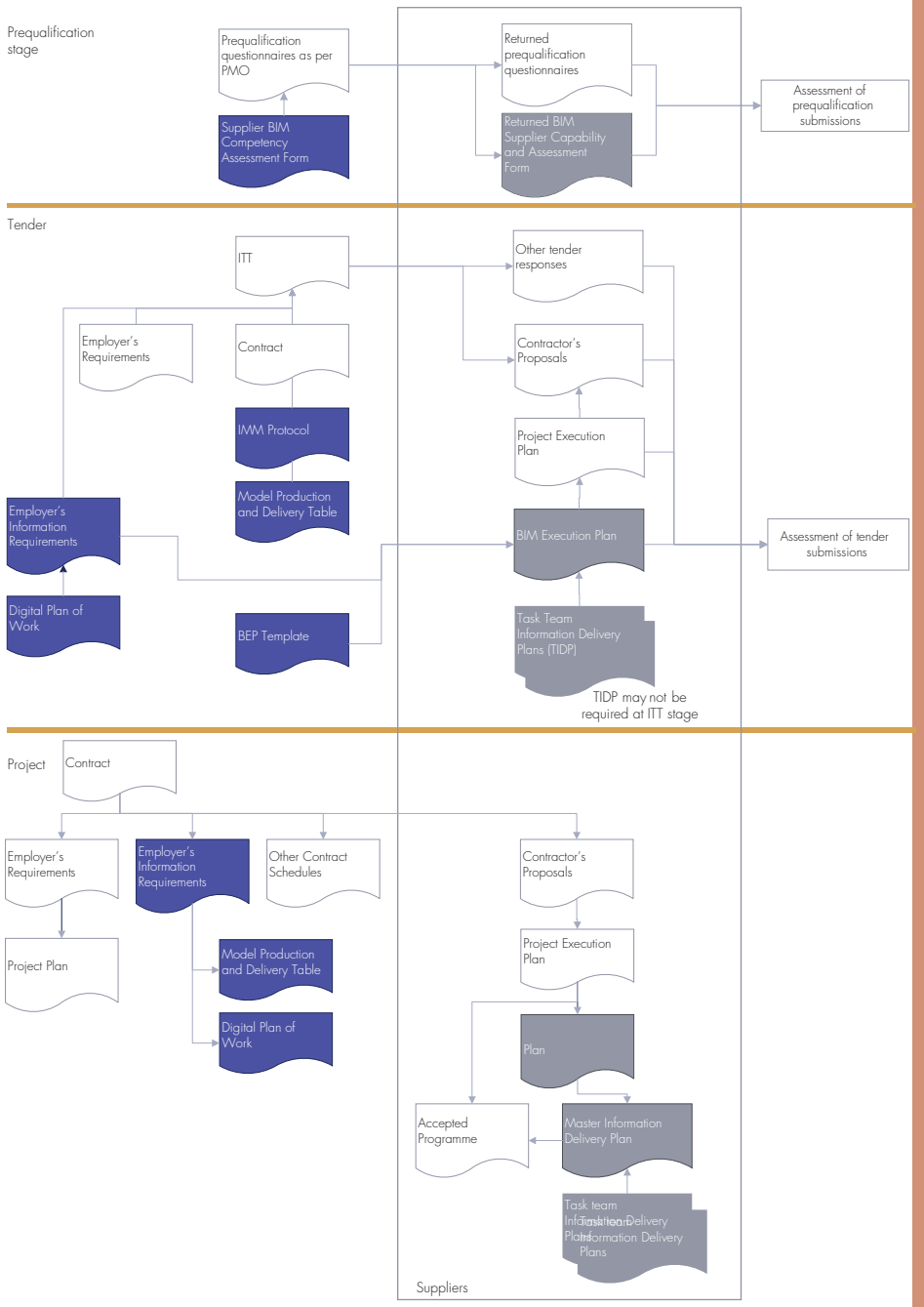


Figure 5.24 BIM documents that are to be produced during the prequalification, tender and contract phases of a project.

Contract change should include an impact assessment of introducing BIM into the supply chain including the extent of changes needed to documentation, the readiness of the supply chain to adopt the BIM approaches, and the cost implications of any additional activities.

The key activities required are:

- High-level review of contracts. This review will focus upon capital and operational contracts between the asset owner and their Tier 1 suppliers. The objective of the review is to examine the alignment of current procurement and contract arrangements and the broad objectives of implementing BIM — identifying whether any changes will be required to existing documentation. This can be undertaken as a desktop review of documentation. The output will be a schedule of the functional requirements which need to be introduced that will be sufficient to support initial engagement with the supply chain.
- Internal stakeholder engagement. Stakeholder engagement with the asset owner's teams including asset owners, commercial, procurement and legal to address the following issues:
  - Ensuring a full understanding of the asset organisation's approach to procurement and contracts.
  - Introducing BIM to the asset organisation's procurement team.
  - Outlining the potential implications on contracts and procurement — including understanding existing supply chain capability.
  - Identifying any additional special requirements, which will need to be accommodated within the proposed changes to contractual arrangements.
  - Securing buy-in to proposed changes before these are shared with the supply chain.
- External supplier engagement. Stakeholder engagement with external suppliers for capital and operational contractors. Through this engagement, BIM will be outlined in sufficient detail to enable follow-up activities associated with readiness assessment. Where relevant, separate capital and operational contractor sessions should be held in recognition of different procurement strategies. These engagement sessions should manage contractor expectations with respect to information requirements, changed roles and the planned programme, including key dates for pilots and wider implementation.
- Supply chain capability assessment. An initial assessment of the existing supply chain using PAS 1192:2/3 compliant readiness assessment forms should be carried out ahead of any changes in the contract arrangements. This will not be a full assessment using tools such as the Construction Project Information Committee (CPIC) BIM Assessment Form. The aim of the assessment is:
  - To confirm readiness to adopt BIM including systems and resourcing levels.
  - To identify the extent to which suppliers will need support to develop BIM capability.
  - To identify whether the introduction of new requirements and contractual arrangements will have any resource or cost implications for the supply chain.
- Detailed review of contracts and procurement processes. This review should provide the outline specification for any changes to contracts and an impact assessment for the business case.
  - The specification will be a functional specification outlining any changes required to contracts, schedules of service, works information and so on. The specification will provide enough detail for an estimate of resource requirements to be produced. The specification will not provide sufficient detail to commission specialist drafting.
  - The impact assessment will be focused upon an estimated cost of specialist drafting.

Once changes required to the contracts have been identified these will form the basis for the functional specification. This specification will describe the purpose of each change and the expected output including identification of dependencies and or any constraints that may be influenced by drafting of the changes. The above will be based upon the results of the reviews and discussions between commercial and legal teams including external advisors and insurance brokers as necessary.

Consideration should be given to existing long term agreements with service providers. Changes identified could apply to both the asset owner's standard forms of contract and also to existing long-term agreements with service providers. Asset owners should negotiate the changes for suppliers within existing frameworks. An impact assessment and implementation plan should be developed to describe the expected impact on delivery of services and cost of implementation as a result of implementation of the agreed changes.

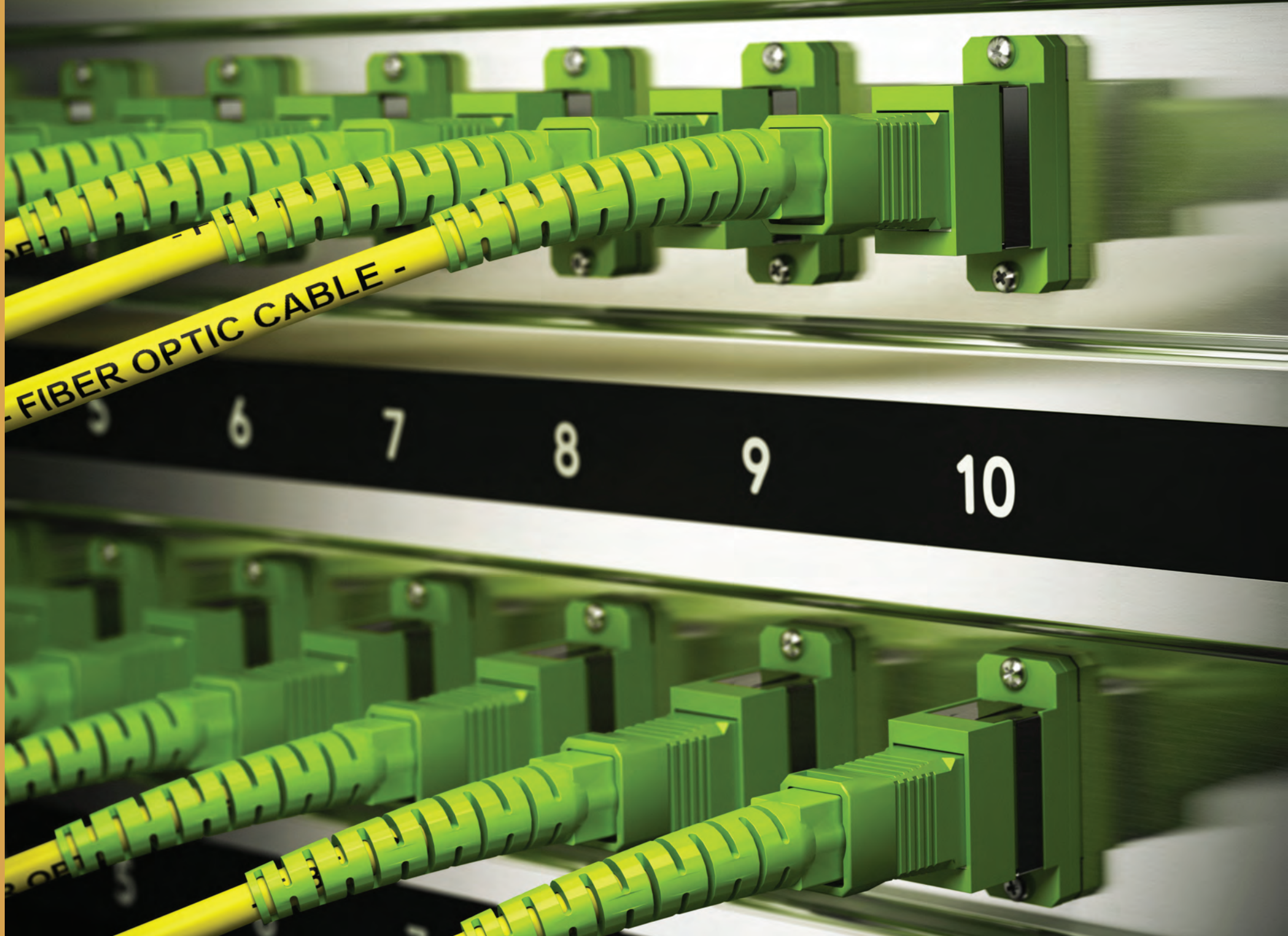
It should be noted that to be effective the supply chain are required to pass down the BIM obligations to their own supply chain. Implementation of BIM may therefore require the asset owner's suppliers to make bespoke amendments to their own sub-contracts, which will result in them incurring costs through the sub-contract tiers and potentially having difficulties securing sub-contract interest.

To implement contract changes the organisation could consider the following two options:

1 Amend existing contracts to include the necessary provisions within the body of the contract.

2 Adopt the industry standard protocol (CIC protocol) as an addendum to the suite of existing contracts and for any new contracts with suppliers.

To agree the approach towards implementing the contact changes, consideration should be given to time, resource and risks for both options in line with commercial and legal preferences, security and Intellectual Property requirements.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6 Stakeholder Management and Communications

The importance of the stakeholders' roles.

Engagement and consultation.

How to support the change.

How to develop the right communications.

6 Stakeholder Management and Communications

This section outlines the approach to stakeholder management and communications. Stakeholder management is essential to successful outcome of BIM as it makes sure that people are aware, engaged and involved. It also acts as a temperature check, i.e. what is the level of support and/or resistance to change? We will provide an overview of stakeholder management and communications tools.

6.1 Stakeholders

Stakeholders are people or parties who have a significant interest in the implementation of BIM programmes. Stakeholders may include those involved in information creation, storing, approving and sharing, or people who can help shape your BIM programme. Successful implementation and adoption of BIM is heavily reliant on the willingness of these stakeholder groups to contribute to and support design and implementation. Pro-active management of these groups, supported by effective communications, should create the required appetite and motivation to help them support your BIM implementation. Typically, stakeholder management will follow five key steps.

1. Identification of stakeholder groups which could be both internal and external parties.
2. Planning effective engagement and consultation to map their key areas of interest and benefits.
3. Building strong relationships, monitor buy-in levels and manage resistance.
4. Co-creating the new BIM tools with stakeholder groups to ensure you build the right solutions.
5. Testing and implementing the new ways of working from inside out, led by the stakeholder.

6.1.1 The importance of engaging with stakeholders when implementing BIM

Depending on the level of maturity of the organisation, implementing BIM and the adoption of enhanced ways of creating and managing information could have a considerable impact on people. To successfully implement BIM, it is important to take the people on a journey from the current way of working to the desired state, enabling and empowering them to co-create the new tools and enhancements and to turn them into change leaders. If the new ways of working are delivering benefits and solutions to current problems and frustrations, it is much more likely these individuals will become change leaders, driven to make sure that the changes are sustainable and will 'stick'.

Insight into people's current ways of working, benefits and culture are key to developing the right solutions, which can only be created if the right people have been consulted at the right time. For example, asset owners need to be engaged to ensure that drawings, health and safety information, etc are fit for purpose at the hand over stage so they can be used during the life of the asset, the supply chain need to understand what information they need to provide and if any changes to systems or documents need to be made, and project managers need to ensure that all the information provided meets the information requirements and standards.

6.1.2 Identification of relevant stakeholders

There are broadly speaking two types of stakeholders: people who have significant interest because they have a relationship with physical assets and will become users of the new tools, and others who can influence the success of the programme, this should include external stakeholders like trade unions, customers, peer infrastructure organisations, etc. Within these two groups, stakeholders will be impacted at different levels by the changes.

Before identifying relevant stakeholders, it is useful to answer a number of questions such as:

1. Will BIM be implemented throughout the phases of the asset lifecycle, e.g. Plan, Design/Construct, Maintain/Operate, Dispose/Renew, or aimed at parts of these?

2. What portfolio of assets do you want the programme to focus on:
   - Full portfolio of assets (highways, structures, technology) or a selection of these?
   - Mobile (fleet), fixed assets or both?

