Digital Construction Pack

MAY 2023

Construction Professionals Skillnet

DCT

Construction Industry Federation

About Construction Professionals Skillnet

The Construction Professionals Skillnet aims to support the development and growth of construction businesses by working with them to identify and address their skills needs and through the provision of construction industry specific training and development solutions.

Construction Professionals Skillnet provides funded training solutions to enhance the skills in the construction industry by:

- offering value for money courses and programmes that are of interest to those in the industry
- sourcing and providing some funding for relevant in-house courses
- offering networking events

Rialtas na hÉireann
Government of Ireland

Tionscadal Éireann
Project Ireland 2040

This report was produced in support of Project Ireland 2040 and the work of the CSG Innovation and Digital Adoption Sub-Group

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Foreword

European and national policies point towards digitalisation as the most achievable method of supporting an industrial transition to a more productive and sustainable economic sector. The challenges remain that construction consists of almost 50,000 enterprises with over 90% having less than 10 employees. This guide has been developed by construction companies to support your company's journey towards a future model of service delivery that is underpinned by digital tools and processes. In this guide we aim to offer a simple guide to the framework of digital standards, tools and policies that exist to help you understand and navigate clients' requirements. The guide provides advice on how to structure and resource your team to support digital project delivery as well as how to commercially assess what digital project requirements entail. Having regard to the new hybrid working model the guide provides a concept of how to establish and set your teams up to maximise your operational efficiency with remote and dispersed operations. We hope that this guide goes some way to providing you with a useful 'How To' for new hires as well as a coordination reference for existing teams managing your projects.

Tim Ferris

Jones Engineering

Chair Construction 4.0 Committee, CIF

While there is increasing demand for digital project delivery, many smaller construction companies have only begun to dip their toes into the world of technology and digitisation. This pack puts the need for digital project delivery into context and brings the reader from the first steps of introducing technology to your company all the way through to what you need to know for bidding for digital project delivery. It provides check lists, "how to" guidance, links to resources, etc., so that you, or your staff, can clearly see what you need to do in your own company.

The Construction Professionals Skillnet is delighted to bring this reworking and updating of CIF's previous BIM guides to the sector in the belief that it will assist the transition of companies of all sizes to the use of digital technology.

Tara Flynn

Paul Flynn Construction Ltd

Chairperson of the Construction Professionals Skillnet

Section 1:

Introduction – Background

Section 1 Introduction – Background

1.1 Overview

The aim of this guide is to bring even the uninitiated reader logically through the pre-construction and delivery of construction projects using digital technology, i.e. digital construction. The contents are clearly marked so you can dip in and out of the sections as they are relevant to you. There are four main sections, other than the introduction and context of the guide. These are:

- First steps in going digital
- Digital construction starter pack
- Standards, policies and guides
- Bidding for project delivery

As BIM is a term that will be used throughout this document, the following are three definitions:

ISO 19650-1:2018 defines BIM as:

Use of a shared digital representation of a built asset to facilitate design, construction and operation processes to form a reliable basis for decisions.

The National Standards Authority of Ireland (NSAI) defines it as:

BIM or Building Information Modelling is a process for creating and managing information on a construction project across the lifecycle of the project.

British Standards Institution (BSI):

BIM is an information management process underpinned by collaborative working and digital technologies. It uses a shared digital representation of an asset to facilitate design, construction and operation processes to form a reliable basis for decisions.

1.2 The digital evolution in Ireland

This section provides the background to the development of policy regarding the digitisation of construction over the last 10 years and puts the need for the provision of digital project delivery in context.

"Digital project delivery is the use of digital data to design, construct, inspect and record as-built conditions during the delivery of a construction project." Digital Project Delivery: A Primer for Engineers". 29 Apr 2022 https://www.enr.com/articles/54020-digital-project-delivery-a-primer-for-engineers

Digital project delivery is becoming more prevalent as public and private clients seek to optimise pre- and post-construction project efficiencies.

Figure 1: Document timeline between 2013 – 2020. (DCT)

Figure 1 summarises key milestones in the development of policies regarding digital delivery. Starting in 2013, in the UK, Publicly Available Specifications PAS, 1192-2, was released. This dealt with the construction (CAPEX) phase of a project and specified the requirements for Building Information Modelling (BIM) maturity, setting out the framework, roles and responsibilities for collaborative BIM working and detailed the scope of the Common Data Environment (CDE).

The Publicly Available Specifications, (PAS) 1192 framework set out the requirements for the level of model detail (the graphical content), model information (non-graphical content, such as specification data), model definition (its meaning) and model information exchanges.

The UK is the most influential country regarding BIM standards worldwide and the UK's BIM influence within Ireland is shown to be particularly strong.

The Irish construction industry used this PAS 1192 suite of documents as a suitable standard for the Irish construction sector as regulations are similar between both jurisdictions.

At a European level, in 2014, the Procurement Directive 2014/24/EU which promotes the use of BIM in construction projects, recognised the role of BIM in project delivery and the value that it can deliver across the full lifecycle of a project. This was the first directive to introduce common standards and operating methods for BIM across Europe.

The aim of the introduction of these common standards and operating methods using BIM was to:

- reduce barriers to operation and trade across the European market area and beyond
- reduce both the capital and operating cost of construction assets
- reduce the time wasted because of inefficient breaks between productive construction processes
- improve the reliability of construction output, with better quality and fewer defects
- improve the resource efficiency of construction products and materials, improving both operating and embodied carbon performance
- support improvements in team working and collaboration
- improve the operations processes of construction assets

In 2014, the Irish Government Contracts Committee for Construction (GCCC) produced the Review of the Performance of the Public Works Contract, which highlighted a number of key findings, including the poor definition of the works requirements, insufficient identification of risk and inappropriate risk allocation. The report highlighted and acknowledged that BIM was a powerful risk management tool.

To assist with the implementation of BIM standards across the EU, the European Committee for Standardisation (CEN) Technical Committee 442 on Building Information Modelling was established in 2015. The aim was to assist the construction sector to be more cost-efficient and sustainable by enabling smooth data exchange and sharing between partners in the value chain.

In April 2016, the UK government mandated the requirement to work to Building Information Modelling (BIM) Level 2. This stipulated that all centrally procured UK public sector projects would require the implementation of BIM Level 2.

Also in 2016, the European Commission awarded the EU BIM Task Group funding for two years to deliver a common European network aimed at aligning the use of Building Information Modelling (BIM) in public works projects. The focus of the group was to develop a handbook containing the common principles for public procurers and policy makers to consider when introducing BIM to their public works or strategies.

In 2016, the National Standards Authority Ireland (NSAI) established a BIM working group of technical committee members to

- reference material currently available,
- consider the application of the PAS 1192 framework and later ISO 19650 in an Irish context, and
- examine what the adoption of these new European standards meant for the development of a roadmap for BIM in Ireland.

In March 2017, the Irish Government Construction Contracts Committee (GCCC) published their position paper *'A Public Sector BIM Adoption Strategy',* as part of the consultation process on the adoption of BIM in the public capital programme.

It was noted within the position paper that *"Properly implemented, a public sector Building Information Modelling (BIM) adoption strategy will support the implementation of Government policy objectives in the procurement of public works projects, in their construction and their maintenance upon completion."*

Furthermore, the position paper highlighted an indicative phasing concept for the BIM implementation to be phased over several years to accommodate the training and knowledge base in the Irish construction sector. The intention was to increase the use of digital technologies in particular categories of public works projects over a 4-year timeframe ending in 2021.

In 2017, the National BIM Council (NBC) was established by Enterprise Ireland and set out to develop a BIM roadmap for the Irish Architectural, Engineering and Construction (AEC) industry to support the intentions set out by the Irish government's procurement strategy. The BIM roadmap, see Figure 2, shows four pillars:

- Leadership
- Standards
- Training
- Procurement

with milestones to be achieved for each of the pillars during the programme period 2018-2021.