3. Which external stakeholders do you include, e.g. supply chain, other organisations you work with?

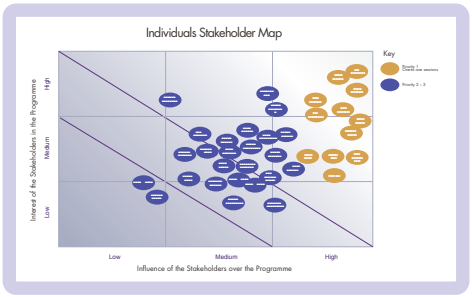
Decisions will have to be made on where to focus BIM implementation, the results of which will inform your stakeholder group. For example, a large asset owner could decide to focus BIM implementation on the full portfolio of assets throughout the lifecycle, but exclude mobile assets like buses and river boats.

The second group of stakeholders who can influence the programme are external stakeholders like peer highway authorities, trade unions, customers, etc.

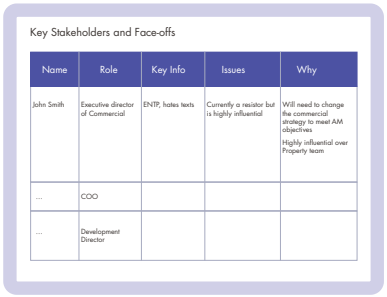
A number of tools are available for use throughout the programme to help you understand who you need to engage with and how. (See Appendix 6 for pull out copies.)

1 Identify stakeholders

2 Stakeholder mapping



3 Capture key information and issues



4 Map level of impact

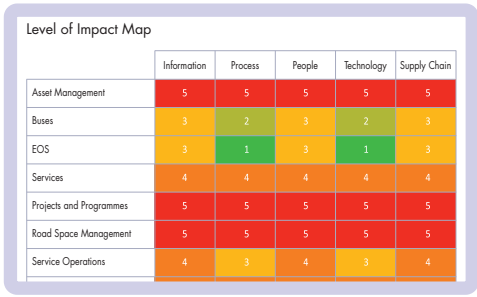


Figure 6.1 Examples of tools used to understand which stakeholders to engage with and how.

6.2 Engagement and Consultation

6.2.1 Stakeholder information

Once we know who our key stakeholders and communities are, we need to establish why they are important to success and identify how they can help us drive BIM and realise its benefits. To understand how individuals can support us, we should map the following information about them:

- How do they influence the programme?
- Who do they influence?
- What do we need them to change?
- How can they help us?
- How could they disrupt it?
- What effect will it have on them?
- What do we need to understand from them?

When you start to engage with people and start digging into their individual challenges to adopt new ways of working, you often find a different set of concerns coming up about deeper and broader issues than you may have foreseen. These concerns (see Figure 6.2 right for examples) are very valuable and should be developed into powerful and consistent messages by the communications manager and shared with the team to ensure everyone addresses these specific issues during stakeholder engagement. An integrated approach to communicating the purpose, approach, benefits and challenges is important to ensure consistent messaging. Appreciating such underlying dynamics is critical to create efficient, effective and sustainable BIM solutions.

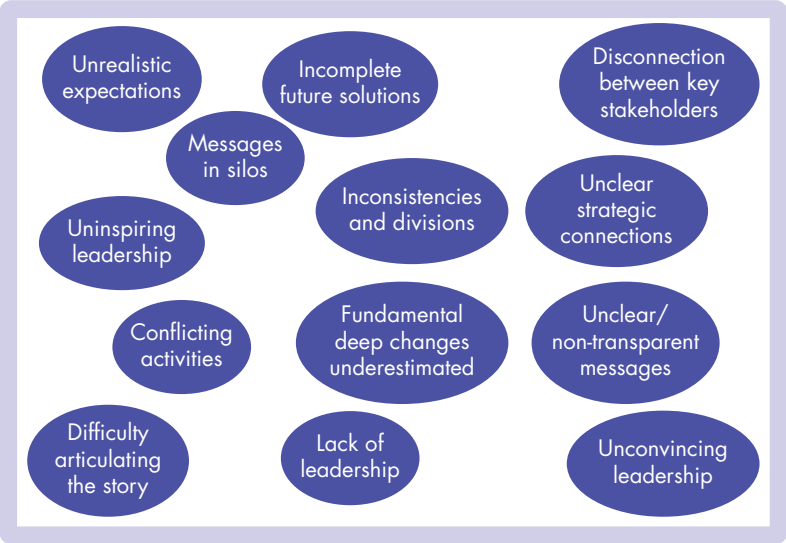


Figure 6.2 Example concerns of stakeholders when faced with change.

6.2.2 Engagement

Effective engagement is a fundamental element in creating stakeholder appetite and energy to participate in the BIM programme. Change can be met with enthusiasm or resistance. If it is the latter and it is not dealt with, it could have a significant adverse impact on the progress and success of BIM. Because implementation of BIM is likely to affect a large group of people in significant ways, stakeholder engagement will require considerable planning and preparation. A good starting point is to develop a stakeholder engagement strategy to support careful planning of this engagement, which is likely to be a combination of tools including stakeholder maps (see Figure 6.3 overleaf), buy-in vs. influence maps and impact assessments, and communication methods such as workshops, one-to-one meetings and emails. It is important that this engagement strategy is jointly developed by all workstreams, the project management team and tested with stakeholders prior to scheduling any meetings.

Proactive and intelligent engagement can help mitigate the risk of not winning the hearts and minds of staff, which often leads to resistance, delays and not providing the right information for the right solutions. The context within which stakeholders need to be engaged is often complex, which makes it necessary to raise awareness as to why, what and how the change will affect them, and demonstrate to them how they will benefit from implementation of BIM.

A BIM implementation programme can take considerable time (sometimes years, depending on the size of the organisation) and is likely to run through different phases such as information gathering, design, development, testing and implementation. Throughout these phases support is required from different sets of internal and external stakeholders at different times. It is important to maintain momentum once the engagement has commenced.

To maintain relationships and momentum with stakeholders throughout development and implementation of BIM requires careful planning of communications and engagement to keep them informed and excited about the future state. This ongoing engagement also allows the team to monitor how internal and external stakeholders respond to the BIM initiatives, while continuous tracking (see Figure 6.3) enables identification of stakeholders who are showing resistance. The availability of stakeholders to engage with BIM activities is critical, but they will often be under pressure due to day-to-day tasks and responsibilities, and the engagement approach should be designed to mitigate this risk. Positively influencing and engaging with senior leaders is crucial to creating ownership and energy to help the project team mobilise the business.

Team/ Assets type	Relevant stakeholders	S3 Process Sign-off	S1 4 Process Sign-off	Process workshops S14	Pioneer	Early Adopter	Champion	Influential Stakeholder	Informed Leader	Surface Steering Group	Group (CDE)	B3/4 CDE consultation	Stage 3	Stage 4	Form of engagement Q3/4 15 other than comms	Level of engagement at Nov 2015	Unknown to SH	Level of engagement at Q3 2015 RAG Status Green - Onboarding successful Amber - Potentially resistant Red - Resistance to cooperate
1. Structures	Name 1	✓	✓	✓	✓					✓		✓	X	X	Workshops Champions Pioneers	Aware, driving		
	Name 2	✓		✓	✓	✓						✓	X	X		Aware, supporting		
	Name 3			✓		✓							X			Aware, supporting		
	Name 4	✓		✓	✓	✓							X	X		Aware, supporting		
	Name 5												X	X		Aware supporting		
	Name 6	✓		✓		✓						✓	X	X		Aware, supporting		
	Name 7			✓		✓							X			Aware, supporting		
	Name 8												X	`		Aware, inactive		
	Name 9												X			Aware, supporting		
	Name 10											✓	X	X		Aware, inactive		
	Name 11			✓	✓							✓	X	X		Aware, supporting		
	Name 12			✓	✓									X		Aware, supporting		
	Name 13			✓	✓							✓		X		Aware, supporting		
	Name 14									✓		✓		X		Doubting		Workshop 30/09/15 (PB)
	Name 15			✓		✓						✓	X			Aware, supporting		
	Name 16													X		Aware, supporting		
2. Streetlighting	Name 1	✓										✓	X		None	Aware, supporting		
	Name 2	✓											X			Aware, supporting		
3. Tunnels	Name 1	✓										✓	X		Champion CDE Consult Silvertown	Doubting		Workshop 30/09/15 (JC)
	Name 2												X			Doubting		
	Name 3	✓										✓	X			Aware, supporting		
	Name 4	✓											X			Aware, supporting		
	Name 5	✓											X			Aware, supporting		
	Name 6 Champion	✓					✓						X			Aware, driving		
	Name 7												X			Aware, supporting		
	Name 8									✓								

Figure 6.3 Example stakeholder map and tracker.

6.3 Champions

Champions are members of the organisation in which BIM is being implemented who engage with their colleagues and external stakeholders, e.g. suppliers, to grow support for the new ways of working. These individuals help motivate other stakeholders to support design and implementation of the new tools. Communicating the benefits of BIM for people and teams through champions is more likely to be understood and listened to, and it gives the impression that the change is driven from inside the organisation, rather than from outside or top-down. Champions are the eyes and ears of the project team, gathering feedback on communications, identifying issues and resistance and raising them to the project team.

Implementing BIM requires considerable change to traditional ways of working, and this could come as a culture shock to many. For others who may have been waiting for innovation and the introduction of smart technology to become more productive, the initiative may be welcome. Most change programmes (70%) fail to deliver anticipated benefits. We suggest making best use of champion communities to create strong leadership and ensure that BIM delivers its full potential.

Champions can aid in translating BIM benefits into more personal benefits helping stakeholders understand how the proposed changes will positively influence them, their teams and the organisation. This can lead to growth of a community of 'change leaders' among new users of the tools and technology, who become motivated and committed to the initiative, and develop a sense of ownership of the change. Insight from champions, critical to understanding cultural drivers and interconnections, is needed to integrate new ways of working which respond to people's Information Management challenges and frustrations.

Champion communities come in different forms and can be made up of diverse groups within an organisation, including early adopters, leadership teams and pilot project team members (Figure 6.4 overleaf).

These champions can help to:

- Communicate information challenges and blockages in the current ways of working.
- Provide a clear articulation of the issues and the opportunities that BIM practices can provide.
- Contribute to communications and stakeholder management activities
- Provide feedback.
- Identify and raise issues occurring on the ground.
- Assist with managing any resistance to BIM.
- Become 'super users' and assist in training of others.

The implementation team should consider carefully the additional workload that is likely to be required from these champions, whilst ensuring that they are recognised and valued for their additional effort and provided with support.

A good first step to building a mobilisation network is to ask leaders and impacted teams to put forward representatives. This can be followed by inviting people who you think are interested in the subject and have a good network within the organisation to spread the word and cascade messages to mobilise other parts of the business. The champions' network often grows organically if there is energy and appetite. It is important to make sure that champions feel important (because they are!) and give them the opportunity to help shape and see new products and hear of initiatives first, before the rest of the organisation.

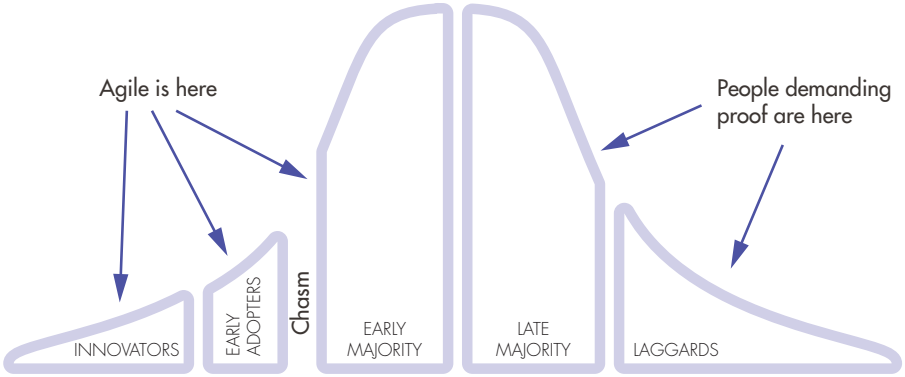


Figure 6.3 Using your Champion community as Early Adopters to grow support for change.

6.3.1 Leadership support

An involved and active leadership team is a critical success factor for mobilising the business and to champion and role model new ways of working. We need to be certain of their support and ensure they understand the programme objectives, benefits, impact and challenges for their parts of the organisation. These individuals can then garner support within their teams and drive implementation to achieve the benefits.

At the start of the programme, the leadership team should help to identify critical stakeholders and champions in their teams who are best placed to support the BIM team. They should also aid in identifying the organisation's information requirements, processes, and challenges to support design of the right solutions. These leaders are important in providing direction and have the ability to see the bigger picture and interconnections between different parts of the organisation. They will probably also have interests in delivery of both the financial and non-financial benefits, which form the basis for the business case to invest in BIM. A useful engagement tool to set up is a steering group, which informs and interacts with leaders of the relevant stakeholder groups on a regular basis to ensure ongoing support and promote active involvement in creating and cascading the programme's implementation.

When the programme reaches implementation and testing of the tools, it is important that leaders understand how they should support by role modelling the new ways of working. To mobilise the leaders the project team needs to plan structured engagement to make sure that they understand the context, are aligned behind the future state strategic framework and benefits case, and are informed of the latest progress. There is value in planning the leadership engagement through development of a leadership strategy, which can be tested in advance to ensure it aligns with the busy schedules of these individuals. Careful planning should mitigate the risk of overloading, which could lead to resistance, lack of personal commitment or send out the wrong messages. Following implementation of BIM, these leaders can maintain momentum by engaging teams to overcome challenges, adjust course on day-to-day actions and promote a culture of continuous improvement. This will help realise BIM benefits.

Top Tips!

- Keep it simple
- Think of questions, as well as messages — communication should be two-way.
- Assume people know nothing about BIM!
- Focus on benefits.
- Take people through the emotional cycle of change.
- Relate to the emotional/political and rational.
- Setting up a communications focus group to test messages.

6.4 Communications Strategy

Successful engagement with stakeholders is critical to the success of a change programme like BIM, because people's buy-in and uptake of the new tools and processes is vital to achieving benefits. Effective engagement requires careful consideration, planning and testing. This should be done together with the people who know the organisation's culture so that it informs the content, tone and style of the messages and the appropriate tools to use. The intent is to positively influence and energise the people, clearly outlining the case for change and provide the individual with "what's in it for me?".

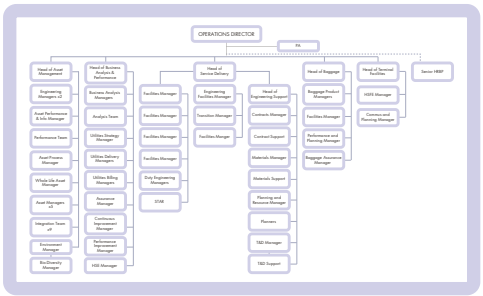
At the start of the project, it is helpful to develop a communication strategy that defines the principles, rational for communication, core messages, target audiences and the core communications methods to be used. The communication strategy should be accompanied by a communication plan, which shows all the communication activities required to deliver the successful outcome of the communication strategy.

The plan includes:

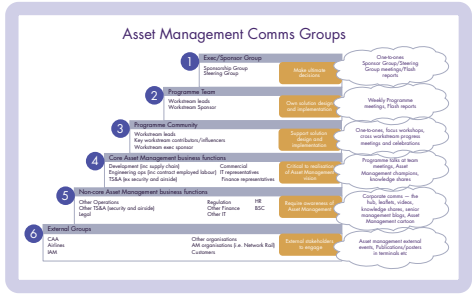
- Core programme milestones and resulting communication needs.
- Planned communication activities per stakeholder group.
- Required stakeholder input into programme outputs and resulting need to on-board these stakeholders.
- Any existing organisational communication deadlines (internal newsletters, internal communication events, internal meetings, etc).
- Delivery methods to be used for all communications activity including (as appropriate) workshops, roadshows, information fairs, one-to-one meetings, intranet publications, emails, poster campaigns.

The plan is there to maintain the communications 'drum-beat' and is a tool that enables a growing understanding of BIM throughout the organisation. It will drive the need for timely and frequent communication activities.

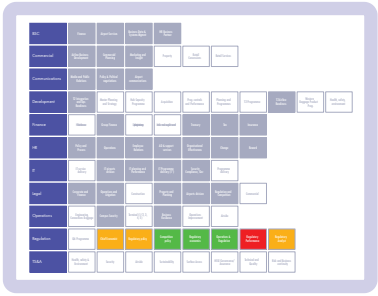
1 Identify communities



2 Divide into logical groups



3 Assess current engagement level



4 Select tools and design messages

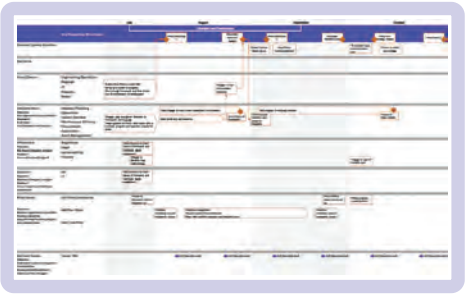


Figure 6.4 Steps for identifying audiences and engagement tools.

There are a number of tools throughout the programme to help identify different audiences and levels of engagement to inform selection of the best tools and messages; messages including elevator pitches, presentations, one-pagers, team focused communications materials, etc (Figure 6.4.).

Depending on the scale of the change, a dedicated or part-time communications manager should be part of the project team. The communications manager would be responsible for:

1. Creating the communications strategy and plan.
2. Updating the communications plan.
3. Creating BIM programme materials.
4. Quality assurance of all the materials produced, i.e. right format, messages, focus.

It is also important to make sure two-way engagement and feedback takes place, not only to understand, record and respond to the challenges and benefits raised by stakeholders, but also to inform ongoing message development and updates. Ongoing monitoring helps in developing communications that are clear, coherent, timely, transparent and encourage ongoing two-way communication.

Communications are closely linked to stakeholder management, and often delivered by a single workstream, as shown below in Table 6.1.

Stakeholder Management	Key Elements	Communications
Who has significant interest in the programme and what are their feelings towards the programme?	WHO?	Which communities are relevant, what are their priorities?
How do they influence the programme, what do we need to change and how can they help/disrupt us?	WHY?	What we need them to do differently and what we can learn from them?
What messages will work and how can we help them build skills and knowledge? What questions need to be asked and what needs to change?	WHAT?	What messages will build support for the BIM programme and what level of information does each group require?
When are our milestones, how do we phase our messages to ensure they are kept in the loop?	WHEN?	What are our key milestones and what message phasing will work best?
What is the most powerful and effective way to deliver our messages?	WHO?	What is the most powerful and effective way to deliver our messages?

Table 6.1 Link between stakeholder management and communications.

6.5 Project Team

The BIM project/mobilisation team is likely to consist of a combination of external subject matter experts and internal people who are responsible for embedding BIM. The complexity of the project necessitates that these people share similar objectives and be able to work together effectively.

A typical project team might incorporate the workstreams shown in Table 6.2. Depending on the organisation's capability and capacity the activities can be carried out by the internal team such as developing the benefits case, contract reviews, etc. Subject matter experts can provide guidance and/or can do the delivery if or when the organisation is not able to provide the resources or know-how themselves

For teams to work together successfully, it is important that they identify what success will look like, developing a clear set of shared goals and objectives and how each team member is going to contribute to this, through taking personal accountability and providing the right skills and behaviours at the right times.

Another key component is to create an enjoyable and inspiring atmosphere, in which success is celebrated and all team members feel valued and empowered. This can often be aided by team building activities (which are also a good way for the team to get to know each other) and team socials.

6.6 Conclusion

This brings us to the end of the BIM guidance. We hope the information provided was useful and contributed enough insight and pointers for you to understand what is required to develop and implement BIM in your organisations.

Workstream	Example Products
Information	• Information Requirements. • Information Standards.
Security-mindedness	• Built Asset Security Strategy. • Built Asset Security Management Plan. • Security Breach/Incident Management Plan. • Built Asset Security Information Requirements.
Process	• Process workflow. • Information production RACI.
Business Mobilisation	• Change readiness assessment. • People Change Plan. • Skills assessment. • Training strategy.
Stakeholder and Communications	• Stakeholder and Communications strategy. • Stakeholder map and impact assessment. • Communications Plan.
Benefits Management	• Benefits case. • Benefits realisation strategy.
Commercial	• Contract review. • Supplier engagement.
Technology	• Specify and procure common data environment.

Table 6.2 Structure of a typical project team with examples of deliverables.

Appendices

Examples of tools used to support making the change.

Pull-outs for the work done in supporting making the change and stakeholder engagement.

Appendices

Glossary

Terminology	Description
Asset Information Requirements (AIR)	The information and data that a business needs about its assets and infrastructure.
BIM Execution Plan (BEP)	The BIM Execution Plan is the response to the Employer's Information Requirements (EIR) and sets out how the information required in the Employer's Information Requirements will be provided. The BEP covers: • Information Management Objectives. • Information Utilisation Planning. • Standards, Methods And Procedures. • Information Management. • Digital Engineering.
BIM Protocol	The BIM Protocol is a supplementary legal agreement that is incorporated into professional services appointments and construction contracts. The Protocol creates additional obligations and rights for the employer and the contracted party.
Business Case	The business case is a document which provides justification for undertaking a project or programme. It evaluates the benefits, costs and risks of alternative options and provides a rationale for the preferred solution.
Champions	Champions are individuals within an organisation that volunteer or are selected to facilitate improvement and/or change. They are active members within the project, they understand the vision and have a desire to actively advocate for and facilitate the process.
COBie	Construction Operations Building Information Exchange (COBie) is a data format that helps organise information about new and existing facilities. It is a means of sharing structured information for both Buildings and Infrastructure assets, and can be transmitted using a spreadsheet.
Common Data Environment (CDE)	A Common Data Environment is a combination of processes and technology which when combined together are used for exchanging and managing data and information, including Models, Production Information and Handover Information.
CPIC	Construction Project Information Committee (CPIC).
Digital Plan of Works	The Digital Plan of Works (dPoW) sets out the project delivery stages and the associated tasks that need to carried out in relation to data and information. It also details the level of detail of data and information that needs to be delivered by each supplier/discipline to the employer at any point in time for the different delivery stages.

Terminology	Description
Employers Information Requirements (EIR)	A subset of the Asset Information Requirements for a particular project in a particular location. The EIR sets out the information to be delivered, the standards and processes to be adopted and the information exchange mechanism to be used by the supplier as part of the project delivery process.
IFC	Industry Foundation Classes (IFC) is an international open data standard that digital engineering tools can export to support interoperability between proprietary design software tools.
Information Standards	Information standards define exactly what is required, i.e. what good looks like for a particular type of information. Clear standards and requirements enable the quality of the information that is delivered to be assessed.
Level of Detail (LoD)	LoD describes the graphical and non-graphical model content required at specific data drops.
Master Information Delivery Plan (MIDP)	The Master Information Delivery Plan is the plan which sets out when project information is to be prepared, by whom, and using what protocols and procedures, The MIDP is built up from a series of individual Task Information Delivery Plans which set out responsibility for specific information tasks.
NBS	NBS (formerly known as National Building Specification) is an organisation which manages a UK-based system of construction specifications used by architects and other building professionals to describe the materials, standards and workmanship of a construction project.
Organisational Information Requirements (OIR)	The information that an organisation needs to know to enable it to operate its business and achieve its strategy. This includes information required under the AIR plus additional requirements.
PAS 1192	PAS 1192 is the specification for Information Management for the capital/delivery of construction projects (Part 2) and for the operational phase of assets (Part 3), using building information modelling. The PAS is closely related to BS 1192. PAS1192-5 covers the security aspects which need to be managed when using building information modelling to support digital built environments and asset management.
Project Execution Plan (PEP)	The PEP is the governing document that establishes the means to execute, monitor, and control projects. The plan serves as the main communication vehicle to ensure that everyone is aware and knowledgeable of project objectives and how they will be accomplished.
Task Information Delivery Plan (TIDP)	Task information delivery plans set out the responsibilities for each information deliverable and are used to manage the delivery of that information.
Task Team	Any team which may comprise one or more Project Team Members assembled by the client, consultant or the contractor to complete a task which requires data and/or information to be produced and exchanged. Examples include highway, geotechnical, structures, lighting, urban realm, technology, architecture internal and external design teams.
Work-in-Progress (WIP) and Shared	WIP and Shared are both components of the CDE. WIP is the section of the CDE which is used to hold unapproved information. Shared is where information can be made available to others in a 'safe' environment where its status is clear.

Appendix 1: Maturity Assessment tool

A simplified maturity assessment tool

Level	Criteria	Requirement	Best practice within the organisation	General capability
0	Design information produced in 2D drawings and documents.	✔		
	Have documented Information Standards complying with BS 1192:2007 and BS 7000-4:2013.	✔		
	Have a system to manage electronic documents and drawings.	✔		
	Have a system to manage the exchange of information.	✔		
	Staff and supply chain are trained and have capability to achieve the Level 0 maturity requirements.	✔		
1	Design information produced from 3D/2D (used where there is insufficient value in using 3D) models and documents. Drawings are produced from the models.	✔		
	Asset data where specified is collated in documents as 3D/2D models do not have structured data.	✔		
	Have documented Information Standards complying with BS 1192:2007 and BS 7000-4:2013.	✔		
	Have a system to manage electronic documents and drawings.	✔		
	Have a system to manage the exchange of information using file sharing systems.	✔		
	Staff and supply chain are trained and have a capability to achieve the Level 1 maturity requirements.	✔		
2	Business wide engagement in defining information requirements covering the whole asset lifecycle with Employers Information Requirements issued for projects and Asset Information Requirements issued for the operation and maintenance of assets.	✔		
	Design information produced from 3D/2D (used where there is insufficient value in using 3D) models and documents. Models are produced using objects to which data is attributed in line with the information requirements. Drawings are produced from the models.	✔		
	Non-graphical data is extracted and enhance from models.	✔		

Level	Criteria	Requirement	Best practice within the organisation	General capability
2 (cont)	Have documented Information Standards including model and data validation and verification complying with BS 1192:2007 and BS 7000-4:2013, PAS 1192-2, PAS 1192-3, BS 1192-4 and PAS 1192-5.	✔		
	Have a system to manage electronic documents and drawings focused on a collaborative digital review of combined information and data sets.	✔		
	Have a system to manage the exchange of information using a controlled collaborative online file management system.	✔		
	Staff and supply chain are trained and have a capability to achieve the Level 2 maturity requirements.	✔		

An extensive maturity assessment tool, which can be used to assess the maturity of the organisation against the BIM standards:

Organisational Information Requirements

Define the data and information relating to asset management activities (aligned with PAS 55-2), capable of enabling the organisation.	Department 1	Department 2	Department 3	Department 4
Optimise its asset management strategy and optimise/prioritise its asset management plan(s).	Yes/No			
Assess the financial benefits of planned improvement activities.				
Determine the operational and financial impact of asset unavailability or failure.				
Make lifecycle cost comparisons of alternative capital investments.				
Identify expiry of warranty period and warranty.				
Determine the end of economic life of assets/asset systems, e.g. The point in time when the asset related expenditure exceeds the associated income.				
Determine the cost of specific activities (activity based costing), e.g. The total cost of maintaining a specific asset(s)/asset system.				
Obtain/calculate asset replacement values.				
Undertake financial analysis of planned income and expenditure.				
Obtain/calculate the financial and resource impact of deviating from plans that might result in a change in asset availability or performance, e.g. What is the financial impact of deferring the maintenance of a specific generator by six months?				

Define the data and information relating to asset management activities (aligned with PAS 55-2), capable of enabling the organisation.	Department 1	Department 2	Department 3	Department 4
Assess its overall financial performance.				
Undertake the ongoing identification, assessment and control of asset related risks.				
Comply with statutory and regulatory obligations.				

Asset Information Requirements

Capture information relating to assets in accordance with BS 8587 and PAS 55-2	Department 1	Department 2	Department 3	Department 4
Legal Information				
Details of ownership and maintenance demarcation where assets interface across a system or network of assets.	Yes/No			
Work instructions together with diagrams and reporting requirements, legal obligations such as health and safety file information, and safety/environmental considerations.				
Asset related contractual information.				
Task risk assessments and control measures.				
Commercial Information				
Descriptions of assets and the asset systems they serve.				
Functions of assets, including any interdependencies to the activities that require them.				
Vendor data (details of the organisation that supplied the asset) including asset lead time.				
The condition and duty of assets including intensity of use.				
Key performance indicators.				
Condition and performance targets or standards.				
Criteria of non-conformance and the actions to be taken.				
The criticality of assets and spaces to the organisation.				
Identities and levels of spares held, inter-changeability, specifications and storage locations.				
Financial Information				
Financial data including, where available.				
Whole life costs of asset deployment including cost of historical and planned maintenance tasks.				