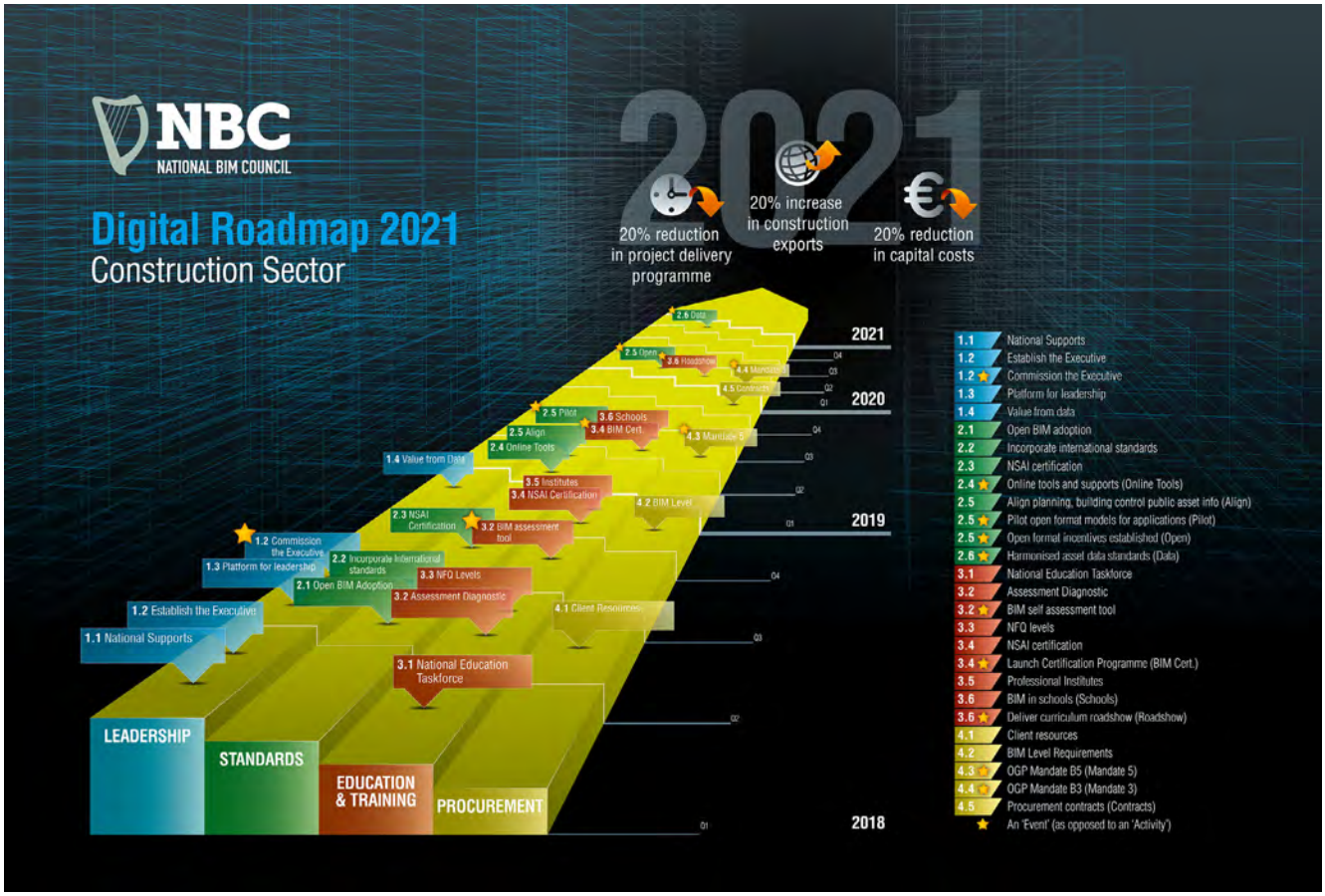


Figure 2: NBC Digital Roadmap for the Construction Sector. (National BIM Council)

1.3 Principles underpinning the roadmap

The National BIM Council (NBC), through its consultancy processes, identified several important principles upon which to base its key recommendations. These principles are summarised below.

1. Foster engagement from government, industry and academia by demonstrating the specific value propositions of BIM at an individual, company-wide and collective level.
2. Facilitate the development of guidelines, protocols, technical codes and standards to further enable and standardise the use of BIM.
3. Specify training, educational and certification support initiatives to develop the core BIM capabilities.
4. Create a culture of collaborative project delivery environments that facilitates the use of BIM.
5. Measure, evaluate and assess the impact and maturity of BIM regularly.
6. Provide a platform to adapt and sustain the transition to BIM and collaborative project delivery practices.
7. Support the development of BIM capability in a measured way that does not disadvantage SMEs or create a divided sector (digital and non-digital).
8. Recognise and profile the creation of long-term digital assets that can be used to improve estate and facilities management practices.

To ensure their members were ready for the impending government BIM implementation, the CIF engaged with the Construction 4.0 Sub Committee in 2017 and produced several supporting BIM guidance documents.

Figure 3: Superseded CIF guide documents. (CIF 4.0 Committee)

These documents are now being updated in the form of this Digital Construction Pack.

A major milestone for the evolution the international standardisation of BIM and Information Management is the I.S. EN ISO 19650 series of standards (herein after referred to as the ISO 19650 series) which was introduced in 2018. These standards superseded some of the existing British Standards and Publicly Available Specifications related to Building Information Modelling (BIM) and are part of a landscape, or ecosystem, of national and international standards supporting the BIM and Information Management processes.

The National BIM Council set the vision in Ireland with their roadmap in 2018, and it was highlighted in the Irish Government's National Development Plans that digital construction was required to enable the construction sector to meet the government development needs in terms of these plans.

Figure 4: Government of Ireland National Development documents (Government of Ireland)

The Construction Sector Group (CSG) was established in 2018 to ensure regular and open dialogue between government and industry on how best to achieve and maintain a sustainable and innovative construction sector positioned to successfully deliver on the commitments in Project Ireland 2040, see Figure 4. It is made up of representatives of key industry bodies as well as senior representatives of relevant government departments and agencies with responsibilities for policy and the delivery of infrastructure and is chaired by the Secretary General of the Department of Public Expenditure and Reform (DPER). The group reports to the Minister for Public Expenditure and Reform.

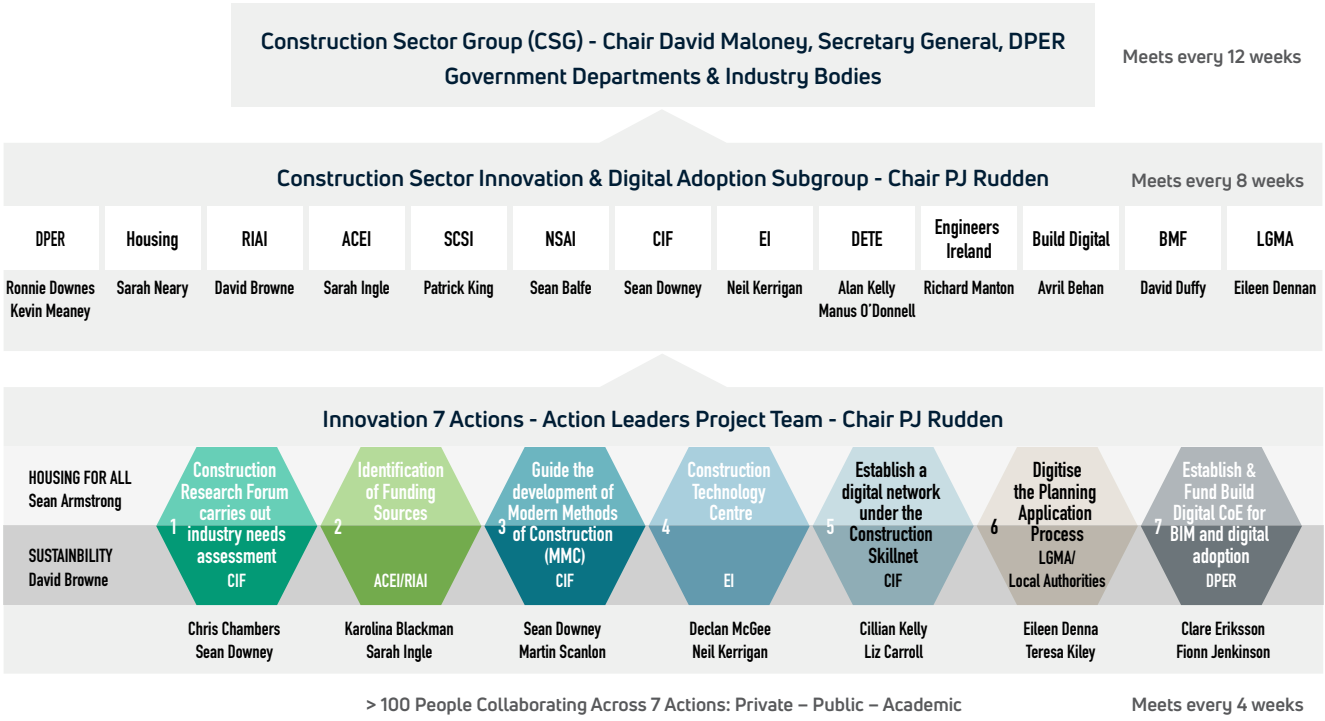


Figure 5: Overview of Construction Sector Group and Construction Sector Innovation and Digital Adoption Subgroup

The Innovation and Digital Adoption Subgroup of the CSG was established in September 2020 with the appointment of PJ Rudden as Chair. See figure 5 for an overview of the subgroup.

In preparation for the development of Ireland's National Development Plan (NDP), the Department of Public Expenditure and Reform (DPER) appointed KPMG and Future Analytics to undertake a report on the economic analysis of productivity in the Irish construction sector. This was published in May 2020 and enabled a baseline of the Irish construction sector to be created.

In 2021, the NSAI BIM Working Group completed the Irish National Annex to EN ISO 19650-2:2018 Irish National Annex to I.S. EN ISO 19650 - 2:2018, Organisation and digitization of information about buildings and civil engineering works, including building information modelling (BIM) - Information management using building information modelling - Part 2: Delivery phase of assets.

In this Annex, one of the key additions is that information container identification plays a critical role in effective information management and requires a field-based system for information container ID. This is covered in detail in Section 5.

As a result of the Construction Sector Group, three key projects have been developed to support the development of the construction sector:

- Build Digital
- Construct Innovate
- the Demonstration Park in Mount Lucas.

Build Digital Project

In 2021, the Build Digital Project was established as part of Project Ireland 2040 and the work previously undertaken by the National BIM Council now falls under the remit of the Build Digital Project.

Figure 6: Overview of Build Digital project pillars

As can be seen in the figure above, the keys areas the digital build project covers are:

1. Digital Leadership and Cultural Change
2. Digital Standards
3. Digital Education and Training
4. Digital Procurement
5. Sustainability and Circular Economy

Resource: Build Digital Project - https://www.builddigitalproject.ie/

Construct Innovate, Construction Technology Centre

In order to develop the specification for the Construction Technology Centre, Enterprise Ireland worked with Ernst and Young and identified the construction sector's current, emerging and future innovation and technology needs through detailed engagement with firms, stakeholders, and national and international experts. In line with the Government's Housing for All strategy, the new centre, Construct Innovate, has a particular focus on advancing innovation and productivity in residential construction.

Construct Innovate
Built Environment
Research Ireland

Their remit is covered under five pillars, namely:

- Productivity, affordability and cost
- Quality and safety
- Sustainability
- Skills and training
- Collaboration

Construct Innovate aims to accelerate innovation in construction and the built environment by bringing together the whole value chain. With active engagement with members, partners and a European network of innovation clusters the immediate focus is to address the challenges of housing, followed by addressing other strategic outcomes identified by the Irish Government and construction sector stakeholders.

Resource: Construct Innovate - https://constructinnovate.ie/

Mount Lucas Demonstration Park

In July 2022, the Modern Methods of Construction (MMC) Demonstration Park was launched. This is a significant investment by the Department of Further and Higher Education, Research, Innovation and Science through SOLAS and should help to drive further awareness and technical capability and increase capacity in the construction sector for the use of MMC. The park aims to inspire the industry to embrace new ways of building that can help to meet the ambitious targets set out in the Housing for All strategy, by showcasing the latest technologies and methods in construction.

MOUNT LUCAS
Ionad Náisiúnta Oiliúna Foirgníochta
National Construction Training Centre

Resource: Mount Lucas Demonstration Park - https://mountlucas.ie/

1.4 Document navigation

The development of this document introduces the key considerations of all elements of digital construction and BIM as Building Information Modelling using Building Information Management. It includes:

- First Steps in Going Digital (Section 2)
- Digital Construction Starter Guide (Section 3)
- BIM Standards, Policies and Guide (Section 4)
- Bidding for Digital Delivery Guide (Section 5)

Throughout this section, and in the introduction to each section of this pack, we highlight the roles that the section is relevant to. In the case of small companies the roles mentioned may all be taken on by one individual, possibly with a different title. However, in larger companies the job and role title are likely to be the same.