Capture information relating to assets in accordance with BS 8587 and PAS 55-2	Department 1	Department 2	Department 3	Department 4
Operating costs.				
Downtime impact.				
Current asset replacement value.				
Original purchase/leasing cost.				
Technical Information				
Engineering data and design parameters.				
Details of asset dependencies and interdependencies.				
Commissioning dates and data.				
Operational data including performance characteristics and design limits.				
Managerial Information				
Unique asset identification numbers.				
Locations of the assets, possibly using spatial referencing or geographical information systems.				
Spatial data relating to assets, for example pavement areas, room sizes.				
Warranties and guarantee periods.				
Access planning and work schedules.				
When assets were last maintained/inspected and when these tasks are next due.				
List of overdue/outstanding tasks.				
Historical record of planned and unplanned maintenance tasks performed.				
Details of the tasks to be carried out.				
Asset related standards, process(es) and procedure(s).				
The presence of any hazardous contents or waste.				
Details of asset destination at end of current life.				
Details of emergency plans including responsibilities and contact details.				
Details of historical asset failures, causes and consequences (if known).				

Built Asset Security Information Requirements (where appropriate)

Detail the requirements with regard to the arrangement for, and overseeing of, the secure capture, handling, dissemination, storage and access and use of all data and information pertaining to sensitive assets and systems for:

	Department 1	Department 2	Department 3	Department 4
Conducting surveys.	Yes/No			
Arrangements for, and overseeing of, the secure storage of, and secure access to, all data and information pertaining to sensitive assets and systems retained for asset management purposes.				
Arrangements for, and overseeing of, the secure storage of, and secure access to, and ultimately secure disposal of, all project and/or asset information retained for the period required to comply with legal or other regulatory requirements together with any specific requirements of the employer, whichever is longer.				
The maximum amount of information relating to sensitive assets or systems to be contained in model(s), the CDE, other databases and information exchanges.				
The management and monitoring of access to information about sensitive assets and systems contained within any file or database by each organisation with access to any of these files and/or databases.				
The management of access to information relating to sensitive assets and systems to be on a need-to-know basis, with site contractors only having access to information that is relevant and necessary for the completion of their tasks.				
The storing of operations and maintenance procedures for sensitive assets and systems in the CDE or asset management databases.				
Notification of the requirement of any special handling or protection of information which has security sensitivity and has been provided by an organisation within the supply chain.				
The requirements for purpose-specific or volume-specific COBie files for security-related systems.				

Employer's Information Requirements

Capture information relating to compliance with PAS 1192 Part 2.

	Department 1	Department 2	Department 3	Department 4
Technical				
Software Platforms.	Yes/No			
Acknowledge the software platforms used internally.				
Acknowledge requirements for data and information to be produced in a specific software platform.				
Data Exchange Format				
Acknowledge specific formats for data and information to be exchanged at various milestones of an assets lifecycle (Native, COBie, PDF).				
Co-ordinates				
Acknowledge a common coordinate system to be used for fixed assets (including origin, offsets, units, datum).				
Level of Detail (Level of Model Detail and Level of Information)				
Acknowledge the details to which the physical characteristics, of assets, are represented (as Graphical Data) within Model File, at each stage of the assets lifecycle.				
Acknowledge the type and amount of information (about the assets functional characteristics), which may be included as attributes (Non-Graphical Data) within model files, at each stage of the assets lifecycle.				
Training				
Acknowledge what training will be provided (by the Client) in relation to specific systems and/or processes.				
Acknowledge what training is to be provided by the Supplier as part of their contract.				

Capture information relating to compliance with PAS 1192 Part 2.

	Department 1	Department 2	Department 3	Department 4
Management Standards				
Acknowledge the standards, in relation to data and information, which are to be adopted.				
File Naming.				
Classification.				
Data Structure — Graphical Data.				
Data Structure — Non-graphical Data.				
Objects.				
Metadata.				
Survey.				
Modelling.				
British and ISO Standards.				
Roles and Responsibilities.				
Acknowledge responsibilities in relation to the production, use and management of data and information throughout the assets lifecycle.				
Requirement for responsibilities to be assigned, documented and maintained.				
Planning the Work and Data Segregation.				
Acknowledge specific requirements (if any) relating to modelling strategy, massing strategy and volume strategy.				
Security				
Acknowledge security standard to be complied with for all data and information.				
Coordination and Clash Detection Process.				
Acknowledge details relating to:				
Clash detection process (software, process, responsibilities, outputs).				
Technical query workflow.				
Tolerance strategy.				
Clash resolution process.				

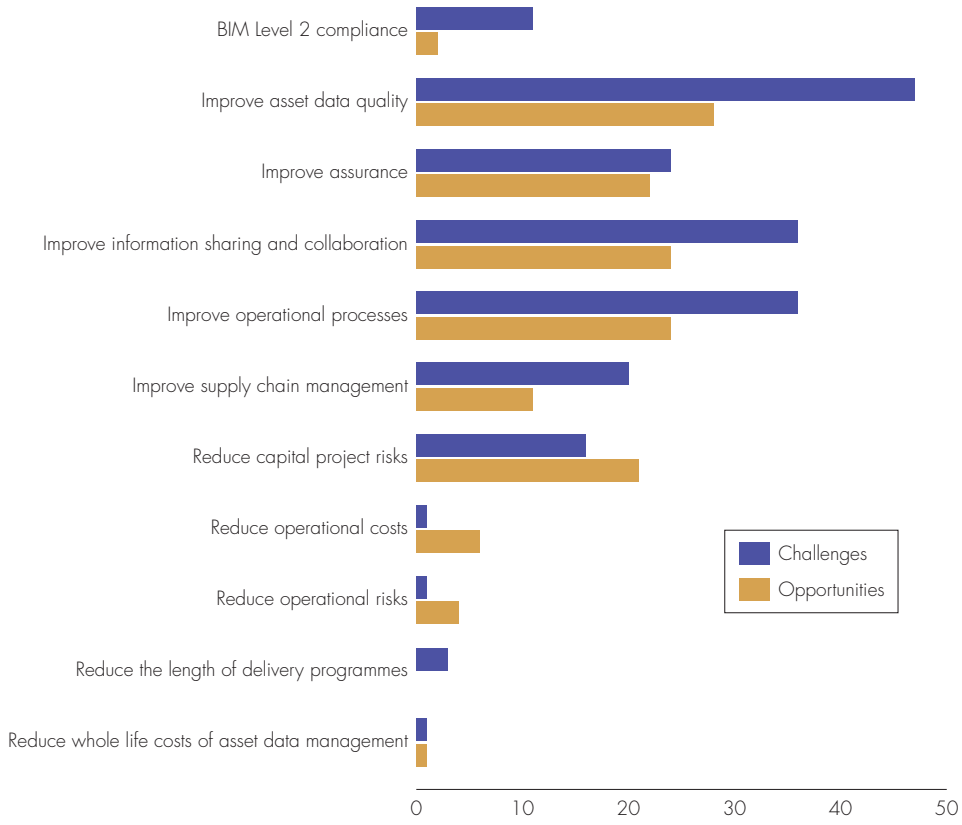
Capture information relating to compliance with PAS 1192 Part 2.

	Department 1	Department 2	Department 3	Department 4
Collaboration Process				
Acknowledge how, where and when data and information is shared.				
Health and Safety and Construction Design Management				
Acknowledge requirements for how BIM will support HSE and CDM.				
Acknowledge what HSE and CDM data and information is required at each stage of the assets lifecycle.				
Systems Performance				
Acknowledge limitations/restrictions (and security issues) of the IT systems.				
Compliance Plan				
Acknowledge requirement for how data and information is to be assured and checked for compliance with adopted standards.				
Delivery Strategy for Asset Information				
Acknowledge information exchange format to enable delivery to the asset management systems.				
Commercial				
Data Drops and Project Deliverables				
Acknowledge content of data drops, how they align to stages of assets lifecycle and the purpose of the data drop.				
Acknowledge the questions to be answered/decisions to be made at each stage of the assets lifecycle.				
Strategic Purpose				
Acknowledge the primary use the data and information throughout the lifecycle of the assets (to define scope of licence for use of the data and information).				
Defined BIM/Project Deliverables				
BIM-specific competence assessment.				
Assess capability and competency of the Suppliers.				

Appendix 2: Example of the challenges and opportunities identified during a BIM programme

The following is a schedule of challenges and opportunities and summary of findings gathered at the start of a BIM Programme.

Row Labels	Count of Challenges	Count of Opportunities
BIM Level 2 compliance	11	2
Improve asset data quality	47	28
Improve assurance	24	22
Improve information sharing and collaboration	39	24
Improve operational processes	36	24
Improve supply chain management	20	11
Reduce capital project risks	16	21
Reduce operational costs	1	6
Reduce operational risks	1	4
Reduce the length of delivery programmes	3	
Reduce whole life costs of asset data management	1	1
Grand Total	**199**	**143**



Business Stage	Asset/Team	Benefit Theme	Challenges	Opportunities
General	Stations	Improve asset data quality	Unable to robustly demonstrate the need for better asset inventory data and system.	
General	Stations	Improve asset data quality	Accuracy of existing information — how accurate is it? Quality of data.	
General	Stations	Improve asset data quality	Limitations in existing asset information.	
Capital Projects: Detailed Design	Stations	Improve asset data quality	Need a more defined client information requirement specification for Project Delivery and Management (or others) to deliver to.	
BAU: Acquire/Create/ Accept	Stations	Improve asset data quality	How to get enough asset information into the system as a baseline.	
BAU: Acquire/Create/ Accept	Stations	Improve assurance		Less disputes about quality if requirements are well defined.
BAU: Operate — Other	Stations	Improve assurance	Cannot adjust O&M Manual details.	
Capital Projects: Project Close	Stations	Improve assurance		Increased efficiency — learning from past projects.
General	Stations	Improve information sharing and collaboration		Establish clear systems of work and work more as a team.
Capital Projects: Concept Design	Stations	Improve information sharing and collaboration		Easier to update/create Business Cases from Design Files.
BAU: Acquire/Create/ Accept	Stations	Improve information sharing and collaboration	Transfer of information between companies/departments takes place by e-mail.	
General	Stations	Improve operational processes	Resource requirements to meet the challenge.	
General	Stations	Improve operational processes	Resistance to change.	
General	Stations	Improve operational processes		Improved project management.

Business Stage	Asset/Team	Benefit Theme	Challenges	Opportunities
Capital Projects: Delivery	Stations	Improve supply chain management	Supply chain readiness.	
BAU: Operate — Other	Stations	Improve supply chain management		Better data assurance to feed back to contractors on site e.g. cleaners/electricians.
BAU: Operate — Other	Stations	Improve supply chain management	Contractor access to BIM system.	
Capital Projects: Outcome definition	Stations	Reduce operational costs		Better investment targeting through understanding asset condition, high ops costs, regular issues.
BAU: Operate — Other	Stations	Reduce operational risks		Identification of repeat failures.
BAU: Operate — Other	Stations	Reduce operational risks		Better lifecycle cost visibility.
Renewals/Improvements — Outcome Definition	Stations	Reduce operational risks		Proactively identifying problem sites.
Capital Projects: Project Close	Drainage	Improve asset data quality	Ensuring condition data is captured and stored consistently across the lifecycle of a project/asset.	
BAU: Operate — Inspect	Drainage	Improve operational processes	Analysing condition and performance data where data is from multiple sources and assets.	
General	Drainage	Improve information sharing and collaboration	Common terms of reference for all projects.	
Capital Projects: Delivery	Drainage	Improve asset data quality		Correct data received at hand over (whether a drainage investigation or renewal scheme).
General	Drainage	Improve asset data quality		Develop a more robust asset register which includes accurate location and condition data.
General	Drainage	Improve information sharing and collaboration		Better understand network configuration and how assets link to those owned by others in order to reduce unnecessary or abortive work.
Capital Projects: Outcome definition	Drainage	Reduce capital project risks		Greater input/approval for the drainage elements of major schemes.

Business Stage	Asset/Team	Benefit Theme	Challenges	Opportunities
General	Drainage	Improve assurance		Improved ability to meet legislative requirements, e.g. Flood Management Act.
BAU: Operate — Other	Drainage	Reduce operational costs		More effective response to flooding and emergency events, i.e. reduced road closures/time spent on site, through knowing the right action to take.
General	Drainage	Reduce capital project risks		Ability to identify shortfalls in the network, e.g. areas with insufficient gullies or attenuation, in order to inform planning and design.
BAU: Operate — Other	Drainage	Improve operational processes		Move towards 'intelligence led' rather than time-based maintenance regimes in order to improve efficiency and reduce likelihood of asset failure.
BAU: Acquire/Create/ Accept	Drainage	Improve supply chain management		Better defined information requirements for the supply chain including when/how information will be provided in order to improve confidence that data provided is complete and accurate.
General	Finance	Reduce capital project risks		Ability to identify and track changes during project delivery.
Capital Projects: Outcome definition	Finance	Reduce capital project risks		More targeted/tighter Business Cases due to better scope, e.g. condition, age, amounts, costs, etc.
Capital Projects: Outcome definition	Finance	Reduce capital project risks		Improved estimating.
General	Finance	Improve operational processes	Increased data requirements has resource implications.	
Capital Projects: Delivery	Finance	Reduce capital project risks		Accurate data for robust forecasts (Financial + Schedule) and better decision-making.
General	Financial/Legal	Improve supply chain management		Information produced as part of commercial lifecycle repeats — consolidate, e.g. develop procurement strategy across multiple stages with break points.
Capital Projects: Outcome definition	Financial/Legal	Improve supply chain management		Stats on costs for information/design for more accurate procurement and project estimating.
Capital Projects: Outcome definition	Financial/Legal	Reduce capital project risks		Better commercial information (costs, risks, supplier info) to assist with outcome definition.

Business Stage	Asset/Team	Benefit Theme	Challenges	Opportunities
Capital Projects: Delivery	Financial/Legal	Reduce capital project risks	Tender price is not reflective of outturn cost due to lack of feedback on Compensation Events impact (number and size of CEs).	
Capital Projects: Detailed Design	Financial/Legal	Reduce capital project risks	Poor hand-over information onto project delivery.	
Capital Projects: Concept Design	Green Estate	Improve asset data quality		CAD object for developments/capital (post consultation).
Capital Projects: Concept Design	Green Estate	Reduce capital project risks		Arboriculture and Landscape Team early involvement in schemes.
Capital Projects: Delivery	Green Estate	Improve supply chain management	No defined guide of what data required about Green Estate items, e.g. 3rd party or non-LOHAC works.	
BAU: Operate — Other	Green Estate	Improve assurance	Defining capital and revenue funding requirement/need.	
BAU: Operate — Other	Green Estate	Improve asset data quality		Better information on asset corridor makes it easier to manage Green Estate.
Renewals/Improvements — Outcome Definition	Green Estate	Reduce capital project risks		Opportunity to better highlight impacts of Green Estate on other assets (Footway/Carriageway and Drainage).
General	Highways, Cycleways and Footways	Improve information sharing and collaboration	Bringing data from multiple sources together to make informed decisions.	
General	Highways, Cycleways and Footways	Improve supply chain management	Different types of information is collected from the supply chain for different assets.	
Capital Projects: Project Close	Highways, Cycleways and Footways	Improve operational processes		Improve accountability for information collection and accuracy (RACI).
Capital Projects: Project Close	Highways, Cycleways and Footways	Improve assurance		Improve data collection on financial out-turns — kept on individual spreadsheets.
General	Highways, Cycleways and Footways	Improve information sharing and collaboration		Improve access to information — costs, inventory, Bill of Quantities.

Business Stage	Asset/Team	Benefit Theme	Challenges	Opportunities
General	Highways, Cycleways and Footways	Improve asset data quality		Confidence in information quality and validity.
General	Portfolio Offices	Improve operational processes	Very rare for the same PM to start and finish a project — standardisation of information naming and storage is therefore essential.	
General	Portfolio Offices	Improve operational processes	Improvements needed to document control throughout lifecycle of project.	
General	Portfolio Offices	Improve operational processes	Lack of ownership and/or focus on data quality and deadlines.	
General	Portfolio Offices	Improve operational processes	Lack of pan-organisation document control system with ability to share externally.	
General	Portfolio Offices	Improve operational processes	Lack of version control and poor naming convention for documents.	
General	Portfolio Offices	Improve operational processes		Expand use of Enterprise Management System (EPM).
General	Portfolio Offices	Improve operational processes		Introduce pan-organisation document system with external access but direct control.
Capital Projects: Outcome definition	Portfolio Offices	Improve assurance	Incomplete datasets provided and duplication of schemes already planned or delivered.	
General	Internal Design Consultancy	Improve information sharing and collaboration	No common file naming or filepath/folder structure accessible to all.	
General	Internal Design Consultancy	Improve asset data quality	Lack of archiving and cleaning of legacy data.	
General	Internal Design Consultancy	Improve information sharing and collaboration		Consistency between teams.
General	Internal Design Consultancy	BIM Level 2 compliance	Getting sign-up across the business and with external suppliers.	

Business Stage	Asset/Team	Benefit Theme	Challenges	Opportunities
General	Internal Design Consultancy	Improve supply chain management	Poor hand-off of data to supply chain. Information is probably held in different parts of the business but doesn't move through the build/operate/maintain phases.	
General	Internal Design Consultancy	Improve operational processes		Create higher and more consistent standards.
General	Internal Design Consultancy	Improve information sharing and collaboration	Finding the correct information.	
General	Internal Design Consultancy	Improve information sharing and collaboration	Security — freely sharing data/systems is restricted and supply chain cannot have unrestricted access to certain information.	
General	Internal Design Consultancy	Improve operational processes	Cloud computing — hardware/software limitations.	
Capital Projects: Project Close	Internal Design Consultancy	Improve information sharing and collaboration		Common project documentation will enable clearer and more consistent handovers.
General	Internal Design Consultancy	BIM Level 2 compliance	Network speeds, resilience and bandwidth. Hardware not capable of supporting latest software.	
General	Internal Design Consultancy	Improve operational processes	Silo working.	
General	Internal Design Consultancy	Improve supply chain management	Ensure supply chain adhere to CAD standards, data formats, etc.	
General	Internal Design Consultancy	Improve information sharing and collaboration	No common web-based management system.	
General	Project Sponsorship	Improve assurance		Discipline of configuration control/audit trail/variations.
General	Project Sponsorship	Improve assurance		Proper Benefits Management and outcome realisation to inform future programmes.
Capital Projects: Delivery	Project Sponsorship	Improve supply chain management		Linkage to supply chain — in particular materials on long lead times.

Business Stage	Asset/Team	Benefit Theme	Challenges	Opportunities
General	Project Sponsorship	Improve asset data quality		Single source of the truth — less chasing around.
General	Project Sponsorship	Reduce whole life costs of asset data management		Less bureaucracy, paper, out of date plans, etc.
General	Project Sponsorship	Improve information sharing and collaboration		Consistency in approach and definitions within teams and across different teams.
General	Project Sponsorship	Improve operational processes	Migrating to new way of working/systems without a lot of pain/chaos.	
General	Project Sponsorship	BIM Level 2 compliance	Transitioning to a fundamentally new way of working will take and need sustained effort over a significant time.	
General	Project Sponsorship	Improve operational processes	Sheer volume of new and emerging business initiatives relating to 'information'.	
General	Project Sponsorship	Improve information sharing and collaboration	Ability to look up information held elsewhere in the organisation or by 3rd parties.	
General	Structures and Tunnels	Improve asset data quality	Cost of creating information during design and construction.	
General	Structures and Tunnels	Improve asset data quality	Too much information being captured.	
Capital Projects: Delivery	Structures and Tunnels	Improve supply chain management	Supply chain Tier 2 & 3 competence, ability and willingness.	
General	Structures and Tunnels	Improve supply chain management	Resource availability in client and design/contractor.	
General	Structures and Tunnels	Reduce capital project risks		Use of 6D (resource, time, cost) modelling.
General	Structures and Tunnels	Improve information sharing and collaboration	Lack of technology to view/search for models or point clouds, etc at handover and during projects.	

Business Stage	Asset/Team	Benefit Theme	Challenges	Opportunities
Capital Projects: Feasibility	Street Lighting	Improve operational processes		Make better investment decisions from up to date asset condition and performance data.
Capital Projects: Project Close	Street Lighting	Improve supply chain management		Provide data, e.g. test certificates, as the scheme progresses rather than at the end – better transparency of scheme progress.
Capital Projects: Project Close	Street Lighting	Improve supply chain management	Ensuring 3rd party delivery teams can install and sign-off assets appropriately.	
BAU: Acquire/Create/ Accept	Street Lighting	Improve information sharing and collaboration		Sharing of studies/designs with all stakeholders during and after approval.
BAU: Operate – Inspect	Street Lighting	Improve asset data quality		Automatically update asset data as inspections are carried out, e.g. downloads from tablets.
Renewals/Improvements — Delivery	Street Lighting	Improve asset data quality	Cyclical testing information not being supplied or gets lost.	
Capital Projects: Detailed Design	Structures	Improve information sharing and collaboration	Being able to transfer data/information between contractors, e.g. change of contract.	
BAU: Acquire/Create/ Accept	Structures	Improve assurance	Accuracy of As-Is Built data held; is it As-Built or As-Designed?	
General	Structures	Improve assurance	Estimating benefits post-handover and project close.	
BAU: Operate – Inspect	Structures	Improve asset data quality		Visual 3-D representation on inspection (re-use data).
General	Structures	Improve information sharing and collaboration	Need to gather information on scheduled works/ potential works directly from stakeholders. Not easy to see through data/systems.	
General	Structures	Improve information sharing and collaboration		CDE for information gathered during feasibility stage.
General	Structures	Improve information sharing and collaboration	Information is held by different people and often duplicated.	

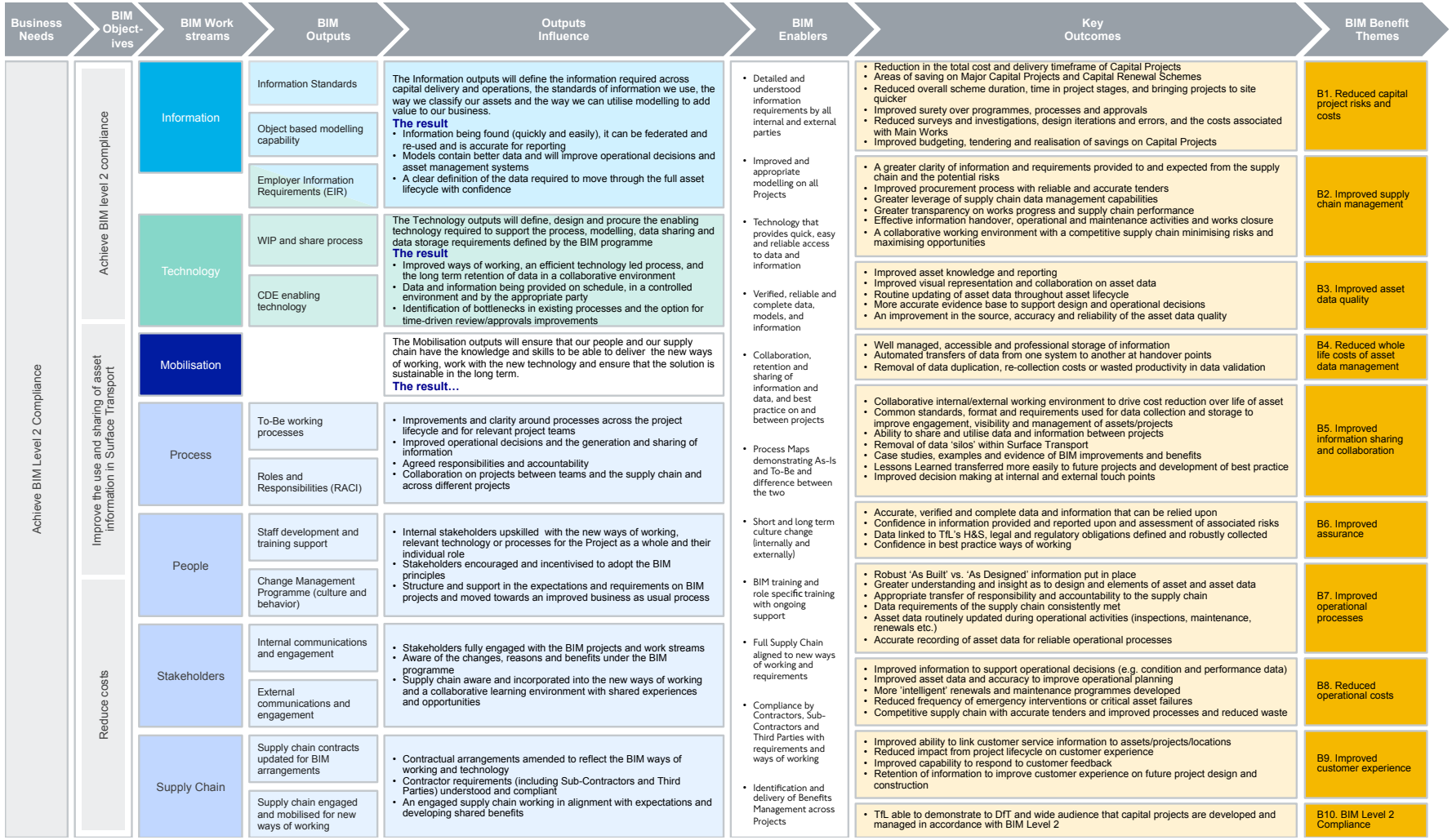
Business Stage	Asset/Team	Benefit Theme	Challenges	Opportunities
BAU: Operate — Other	Traffic Information	Improve information sharing and collaboration		Collate performance data from different sources/systems to inform operational decisions.
Capital Projects: Delivery	Traffic Information	Improve information sharing and collaboration		Detail on maintenance issues being captured during delivery and input into future design.
General	Traffic Information	Improve asset data quality	Duplication of data and lack of clarity over the 'master' version.	
General	Traffic Information	Improve operational processes	Capturing the right data to make the right decisions for asset management strategies.	
Renewals/Improvements — Outcome Definition	Traffic Information	Improve assurance	Assurance that compliance requirements are being met, e.g. equipment specifications.	
General	Traffic Signals	Improve operational processes	Cost/resource for ongoing maintenance and updating of systems.	
General	Traffic Signals	BIM Level 2 compliance	Object model vs. complexity of asset, i.e. can the right data be attached to a model?	
General	Traffic Signals	Improve information sharing and collaboration	Two sources of the truth (drawings and system). These are not directly linked.	
General	Traffic Signals	Improve assurance		Benefit of workflow system is clear ownership of projects and project stages.
General	Traffic Signals	Reduce operational risks		Opportunity to link with street lighting capital installation programme.

Business Stage	Asset/Team	Benefit Theme	Challenges	Opportunities
BAU: Operate — Other	Traffic Signals	Reduce operational risks	Linking fault data to asset issues (root cause identification).	
	Project Delivery Management	Improve information sharing and collaboration		Much improved Comms and Reporting as information is aligned between directorates.
	Project Delivery Management	Improve asset data quality		Cost trends can be spotted earlier to minimise risk to overspending.
	Project Delivery Management	Improve information sharing and collaboration		Faster process to obtain accurate data without relying on chasing individuals.
	Project Delivery Management		Enough clear communications to set expectations that this process will be better.	
	Project Delivery Management	Improve asset data quality	More than one of the same document from different authors causing confusion.	
	Health & Safety		Getting H&S file at the end of a project.	
	Health & Safety		Make sure the right people check if suitable H&S information has been supplied at handover.	
	Health & Safety			Attach Health & Safety information to library projects.
	Health & Safety			Live risk registers related to objects.
	Health & Safety			Better use of improved business processes and RACI.
Opex	Service Operations		Business priority understanding.	
Opex	Service Operations		Getting reliable data from suppliers.	
Opex	Service Operations		Volume of information.	
Opex	Service Operations		Ownership and responsibility (operational conflicts).	
Opex	Service Operations			Improved contract management information.
Opex	Service Operations			Better understanding of asset condition.
Capital Renewals	Service Operations			Informed asset management (AM) strategy — work with suppliers.
Capital Renewals	Service Operations			Better information from suppliers (better questions PLQ).

Business Stage	Asset/Team	Benefit Theme	Challenges	Opportunities
Capital Renewals	Service Operations			Better lifecycle information.
General	Business Planning	Improve information sharing and collaboration	Lack of ownership/responsibility for data.	
General	Business Planning	Improve information sharing and collaboration	Information silos within the business.	
Capital Projects: Project Close	Business Planning	Improve assurance	Major projects — benefits analysis review at end of project — did we achieve what we intended or achieve more/less and why?	
General	Business Planning	Improve assurance		Improved decision-making.
General	Business Planning	Improve information sharing and collaboration		Use all the sources of data available intelligently.
Capital Projects: Outcome definition	Business Planning	Reduce capital project risks		Use project outcomes to validate/test future project objectives.
General	Business Planning	Improve information sharing and collaboration		Improve visibility of rolling forward programmes (12 months).
General	Business Planning	Improve asset data quality		Define Information Standards and classifications for the long term, e.g. links to Profit Centres, to enable trends to be examined.