Section 2. First Steps in Going Digital

What information will I get?

On account of the pandemic most companies took on the use of new technologies that they may have otherwise ignored, and amongst other things, remote working became common. With the introduction of these technologies, came a number of benefits, including the digital upskilling of large numbers of people in the construction sector. And while the skills gained can be seen as foundational in many instances, it does show that adaptation and the introduction of technology is possible. This section outlines best practice in developing a digital strategy and the initial steps in its implementation and is relevant to all levels of implementation, including remote working. It covers key considerations in IT (hardware and software) requirements, health and safety and legislation.

Who is this section for?

Contractors – Main Contractor, Sub contractors

Roles – Owner Managers, Directors, Senior Managers, Project Managers, Information Managers, BIM Managers, Human Resource Departments

Section No. and Title	Who is this section for?	Aim	What does it cover?
2. First Steps in Going Digital	Contractors » Main contractor » Sub-contractor Roles » Owner Managers » Directors » Senior Managers » Project Managers » Information Managers » BIM Managers » Human Resource Departments	Key steps to be taken when introducing technology to a company	» Strategy » People » Processes » IT

Table 1: Section 2

Section 3. Digital Construction Starter Guide

What information will I get?

This section provides a starting point for developing the operations of a construction company using digital construction methodologies and identifying digital delivery requirements including strategy, resources, hardware/software requirements and training. The implications of BIM will be made explicit along with the benefits of BIM standards and protocol.

Who is this section for?

Contractors – Main contractor, Sub-contractors

Roles – Owner Managers, Directors, Senior Managers, Information Managers, BIM Managers

Section No. and Title	Who is this section for?	Aim	What does it cover?
3. Digital Construction Starter Guide	Contractors » Main contractor » Sub-contractors Roles » Owner Managers » Directors » Senior Managers » Information Managers » BIM Managers	Identify key areas to review in preparation for going digital	» Strategy » Resources » Technology » Training, including BIM Certification

Table 2: Section 3

Section 4. Standards, Policies and Guides

What information will I get?

This section aims to provide contractors with a high-level understanding of existing standards and policy guidance relating to digital delivery and information management.

Who is this section for?

Contractors – Main contractor, Sub contractors

Roles – Owner Managers, Directors, Senior Managers, Project Managers, Information Managers, BIM Managers, Document Controllers.

Section No. and Title	Who is this section for?	Aim	What does it cover?
4. Standards, Policies and Guides	Contractors » Main contractor » Sub-contractors Roles » Owner Managers » Directors » Senior Managers » Project Managers » Information Managers » BIM Managers » Document Controllers	Present the current standards, policies and guides used in industry that are compliant at this time.	» Standards » Policies » Guides » Common Data Environment (CDE)

Table 3: Section 4

Section 5. Bidding for Digital Delivery

What information will I get?

This section is aimed at increasing the knowledge of those staff within a construction company tasked with the responsibility of tendering and estimating the digital delivery of a project. It covers the different delivery methodologies of a digital delivery process and areas that are required to be priced when delivering a project within the built environment.

Who is this section for?

Contractors – Main contractor, Sub-contractors

Roles – Owner Managers, Directors, Senior Managers, Commercial Managers, Project Managers, Information Managers, BIM Managers, Quantity Surveyors

Section No. and Title	Who is this section for?	Aim	What does it cover?
5. Bidding for Digital Delivery	Contractors » Main contractor » Sub-contractors Roles » Owner Managers » Directors » Senior Managers » Commercial Managers » Project Managers » Information Managers » BIM Managers » Quantity Surveyors	Identify key areas to review when preparing to tender for a project which has a requirement for digital project delivery.	» Roles and responsibilities » Information management requirements » Project verification » Asset Information Requirements (AIR)

Table 4: Section 5

Section 2:

First Steps in Going Digital

Section 2 First Steps in Going Digital

2.1 Introduction

The Covid-19 pandemic forced construction companies to work in different and smarter ways and to accelerate the adoption of innovation technologies like video communications, cloud shared files and walk throughs by drones. This has been a game changer for efficiency, enabling project managers to communicate remotely, change plans in real time and track people on site, enabling projects to proceed at pace.

Many companies introduced technology to enable staff to work remotely and in doing so, took their first steps in digital adoption. The purpose of this section is to provide guidance on the introduction of technology to construction companies. Many of the key principles of introducing remote working are also valid for the introduction of any digital technology to a company. So, while remote working may be the first step for many companies in introducing technology, it has shown that there can be many benefits and that once the approach is strategic and logical in manner that it can be relatively simple.

This section is for Senior Management, Human Resource Managers, Project Managers and BIM Managers in main and sub-contracting companies.

2.2 Aim

The aim of this section is to provide direction to companies within the construction industry on basic requirements for introducing digital technology into their company including:

- Digital strategy
- People
- Processes
- Hardware/software requirements

This will give those new to using digital tools in the built environment a broad understanding of the process of, as well as guidance on, how to manage a project which uses digital workflows. In the context of construction, digital project delivery is the process of delivering and operating built assets using well-structured digital information that all the necessary parties have access to.

Operating in this way – often referred to as 'working in a digital environment' – requires all parties to collaborate and share the information they create in a mutually accessible online space known as a Common Data Environment or CDE.

This section is NOT just for BIM modelling projects but for digital ways of working as a whole, across the construction sector.

This section provides a methodology for all disciplines working within the construction sector to enable the successful introduction of a new technology as part of their business model.

2.3 Terminology

Below we define common terms that will be used in this section.

Remote working, also known as working from home, teleworking or mobile working, is a style of work that enables an employee to work outside of the employer's workspace, allowing them to essentially work from anywhere. Whilst many employees have been forced into this working style during the Covid-19 pandemic, generally it is a work style that is put in place by a specific agreement, permanent or temporary, between an employer and employee.

Hybrid working is a version of remote working where employees will work part of their working week at a location remote from the employer's workplace. This can be at home or elsewhere, such as a remote hub.

Flexible working describes a set of working arrangements that could mean changes to the normal length of the working week, working day or location. For example, part-time working, job-sharing and flexitime all fall under this category.

Term	Definition
E-Work	E-Work is a method of working using information and communication technology in which the work is not bound to any particular location. Traditionally this has been understood as working remotely away from the office, usually from home, either full-time or for a period during the working week.
Mobile Work	Mobile work refers to work patterns characterised by the worker (whether employee or self-employed) operating from various possible locations outside the premises of their employer (for example, at home, at a client's premises or 'on the road'), supported by modern technologies such as laptop and tablet computers. This is different from traditional teleworking in the sense of being even less 'place-bound'.
Smart/Intelligent Working	Smart/intelligent working is a set of practices that add greater flexibility to work methods through innovative solutions. Flexibility on areas such as location, schedule, hours worked as well as shared responsibility are some of the markers of this style of working.
Telecommuting	Telecommuting refers to substituting telecommunications for commuter travel.
Hub Work	An arrangement where an employee works from a hub close to or within their local community, either exclusively or some of the time.
Locationless Work	Locationless work refers to jobs without a fixed location. Jobs are advertised without a location and workers can live and work in a location of their choosing.
Co-working	A co-working space is a shared office space where collaboration and networking outside of one's team or company are encouraged.
Home Office	Refers to a work or office space set up in a person's home and used exclusively for business on a regular basis.
Virtual Office	An office with an address and telephone number, communication and administration services, and access to meeting rooms without the need for dedicated office space.
Platform Work	Platform work is an employment form in which company or individuals use an online platform to access other companies or individuals to solve specific problems or to provide specific services in exchange for payment.

Table 5: Key steps to managing homeworking (the Department of Enterprise, Trade and Employment)

Table 5 provides definitions use by the Department of Enterprise, Trade and Employment.

Resource
https://enterprise.gov.ie/en/publications/publication-files/making-remote-work.pdf

2.4 Preparing for change

A company's capabilities are the fuel that drives the engine, as the unique combination of skills, processes, technologies and human abilities are that which differentiate a company and create value. A crisis may put a strain on the company's capabilities and it may require the prioritisation of different capabilities. It is the company's ability to adapt to circumstances that is key.

The implementation and use of new technologies is more than applying a new piece of hardware to the existing processes within a company in the hope that this will solve all the issues.

It requires a re-evaluation of the current business processes and procedures. If there are issues in the current system these will only be speeded up by the application or use of technology. It is critical to do a thorough review before introducing technology.

To allow for growth several elements are required to be aligned to ensure that change can occur.

It is helpful for a company to ask themselves what it is that they wish to achieve by adopting new technologies within their company.This allows the company to start the process with a clear picture or roadmap of where they want to go and assists them in making clear and informed decisions to get from where they currently are to where they aim to be.

Construction companies need to inform themselves as much as possible about the available digital technologies and determine the steps that they need to take to approach it. Trying to adopt digital technologies within a company without knowing what it entails can do more harm than good and can result in wasted time, resources and a loss of faith in the technology.

Developing a plan for the implementation of these digital technologies enables a company to create a clear and structured map that allows all stakeholders to envision how each process and change fits into the bigger digital process picture.

2.5 Digital strategic plan

Both employers and employees can benefit from the many social, economic and environmental benefits associated with new technologies. These possible benefits are wide and varied and can be achieved through building trust and resilience amongst staff, focusing on communication and collaboration and cultivating a digital culture within the team.

It is crucial that construction companies step up and empower their teams with the procedures, tools and skills necessary to adapt to a new digital way of working.

An effective digital culture requires digital collaboration. Shared learnings and insights between teams is paramount to a productive digital culture and project managers should encourage this by engaging their project team in share sessions.

A digital strategic plan is considered as one of the pillars to ease/enhance remote working. Once developed, this plan can then be used to formulate goals and objectives, enabling the company to progress in the required direction.

Companies developing a digital strategy, should ask the following questions (The bullet points below are some things that could be considered):

Where are we now?

- Review the current hardware used
- Review the current software used
- Review the current IT security infrastructure
- Are all processes and procedures documented?
- How is information shared between departments?
- How is information shared to external companies?
- How is information shared and tracked in a secure manner?