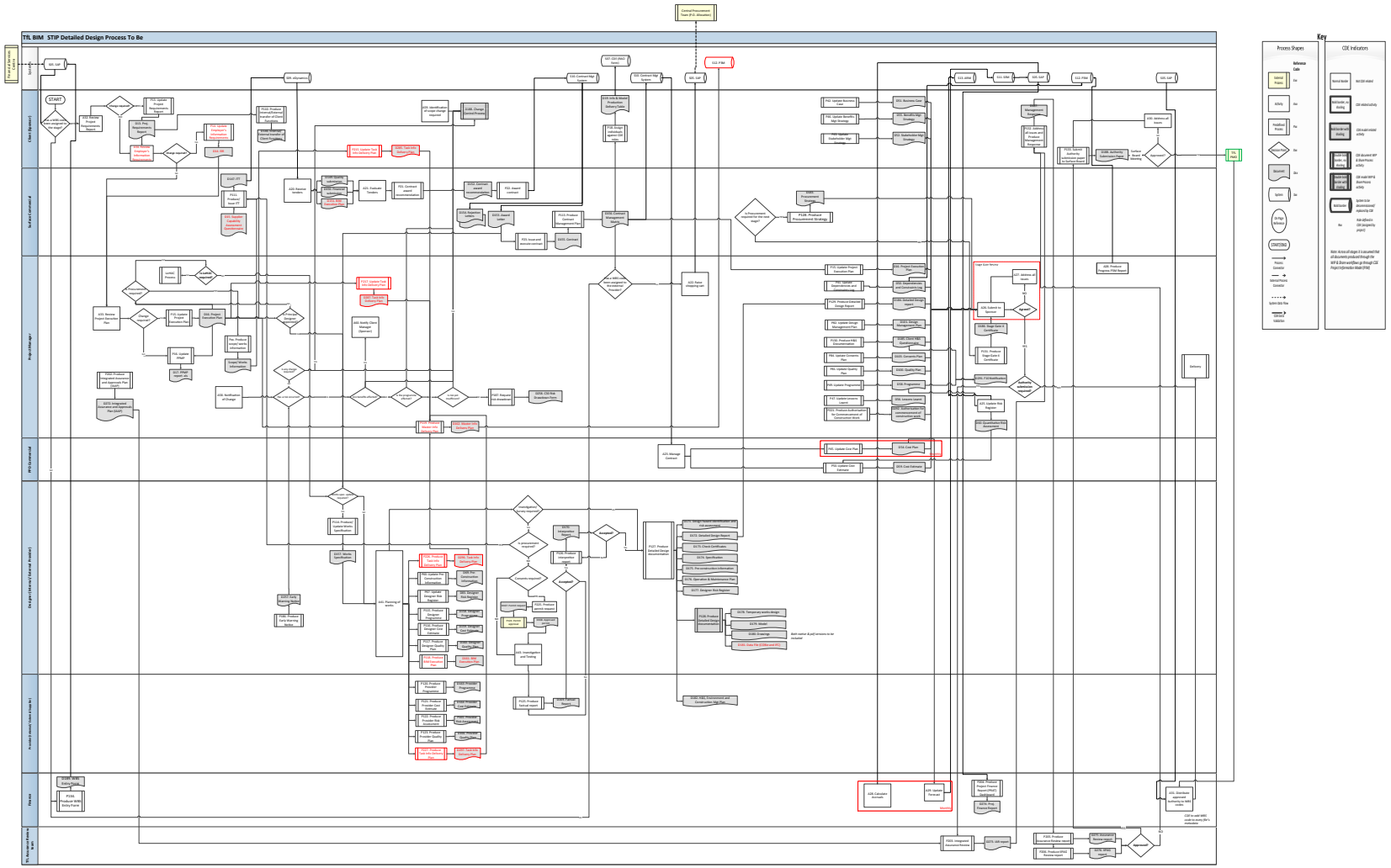
Appendix 3: Example Benefits Map

The following is an example benefits map from TfL Surface's BIM programme.



Appendix 4: Example Level 4 Process Diagram

The following is an example of a level 4 process diagrams for TfL Surface structures and tunnels investment team covering the detailed design activities.



Appendix 4: Example Level 4 Process Schedule

	Ref. No.	Activities/ Products	Total Time (Days)	Inputs		Outputs		RACI - Five Bridges														
				Information	Source	Information	Destination	Responsible - Task Team				Accountable				Consulted				Informed				Comments
								Person	Role	Lead Time	Review Time	Person	Role	Lead Time	Review Time	Person	Role	Lead Time	Review Time	Person	Role	Lead Time	Review Time	
Detailed Design	IP3	Update Project Requirements Report	N/A	Client briefing paper Cross-Asset Business Case	SEPW	Project Requirements Report	N/A	Client Manager	1 week	Senior Client Manager - Operations Senior Client Manager - Structures Operations & Maintenance Senior Client Manager - Tunnels Procurement Commercial	1 week	1. Senior Client Manager - Structures 2. Project Manager 3. Finance 4. Procurement 5. Head of Structures & Tunnels 6. Executive Sponsor	1 week	Senior Client Manager - Structures Senior Client Manager - Tunnels Senior Structures Senior Operations & Maintenance Manager Senior Tunnels Operations & Maintenance Manager	1 week	Senior Client Manager - Structures Senior Client Manager - Tunnels Senior Structures Senior Operations & Maintenance Manager Senior Tunnels Operations & Maintenance Manager	N/A	N/A	N/A	
	IP15	Update Project Execution Plan	N/A	N/A	N/A	Project Execution Plan	N/A	Project Manager	2 weeks	Programme Manager Senior Operations Manager Operations & Maintenance Senior Client Manager - Structures Senior Client Manager - Tunnels Procurement Commercial	1 week	1. Programme Manager 2. Senior Client Manager 3. Finance 4. Procurement 5. Head of Structures & Tunnels 6. Executive Sponsor	1 week	Client Manager Senior Operations Manager Operations & Maintenance Manager Procurement Senior Client Manager - Structures Senior Client Manager - Tunnels Senior Structures Operations & Maintenance Manager Senior Tunnels Operations & Maintenance Manager	1 week	Senior Client Manager - Structures Senior Client Manager - Tunnels Senior Structures Senior Operations & Maintenance Manager Senior Tunnels Operations & Maintenance Manager	N/A	N/A	N/A	
	IP16	Update Task Info Delivery Plan				Task Info Delivery Plan		Client Manager																
	IP17	Update Task Info Delivery Plan				Task Info Delivery Plan		Project Manager																
	IP19	Produce interim/deferred transfer of Client Function	N/A	N/A	N/A	Interim/deferred transfer of Client Functions	N/A	Client Manager	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Project Manager H&S Manager	N/A	N/A	N/A	
	IP4	Update PPMP	N/A	Project Requirements Report Project Execution Plan	N/A	PPMP report	N/A	Project Manager	1 day	N/A	N/A	N/A	1 day	Programme Manager	1 day	N/A	N/A	N/A						
	IP22	Produce Integrated Assurance Plan	N/A	Project Requirements Report Programme Project Execution Plan	N/A	Integrated Assurance Plan	N/A	Project Manager	1 week	Assurance Review team	1 day	Head of Client (Sponsor)	1 week	Senior Client Manager	1 week	Project Manager	N/A	N/A						
	IP38	Produce Scope / Works Specification	N/A	Project Requirements Report Project Execution Plan	N/A	Scope / Works Specification	N/A	Project Manager	1 month	N/A	N/A	N/A	N/A	Surface Commercial Technical Approvals Manager	2 weeks	Surface commercial	N/A	N/A						
	IP11	Produce / issue ITT	N/A	Procurement Strategy Project Requirements Report Project Execution Plan Pre-Construction Information Works Specification Supplier Capability Assessment Questions	N/A	ITT ITT Scope / Works Information Instruction to Tenders Terms & Conditions Financial Schedule	eDynamics	Surface Commercial	N/A	Project Manager PPD Commercial	N/A	Surface Commercial	N/A	Project Manager PPD Commercial H&S Manager	N/A	N/A	N/A	N/A						
	A23	Receive tenders	N/A	N/A	N/A	Tenders (Quality, Financial Docs, BIM execution Plan)	eDynamics	Surface Commercial	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Client Manager	Commercially sensitive	N/A						
	A21	Evaluate tenders	N/A	Tenders (Quality, Financial Submissions)	N/A	N/A	N/A	Surface Commercial	N/A	N/A	N/A	N/A	N/A	Client Manager Tender Assessment Panel H&S Manager PPD Commercial Designer Tender Assessment Panel H&S Manager	N/A	N/A	Commercially sensitive	N/A						
	IP21	Contract Award Recommendation	N/A	N/A	N/A	Contract Award Recommendation	N/A	Surface Commercial	N/A	N/A	N/A	Surface Commercial	N/A	N/A	N/A	N/A	Commercially sensitive							
	IP22	Award Contract	N/A	N/A	N/A	Award Letter Rejection Letters	eDynamics	Surface Commercial	N/A	N/A	N/A	Surface Commercial	N/A	N/A	N/A	N/A	Commercially sensitive	N/A						
	IP23	Issue and execute contract	N/A	Award Letter ITT	N/A	Contract	Contract Management System	Surface Commercial	N/A	N/A	N/A	Surface Commercial	N/A	N/A	N/A	N/A	Commercially sensitive	N/A						
	IP113	Produce contract management matrix	N/A	N/A	N/A	Contract management matrix	Contract Management System	Surface Commercial	N/A	N/A	N/A	Surface Commercial	N/A	Project Manager	N/A	N/A	Commercially sensitive							
	A22	Refer shopping cart	N/A	N/A	N/A	N/A	SAP	Client Manager	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Central Procurement team	N/A	N/A						
	IP24	Produce BIM Execution Plan	N/A	N/A	N/A	BIM Execution Plan		Lead Provider	N/A	Designer Provider	N/A	Client Manager Project Manager	N/A		N/A	N/A	N/A	N/A						
	IP26	Produce Task Info Delivery Plan				Task Info Delivery Plan		Designer																
	IP18	Produce Master Information Delivery Plan	N/A	N/A	N/A	Master Information Delivery Plan		Project Manager																
	IP13	Produce Designer Programme	N/A	N/A	N/A	Designer Programme	N/A	Designer	2 weeks	N/A	N/A	Project Manager	N/A	Project Manager	N/A	N/A	N/A	N/A						
	IP16	Produce Designer Cost Estimate	N/A	N/A	N/A	Designer Cost Estimate	N/A	Designer		N/A	N/A	Project Manager	N/A	PPD Commercial	N/A	N/A	N/A	N/A						
	IP7	Update Designer Risk Register	N/A	N/A	N/A	Designer Risk Register	CDE Risk Form	Principal Designer		Designer Provider	N/A	N/A	N/A	Project Manager	N/A	N/A	N/A	N/A						
	IP17	Produce Designer Quality Plan	N/A	N/A	N/A	Designer Quality Plan	N/A	Designer		N/A	N/A	Project Manager	N/A	Client Manager	N/A	N/A	N/A	N/A						
	IP27	Produce Task Info Delivery Plan				Task Info Delivery Plan		Provider																
	IP20	Produce Provider Programme	N/A	N/A	N/A	Provider Programme	N/A	Provider	2 weeks	N/A	N/A	Project Manager	N/A	Project Manager	N/A	N/A	N/A	N/A						
	IP21	Produce Provider Cost	N/A	N/A	N/A	Provider Cost Estimate	CDE Risk Form	Provider		N/A	N/A	Project Manager	N/A	Project Manager	N/A	N/A	N/A	N/A						
	IP122	Produce Provider Risk	N/A	N/A	N/A	Provider Risk Assessment	CDE Risk Form	Provider		N/A	N/A	Project Manager	N/A	Project Manager	N/A	N/A	N/A	N/A						
	IP123	Produce Provider Quality Plan	N/A	N/A	N/A	Provider Quality Plan	N/A	Provider		N/A	N/A	Project Manager	N/A	PPD Commercial	N/A	N/A	N/A	N/A						
	IP266	Produce Permit request	N/A	N/A	N/A	Permit Request	N/A	Provider	N/A	N/A	N/A	Project Manager	N/A	N/A	N/A	N/A	Acceptable as per submission 28 days as per S&T Guidance Note							
	IP126	Produce Factual Report	N/A	N/A	N/A	Factual Report	N/A	Provider	N/A	N/A	N/A	Client Manager Project Manager	N/A	Client Manager Project Manager	N/A	N/A	N/A	N/A	Acceptable as per submission 28 days as per S&T Guidance Note					
	IP136	Produce Interpretive report	N/A	N/A	N/A	Interpretive report	N/A	Designer	N/A	N/A	N/A	Technical Approvals Manager Client Manager Project Manager	N/A	Project Manager	N/A	Project Manager	N/A	N/A						
	D178	Detailed Design works	N/A	N/A	N/A	Temporary works design	N/A	Designer	N/A	N/A	N/A	Technical Approvals Manager Client Manager Project Manager	N/A	Client Manager	N/A	Senior Client Manager	N/A	N/A	Acceptable as per submission 28 days as per S&T Guidance Note					
	D180		N/A	N/A	N/A	Drawings	N/A	Designer	N/A	N/A	N/A	Technical Approvals Manager	N/A	Client Manager Project Manager	N/A	Senior Client Manager	N/A	N/A						
	IP37		N/A	N/A	N/A	Detailed Design Report	N/A	Designer	N/A	N/A	N/A	Technical Approvals Manager	N/A	Client Manager Project Manager	N/A	Senior Client Manager	N/A	N/A						
	IP74		N/A	N/A	N/A	Specification	N/A	Designer	N/A	N/A	N/A	Technical Approvals Manager	N/A	Client Manager Project Manager	N/A	Senior Client Manager	N/A	N/A						
	IP71		N/A	N/A	N/A	Design hazard identification and risk assessment	CDE Risk Form	Designer	N/A	N/A	N/A	Technical Approvals Manager	N/A	Client Manager Project Manager	N/A	Senior Client Manager	N/A	N/A						
	IP72		N/A	N/A	N/A	Risk Register	N/A	Designer	N/A	N/A	N/A	Technical Approvals Manager	N/A	Client Manager Project Manager	N/A	Senior Client Manager	N/A	N/A						