Where do we want to be?

- Enable remote working
- Enable a paperless workflow
- One source of information with the use of a Common Data Environment (CDE)
- Use 3D models
- Use drone technology
- Upskill all staff to be capable of using the new digital solutions
- Upgrade hardware across the company
- Increase collaboration between company departments/create a collaborative environment

How are we going to close the gap?

- Ensure senior management buy in
- Ensure the vision of the digital strategy is clearly communicated to all staff
- Appoint a digital implementation champion
- Set up a company digital delivery team
- Hire an external consultant to support the process
- How do you ensure that you apply a consistent approach to your customers?
- Attain grants available
- Create a resilient IT infrastructure

These are all important considerations to ensure that a company has a credible, consistent and viable digital implementation strategy.

Furthermore, the development of a structured Digital Strategic Plan must also align with the long-term strategic goals of your company.

2.6 Key elements of your digital strategy

The benefits brought by the introduction of new technologies have also given rise to new challenges that construction companies need to overcome.

It is important to ensure that staff and teams, the processes and the technology are all aligned in terms of the company's overall strategy and the digital strategy.

This section will be investigated in more detail within Section 3 – Digital Construction Starter Pack

IT Infrastructure and Security

Broadband

Broadband infrastructure can be a necessary requirement for working in a collaborative environment. Similarly, video can be considered as an important technology to support effective collaboration. A report issued by NUI, "Remote Working: Opportunities, Challenges and Policy Implication, outlined the bandwidth requirements for different video uses. This can be seen in figure 7.

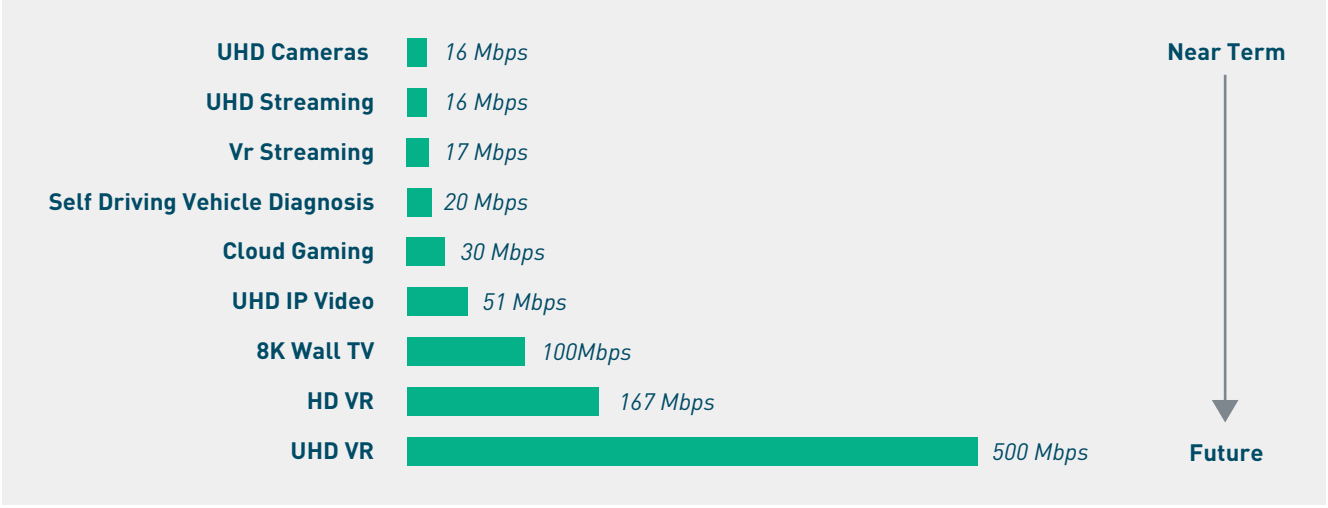


Figure 7: Bandwidth requirements for different video uses. (NUI)

Security

Information security is a process that should be prioritised in order to keep your company's private information just as it is: private. If your company's sensitive information is not properly protected, it runs the potential of being breached and damaging the privacy and future of your company and employees.

It is therefore important for companies to ensure that they have appropriate IT security arrangements and IT support teams in place to facilitate remote working for employees. Various concerns arise when workers are accessing company data from outside the network and care needs to be given to keep data safe. Some companies may deal with particularly data sensitive concerns requiring more robust and secure systems.

I.S. EN ISO/IEC 27001:2017 specifies the requirements for establishing, implementing, maintaining and continually improving an information security management system within the context of the company.

It provides a robust framework that helps you protect information such as financial data, intellectual property or sensitive customer information. It helps you identify risks and puts in place security measures that are right for your business, so you can manage or reduce risks to your information.

The latest version of ISO/IEC 27001 was published in 2017 to help maintain its relevance to the challenges of modern-day business and ensure it is aligned with the principles of risk management contained in ISO 31000. It is based on the high-level structure (Annex SL), which is a common framework for all revised and future ISO management system standards, including ISO 9001:2015 and ISO 14001:2015 i.e. Quality and Environmental Management.