	IP79		N/A	Designer's Risk Register	N/A	Pre-Construction Information	N/A	Principal designer	N/A	N/A	N/A	Technical Approvals Manager	N/A	Client Manager Project Manager	N/A	Senior Client Manager	N/A	N/A						
	IP76		N/A	N/A	N/A	Operation & Maintenance Plan	N/A	Designer	N/A	N/A	N/A	Operations & Maintenance Manager	N/A	Technical Approvals Manager Client Manager Project Manager	N/A	Senior Client Manager	N/A	N/A						
	IP72		N/A	N/A	N/A	Designer Risk Register	CDE Risk Form	Principal designer	N/A	Designer Provider	N/A	N/A	N/A	Project Manager H&S Manager	N/A	N/A	N/A	N/A						
	D264		N/A	N/A	N/A	Construction Phase Plan	N/A	Principal Contractor	N/A	N/A	N/A		N/A	Project Manager	N/A		N/A	N/A						
	D182		N/A			Construction Phase Plan H&S, Environment and Construction Mgt Plan	N/A	Provider	N/A	N/A	N/A	Client Manager	N/A	Technical Approvals Manager Client Manager	N/A	Senior Client Manager	N/A	N/A						
	IP49	Update Programme	N/A	Designer Programme Provider Programme	N/A	Programme	N/A	Project Manager	N/A	N/A	N/A	Head of Client (Sponsor)	N/A	Client Manager	N/A	N/A	N/A	N/A						
	IP69	Update cost estimate	N/A	Designer Cost Estimate Provider Cost Estimate Programme Risk Register Quantitative Risk Assessment	N/A	Cost estimate	N/A	PPD Commercial	N/A	N/A	N/A	Head of Client (Sponsor)	N/A	PPD Commercial Manager Client Manager	N/A	N/A	N/A	N/A						
	A25	Update Risk Register	N/A	Provider Risk Assessment Provider Risk Assessment Programme	N/A		Allen CDE Risk Form	Project Manager	N/A	N/A	N/A	Head of Client (Sponsor)	N/A	Client Manager Finance	N/A	N/A	N/A	N/A						
	IP62	Update Design Management Plan	N/A	N/A	N/A	Design Management Plan	N/A	Project Manager	N/A	N/A	N/A	Client Manager	N/A	Technical Approvals Manager	N/A	Client Manager	N/A	N/A						
	IP61	Update Quality Plan	N/A	N/A	N/A	Quality Plan	N/A	Project Manager	N/A	N/A	N/A	Head of Client (Sponsor)	N/A	Senior Client Manager	N/A	Client Manager	N/A	N/A						
	IP63	Update Contacts Plan	N/A	N/A	N/A	Contacts Plan	N/A	Project Manager	N/A	Contacts Team	N/A	Programme Manager	N/A	Client Manager	N/A	Client Manager	N/A	N/A						
	A28	Produce Progress Report	N/A	N/A	N/A	N/A	PSM	Project Manager	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Senior Client Manager - Structures Senior Client Manager - Tunnels Senior Structures Operations & Maintenance Manager Senior Tunnels Operations & Maintenance Manager	N/A	N/A						
	IP65	Update Cost Plan	N/A	N/A	N/A	Cost Plan	N/A	PPD Commercial	N/A	Quantity Assistant Commercial Manager Project Manager	N/A	Head of Client (Sponsor)	N/A	Project Manager Programme Manager Senior Client Manager Head of Client (Sponsor)	N/A	N/A	N/A	Carried out monthly						
	IP12	Update Stakeholder Management Strategy	N/A	Communications Plan Stakeholder Mapping report	N/A	Stakeholder Engagement Plan	N/A	Client Manager	N/A	N/A	N/A	Head of Client (Sponsor) Head of PPD Head of Communications	1 week	Senior Client Manager	1 week	N/A	N/A	N/A						
	IP2	Update Business Case	N/A	Programme Cost Plan Feasibility Report	ARM	Business Case	N/A	Client Manager	2 weeks	N/A	N/A	Finance Head of Client (Sponsor)	1 week	Senior Client Manager - Structures Senior Client Manager - Tunnels Senior Structures Operations & Maintenance Manager Senior Tunnels Operations & Maintenance Manager Principal investment Analyst	1 week	N/A	N/A	N/A						
	IP67	Update Dependencies and Constraints Log	N/A	N/A	N/A	Dependencies and Constraints Log	PSM CDE Risk Form	Project Manager	N/A	N/A	N/A	Project Manager	N/A	N/A	N/A	N/A	N/A	N/A						
	IP48	Update Benefits Management Strategy	N/A	N/A	N/A	Benefits Management Strategy	N/A	Client Manager	2 weeks	N/A	N/A	Head of Client (Sponsor)	N/A	Senior Client Manager - Structures Senior Client Manager - Tunnels Senior Structures Operations & Maintenance Manager Senior Tunnels Operations & Maintenance Manager	1 week	Senior Client Manager - Structures	N/A	N/A						
	IP15	Update Project Execution Plan	N/A	N/A	N/A	Project Execution Plan	N/A	Project Manager	1 week	Programme Manager Senior Operations Manager Operations & Maintenance Senior Client Manager - Structures Senior Client Manager - Tunnels Procurement Commercial	1 week	1. Head of Client (Sponsor) 2. Head of PPD 3. Finance 4. Procurement 5. Head of Structures & Tunnels 6. Executive Sponsor	1 week	Client Manager Senior Operations Manager Operations & Maintenance Manager Procurement Senior Client Manager Programme Manager Senior Client Manager - Structures Senior Client Manager - Tunnels Senior Structures Operations & Maintenance Manager Senior Tunnels Operations & Maintenance Manager	1 week	Senior Client Manager - Structures Senior Client Manager - Tunnels Senior Structures Operations & Maintenance Manager Senior Tunnels Operations & Maintenance Manager	N/A	N/A						
	D267	Produce H&S documentation	N/A	N/A	N/A	F10 Notification	N/A	Project Manager	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						
	IP130		N/A	N/A	N/A	Client H&S Guidelines/aims	N/A	Project Manager	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A						
	IP131	Produce Stage Gate 4 Certificate	N/A	N/A	N/A	Stage Gate 4 Certificate	N/A	Project Manager	N/A	N/A	N/A	Head of Client (Sponsor)	N/A	Senior Client Manager - Structures Senior Client Manager - Tunnels Senior Structures Operations & Maintenance Manager Senior Tunnels Operations & Maintenance Manager	N/A	N/A	N/A	N/A	Meeting					
	IP138	Produce Procurement Strategy	N/A	Project Execution Plan	N/A	Procurement Strategy	N/A	Surface Commercial	0-6 weeks	Client Manager	N/A	Head of Client (Sponsor) Head of PPD Head of Procurement	N/A	Senior Client Manager - Structures Senior Client Manager - Tunnels Senior Structures Operations & Maintenance Manager Senior Tunnels Operations & Maintenance Manager	1 week	N/A	N/A	N/A						
	IP87	Update Lessons Learnt Report	N/A	N/A	N/A	Lessons Learnt Report	N/A	Project Manager	N/A	N/A	N/A	Head of Client (Sponsor)	N/A	Senior Client Manager Programme Manager	N/A	Project Manager Client Manager PPD Commercial Surface Commercial Designer H&S Manager	N/A	N/A						
	IP139	Produce Detailed Design report	1 month	N/A	N/A	Detailed Design Report	N/A	Project Manager	2 weeks	Client Manager	N/A	Head of Client (Sponsor) Head of PPD Head of Commercial Head of Finance	1 week	Senior Client Manager - Structures Senior Client Manager - Tunnels Senior Structures Operations & Maintenance Manager Senior Tunnels Operations & Maintenance Manager	1 week	Senior Client Manager - Structures Senior Client Manager - Tunnels Senior Structures Operations & Maintenance Manager Senior Tunnels Operations & Maintenance Manager	N/A	N/A						
	IP221	Produce Authorisation for Commencement of Construction Work	N/A	Construction Phase Plan	N/A	Authorisation for Commencement of Construction Work	N/A	Project Manager	N/A	N/A	N/A		N/A	N/A	N/A	Principal Contractor	N/A	N/A						
	IP213	Integrated Review	4 weeks	N/A	N/A	IAR Report	N/A	External Expert (Assurance Review)	N/A	N/A	N/A	Assurance Review team	N/A	N/A	N/A	Client Manager	N/A	N/A						
	IP235	Produce Project Assurance Report	N/A	N/A	N/A	N/A	N/A	Assurance Review team	N/A	N/A	N/A	Surface Board	N/A	N/A	N/A	Client Manager	N/A	N/A						
	IP236	Produce IPRV Report	N/A	N/A	N/A	IPRV	N/A	N/A	N/A	N/A	N/A	Surface Board	N/A	N/A	N/A	Client Manager	N/A	N/A						
	IP43	Address all Issues and Produce Management response	1 week	N/A	N/A	Management response	N/A	Senior Client Manager	N/A	N/A	N/A	Head of Client (Sponsor)	N/A	N/A	N/A	Assurance Review team	N/A	N/A						
	P134	Produce WBS codes	N/A	N/A	N/A	WBS Creation Request	SAP	Finance	N/A	N/A	N/A		N/A	N/A	N/A	Financial Services	N/A	N/A						
	A24	Update Forecast	N/A	Cost Plan	N/A	N/A	SEM SAP	Finance	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A						
	A26	Calculate Accruals	N/A	Cost Plan	N/A	N/A	SAP	Finance	N/A	Project Manager PPD Commercial Client Manager	N/A		N/A	N/A	N/A	N/A	N/A	N/A						
	A27	Distribute approved Authority to WBS codes	N/A	N/A	SAP	N/A	SAP	Finance	N/A	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A						
	IP130	Produce Early Warning Notice	N/A	N/A	N/A	Early Warning Notice	N/A	Provider	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Project Manager	N/A	N/A						
	IP187	Request risk drawdown	N/A	N/A	N/A	C30 Risk Drawdown Form	CDE Risk Form	Project Manager	N/A	Finance PPD commercial	N/A	1. Programme Manager 2. Head of PPD 3. Client Manager 4. Head of Finance	N/A	Senior Client Manager Head of Asset Management Head of Client (Sponsor) Director of PPD Director of Finance	N/A	Finance PPD Commercial	N/A	N/A	Only approved by Finance Director is Client authority exceeded. Subject to change by end of 2019					
	IP133	Produce Authority submission paper	N/A	Business Case Project Assurance Review Report	N/A	Authority submission paper	N/A	Senior Client Manager	1 week	Project Manager	N/A	Principal Investment Analyst Head of Asset Investment Head of Client (Sponsor) Head of PPD Head of Finance	N/A	Project Assurance TS, PMO	N/A	Surface Board Meeting								

Appendix 5: Example Information Requirement Spreadsheet

The following is an example Information Requirements Spreadsheet for the TfL Surface structures and tunnels investment team which were documented during the initial engagement with this department. The outputs from these information requirements spreadsheets have been used to create a template Employer's Information Requirements document along with informing the establishment of the Asset Information Requirements.

Questions and Information Required Schedule - Structures Opex

Project: TfL BIM - Structures
Issue: 6.0

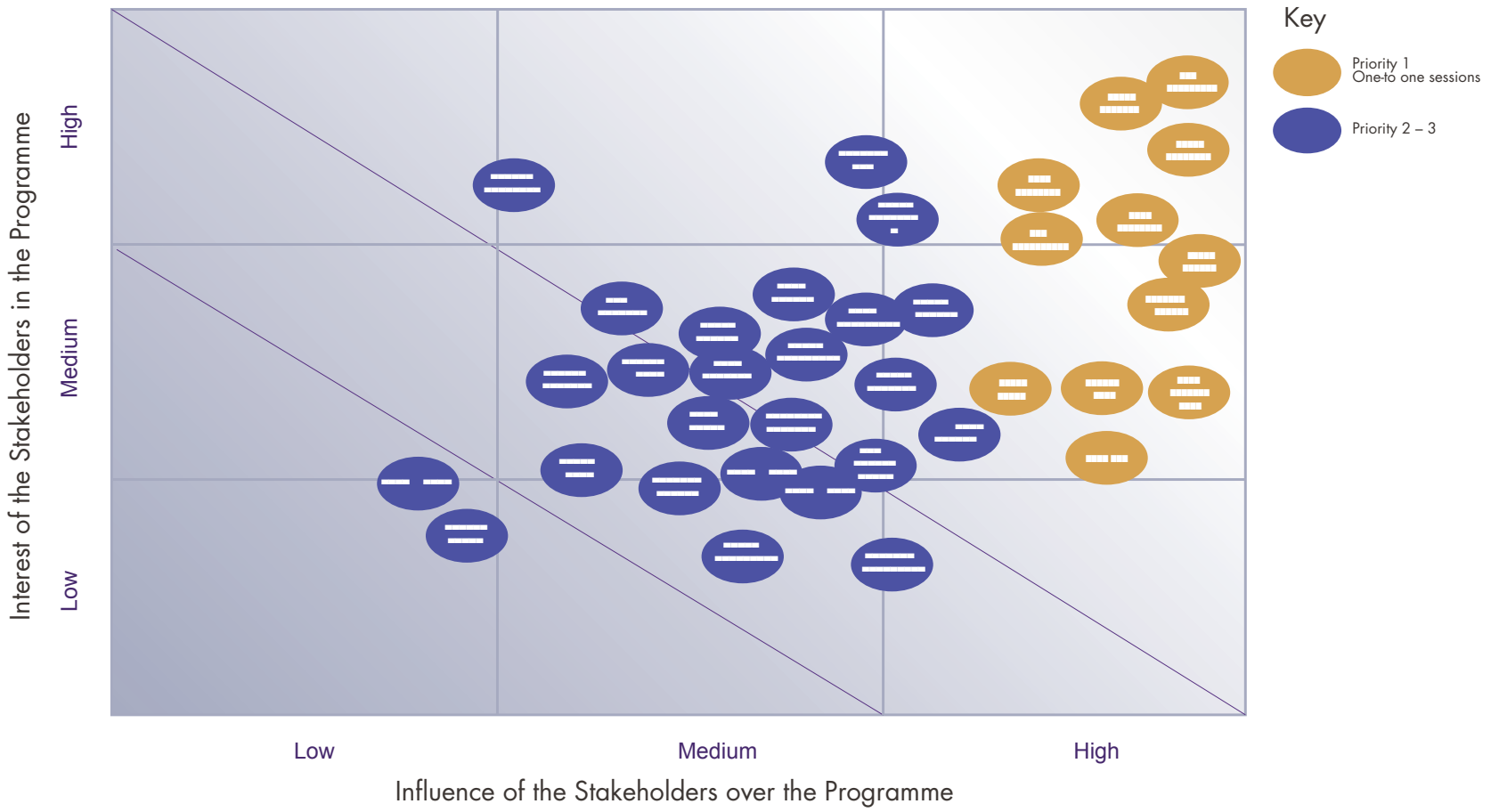
UID	Line Type	Key Decisions and Plain Language Questions	Information Required	Info Type	LoD	Responsibility	Assurance	Information Use	File Format	Notes	Source
TR1	GATE	Safety Inspection									
TR1.1	PLQ	Is the asset in a safe serviceable condition?									
	DCQ	Is the asset in a safe serviceable condition?	Category 1 defect - immediate notification to Structures Opex Team via LOHAC area control room. Defect logged on NAMS	Data	NA	LOHAC	MMAN	MMAN LOHAC	NAMS data	Carried out by highways team and focuses on condition of surfacing	LOHAC
			Category 2+ defect - defect logged on NAMS and notified to Structures Opex Team	Data	NA	LOHAC	MMAN	MMAN LOHAC	NAMS data	Carried out by highways team and focuses on condition of surfacing	LOHAC
TR2	GATE	Maintenance									
TR2.1	PLQ	Is the asset in a safe serviceable condition?									
	DCQ	What is the condition of this structure?	Completed proforma in line with SIMS list. Maintenance schedule comprises (SIMS list defines activities per structure). Scope of maintenance activities is defined in the Series 2900 of the LOHAC contract: - Removal of vegetation and debris - Clean out of the drainage system - Check nuts / bolts - Pressure wash - Mechanical wash - Clean weep holes - Clean bearing shelf and bearings - Clean and check surface mounted expansion joints - Remove bird droppings / check protection measures - De-silting one in the first 3 years	Doc	NA	LOHAC	MMAN	MMAN LOHAC VMAN	Currently paper - electronic capture would be more valuable and provide traceability of work carried out.	Paper based: Comprises lump sum cyclic inspection and reactive inspection following complaint and or safety inspection. Findings are not logged on a system. Short term is for Bridge Station to be updated to store electronic records of SIMS work done for each invoice period to allow verification exercise to be done prior to payment. Long term looking for CDE to store this information.	LOHAC
TR3	GATE	Monitoring of interim measures									
TR3.1	PLQ	Is the asset in a safe serviceable condition?									
	DCQ	Is the movement within the defined limits to ensure safety of the structure?	Monitoring results reported against trigger values	Doc	NA	LOHAC	MMAN	MMAN LOHAC VMAN	Microsoft Word / pdf	Link to GI and PI which will identify sub-standard structures and potential requirement for interim measures	Generally undertaken by LOHAC but could be by STIP or another supplier
TR4	GATE	Complaints									
TR4.1	PLQ	Is the asset in a safe serviceable condition?									
	DCQ	What is the physical and appearance condition of the asset? Are works required to improve the asset condition?	Details and location of complaint which are to be recorded on NAMS - require structure name or approximate GIS location based on details contained within the complaint.	Doc	NA	LOHAC	MMAN	MMAN LOHAC VMAN	Microsoft Word / pdf	Complaints that come through communication centre get directed to Area Control Rooms to disseminate and deal with complaints.	Public, councillors, MP's, 3rd parties direct / through the communications centre
				Doc	NA	MMAN	MMAN	MMAN LOHAC VMAN	Microsoft Word / pdf	Complaints currently not logged against an asset in Bridge Station - complaints that come through communication centre get directed to Area Control Rooms. Need for digital tool (business intelligence) to associate complaint to asset.	Public, councillors, MP's, 3rd parties direct / through the communications centre
TR5	GATE	Emergencies									
TR5.1	PLQ	Is the asset in a safe serviceable condition?									
	DCQ	Is the asset in a safe serviceable condition? Are interim measures required?	Visual inspection of structure to assess serviceability of the structure following an emergency which detail need for immediate temporary measures and or further structure inspections. Bridge Station not capable of storing emergency information as structured data. Data: - Date and time of incident - Element impacted on (in line with the elemental condition reporting) capturing updated condition - Defined inspection requirement - What was done - Interim measures installed	Doc	NA	LOHAC	MMAN	MMAN LOHAC VMAN	Microsoft Word / pdf	Outcome not always captured - Bridge Station not searchable. CAT 1 trigger - immediate response i.e. closure / install Interim Measures. CAT 2+ lead to separate inspection which would be logged on Bridge Station	LOHAC
			Third Part Claim Form	Doc	NA	RMAN	Third part claim team	MMAN LOHAC VMAN	Microsoft Word / pdf	Currently stored on network drives. Ideally should be added to Bridge Station to maintain the history of each structure.	Structures Opex
TR6	GATE	General inspection									
TR6.1	PLQ	Is the asset in a safe serviceable condition?									
	DCQ	What are the findings from the General Inspection?	Completed proforma using template. Inspection to be carried out in accordance with BD63/07.	Data	NA	LOHAC	CMAN	CMAN MMAN LOHAC VMAN	Bridge Stations	Proforma is provided on Bridge Station	LOHAC
				Doc	NA	LOHAC	CMAN	CMAN MMAN LOHAC VMAN	Microsoft Word / pdf	Appendix to inspection e.g. drawings, word files etc. loaded into Bridge Station separately	LOHAC
			Structured data: - Date of General Inspection - Updated elemental condition	Data	NA	LOHAC	CMAN	CMAN MMAN LOHAC VMAN	Bridge Stations	CONDITION SCORE - CORE CORPORATE INFO REQUIREMENT	LOHAC
TR7	GATE	Principal inspection									
TR7.1	PLQ	Is the asset in a safe serviceable condition?									
	DCQ	What are the findings from the Principal Inspection?	Completed proforma using template. Inspection to be carried out in accordance with BD63/07	Data	NA	LOHAC	CMAN	CMAN MMAN LOHAC VMAN	Bridge Stations	Proforma is provided on Bridge Station	LOHAC
				Doc	NA	LOHAC	CMAN	CMAN MMAN LOHAC VMAN	Microsoft Word / pdf	Appendix to inspection e.g. drawings, word files etc. loaded into Bridge Station separately	
			Structured data: - Date of Principal Inspection - Updated elemental condition	Data	NA	LOHAC	CMAN	CMAN MMAN LOHAC VMAN	Bridge Stations	CONDITION SCORE - CORE CORPORATE INFO REQUIREMENT	LOHAC
TR8	GATE	Special inspection									
TR7.1	PLQ	Is the asset in a safe serviceable condition?									
	DCQ	What are the findings from the Special Inspection?	Inspection Brief	Doc	NA	CMAN	CMAN	MMAN LOHAC VMAN	Microsoft Word / pdf	CAPEX ACTIVITY NOT OPEX	CMAN
			Completed proforma using template. Inspection to be carried out in accordance with BD63/07	Data	NA	LOHAC	CMAN	CMAN MMAN LOHAC VMAN	Bridge Stations	CAPEX ACTIVITY NOT OPEX	LOHAC
				Doc	NA	LOHAC	CMAN	CMAN MMAN LOHAC VMAN	Microsoft Word / pdf		
			Structured data: - Date of Special Inspection - Updated elemental condition	Data	NA	LOHAC	CMAN	MMAN LOHAC VMAN	Bridge Stations	CAPEX ACTIVITY NOT OPEX	LOHAC
TR9	GATE	Inspection for structural reviews									
TR9.1	PLQ	Is the asset in a safe serviceable condition?									
	DCQ	Do we have sufficient information to complete the structural assessment? What is the scope of the assessment?	Inspection to be completed in accordance with BD63/07. Assessment to be completed in accordance with BD21/01. Extent of inspection will depend on the structural assessment to be performed. A scope for the assessment should be document based on a review of the as-built records.	Doc	NA	LDES	TMAN	CMAN LOHAC VMAN	Microsoft Word / pdf	CAPEX ACTIVITY NOT OPEX	LOHAC or STIP
			Inspection report detailing findings from inspection. Drawings of the structure will be required where the as-built records do not provide sufficient information for the assessment to be undertaken. Native models along PDF drawings are to be provided. Drawings to be produced in accordance with TfL Surface's modelling standard.	Doc, Model, Drg	NA	LDES	TMAN	CMAN LOHAC VMAN	Microsoft Word / native model files / pdf	CAPEX ACTIVITY NOT OPEX	LOHAC or STIP
	DCQ	What is the capacity of the structure?	Assessment to be completed in accordance with the DMRB. Report detailing the findings of the assessment with copies of the calculations and computer models.	Doc	NA	LDES	TMAN	CMAN LOHAC VMAN	Microsoft Word / pdf	CAPEX ACTIVITY NOT OPEX	LOHAC or STIP
			Structured data: - Updated load capacity	Data	NA	LDES	TMAN	CMAN LOHAC VMAN	Bridge Stations	CAPEX ACTIVITY NOT OPEX	LOHAC or STIP
TR9	GATE	Resilience									
TR9.1	PLQ	Is the asset in a safe serviceable condition?									
	DCQ	What is the threat risk of the structure?	Resilience assessment proforma	Doc	NA	MMAN	MMAN	MMAN CMAN VMAN	Microsoft Excel	Not currently stored on Bridge Station. Have been training other asset owners within Surface.	Structures Opex
			Structured data (to be tested back with structures): - Resilience field completed on Bridge Station	Data	NA	MMAN	MMAN	MMAN CMAN VMAN	Bridge Stations		Structures Opex
TR10	GATE	Scour									
TR10.1	PLQ	Is the asset in a safe serviceable condition?									
	DCQ	Are the foundations at risk from scour?	Scour assessment produced following guidance of BD97/12. Assessment of findings to be presented using the proforma provided in Appendix A of BD97/12.	Doc	NA	LOHAC	MMAN	MMAN CMAN LOHAC VMAN	Microsoft Word / pdf	Risk assessment activity. Principal Inspections undertake underwater surveys.	LOHAC
			Following completion of Scour Assessment, update Bridge Station structured data to identify if structure is at risk of scour	Data	NA	LOHAC	MMAN	MMAN CMAN LOHAC VMAN	Bridge Stations		LOHAC
TR11	GATE	Management of asbestos									
TR11.1	PLQ	Is the asset in a safe serviceable condition?									
	DCQ	Has any asbestos been identified?	Report detailing survey carried out to identify where asbestos is present in the structure. Report to detail where testing has been carried out on suspected asbestos and corresponding test results. Report also the detail where areas have not been assessed due to restrictions such as access.	Doc	NA	LOHAC	MMAN	MMAN CMAN LOHAC VMAN	Microsoft word / PDF	Assessment generally carried out during Principal Inspections. Report loaded onto Bridge Station	LOHAC
	DCQ	Is the presence of asbestos been safely managed?	Asbestos Management Plan	Doc	NA	LOHAC	MMAN	MMAN CMAN LOHAC VMAN	Microsoft word / PDF	Report loaded onto Bridge Station	LOHAC
			Structured data: - Asbestos field completed on Bridge Station	Data	NA	LOHAC	MMAN	MMAN CMAN LOHAC VMAN	Bridge Stations		LOHAC
TR12	GATE	Geotechnical Principal Engineering Slopes inspection - by Highways Team									
TR6.1	PLQ	Is the asset in a safe serviceable condition?									
	DCQ	What are the findings from the Principal Inspection?	Principal inspection report	Data	NA	LOHAC	CMAN	CMAN MMAN LOHAC VMAN	Microsoft word / PDF	NEW ITEM: This is carried out by Highways Team. Structures Team want to be informed of the findings from the Principal Inspection	LOHAC
			Structured data: - Date of Principal Inspection - Updated elemental condition	Data	NA	LOHAC	CMAN	CMAN MMAN LOHAC VMAN	Data Schema		LOHAC
END											

Appendix 6: Stakeholder Engagement Planning Material

The following provides pull-outs of the graphics used in the stakeholder section of the document.

Stakeholder/Content	Priority (1 High 5 Low)	Name	Function	Department	Role	Face-Off
Stakeholder	1	xxxx	CEO	CEO	CEO	xxx
Stakeholder	1	xxxx	CFO	CFO	CFO	xxx
Stakeholder	1	xxxx	Commercial	Commercial Leadership Team	Executive Director of Commercial	xxx
Stakeholder	4	xxxx	Commercial	Retail	Retail Director	xxx
Stakeholder	3	xxxx	Commercial	Retail	Retail Manager	xxx
Stakeholder	3	xxxx	Commercial	Property	Property Director	xxx
Stakeholder	3	xxxx	Commercial	Property	Property Manager	xxx
Stakeholder		xxxx	Communications	Communications	Communications Director	xxx
Stakeholder	1	xxxx	COO	COO	COO	xxx
Stakeholder	1	xxxx	Development	Programme Controls	Programme Manager	xxx
Stakeholder	3	xxxx	Development	Master Planning	Master Planning & Strategy Director	xxx
Stakeholder	3	xxxx	Development	Planning & Programme	Head of Programme Identification	xxx
Stakeholder	4	xxxx	Development	Planning & Programme	Head of Sponsorship	xxx
Stakeholder	2	xxxx	Development	Planning & Programme	Portfolio Manager	xxx
Stakeholder	3	xxxx	Development	Planning & Programme	Programme Lead	xxx
Stakeholder	3	xxxx	Development	Planning & Programme	Programme Lead	xxx
Stakeholder	3	xxxx	Development	Planning & Programme	Programme Lead	xxx
Stakeholder	3	xxxx	Development	Planning & Programme	Design Leader	xxx
Stakeholder	3	xxxx	Development	Acquisition	Commercial Director	xxx
Stakeholder	1	xxxx	Development	Planning & Programme	Programme Lead	xxx
Stakeholder	3	xxxx	Development	Planning & Programme	Programme Lead	xxx
Stakeholder	1	xxxx	Finance	Finance	Finance Director	xxx
Stakeholder	3	xxxx	Finance	Finance	Head of Risk Management	xxx

Individuals Stakeholder Map



Appendix 6: Stakeholder Engagement Planning Material (continued)

Key Stakeholders and Face-offs

Name	Role	Key Info	Issues	Why
John Smith	Executive director of Commercial	ENTP, hates texts	Currently a resistor but is highly influential	Will need to change the commercial strategy to meet AM objectives Highly influential over Property team
…	COO			
…	Development Director			

Level of Impact Map

	Information	Process	People	Technology	Supply Chain
Asset Management	5	5	5	5	5
Buses	3	2	3	2	3
EOS	3	1	3	1	3
Services	4	4	4	4	4
Projects and Programmes	5	5	5	5	5
Road Space Management	5	5	5	5	5
Service Operations	4	3	4	3	4
Strategy and Planning	4	4	4	4	4

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UKRLG

Steering Group

Alex Bywaters	Highways England
Alexandra Luck (Security Information Expert)	A Luck Associates
Darren Thomas	Pembokeshire County Council
Dave Johnson	Transport for London
David Anderson	Transport for Scotland
Garry Sterritt (Chair)	Transport for London
John Cook	Transport for London
Jon Tuson	Bolton County Council
Kevin Dentith	Devon County Council
Rob Gillespie	Ringway
Robert Dean	Network Rail
Steve Berry	Department for Transport
Wayne Hindshaw	Transport for Scotland

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BIM guidance for INFRASTRUCTURE BODIES

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EVERY JOURNEY MATTERS

ARCADIS Design & Consultancy for natural and built assets

PCSG
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