Annex SL helps keep consistency, align different management system standards, offer matching sub-clauses against the top-level structure and apply a common language. It compels companies to incorporate their Information Security Management System (ISMS) into core business processes, make efficiencies and get more involvement from senior management.

Checklist 1 IT Security Measures (DCT)

Here is a checklist of IT security measures to consider. Your internal IT team, external IT company or external consultant may be required to successfully implement the checklist.

- ☐ **Establish a remote work policy:** Create a policy that outlines the rules, responsibilities and expectations for employees if working remotely. Ensure that the policy is clear and easily accessible to all employees.
- ☐ **Use secure remote access solutions:** Use secure remote access solutions such as virtual private networks (VPNs) to ensure that all remote connections are secure and encrypted.
- ☐ **Secure devices and connections:** Require employees to use strong passwords and two-factor authentication to secure their devices and connections. Also, ensure that all devices and software are updated with the latest security patches and updates.
- ☐ **Implement endpoint security:** Implement endpoint security solutions such as anti-virus software, firewalls and intrusion detection and prevention systems to protect against malware, phishing attacks and other cyber threats.
- ☐ **Use secure file-sharing and collaboration tools:** Implement secure file-sharing and collaboration tools that use encryption and access controls to protect sensitive data.
- ☐ **Use secure file-sharing and collaboration tools:** Implement secure file-sharing and collaboration tools that use encryption and access controls to protect sensitive data.
- ☐ **Establish data backup and disaster recovery plans:** Implement data backup and disaster recovery plans to ensure that all critical data is regularly backed up and can be restored quickly in case of a data breach or disaster.
- ☐ **Train employees on IT security best practices:** Conduct regular IT security training sessions to educate employees on the importance of IT security and how to stay safe.
- ☐ **Monitor and audit remote access:** Monitor and audit remote access to identify any potential security threats or breaches.

By following these IT security measures, it is possible to ensure that your remote working strategy is successful and secure.

2.7 Hardware/Software

It is important that companies firstly identify and establish their internal communication platform so that individual team members can work together and stay connected.

Key decision makers within companies are encouraged to liaise with their IT departments/consultants and digital leads to identify what solutions works best in line with their business structure.

The below table is a non-exhaustive list that identifies software applications used by contractors across the industry today. The majority of these applications include a free trial period where elements can be tested for compatibility within a company.

Important note
This is NOT a recommended list. This is only a list of software currently in use in the industry today.

COMMUNICATION AND COLLABORATION PLATFORMS

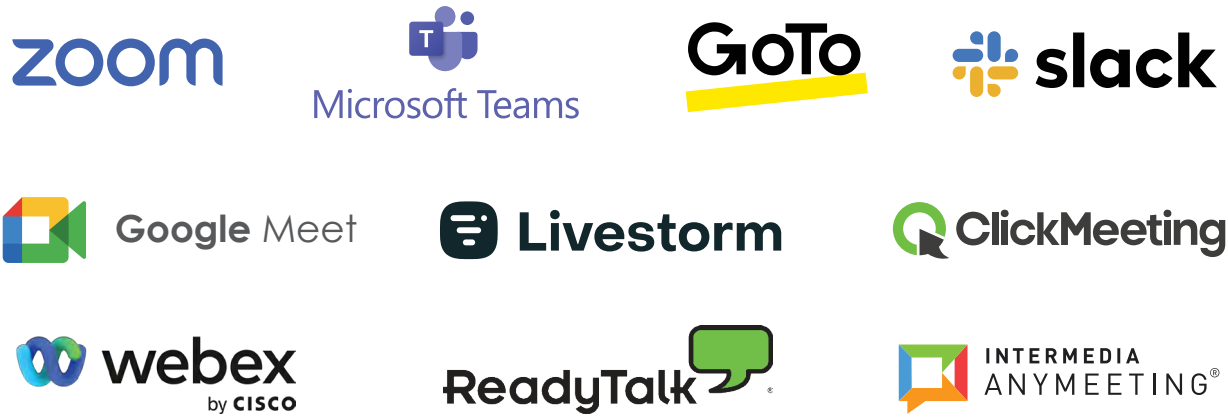


Table 6: Communication and collaboration platforms (DCT)

In parallel with a communication software platform, it is important that companies explore options on how to access data and information located on their internal office network. For successfully remote operation, this would be considered essential in order for the team to access existing project folders and documents.

There are 2 methods to access data, either through a VPN (Virtual Private Network) and VDI (Virtual Desktop Infrastructure). Again, companies should meet with their IT representatives/provider and identify what solution best suits their needs, bearing in mind security and costs, along with the time required to deploy.

Note that companies that are already working in accordance with ISO 19650 in collaboration with a larger project team using a Common Data Environment (CDE) can still progress with coordination works and BIM model development. The items listed above extend the reach of the individual team members and enable full remote working with access to both external and internal information and models.

Those not working in accordance with ISO 19650 and not using a Common Data Environment (CDE) and on projects where a CDE and a BIM Execution Plan has not been defined or established, should contact their current software providers/resellers to discuss options for digital project delivery and options to support remote working.

A list of some of the software products solutions that are currently in use within the industry today can be seen in Section 3 – Digital Construction Starter Pack.

Key elements that can support a digital strategy

There are a number of key elements which support the implementation of a digital strategy, namely communication and collaboration platforms, a Common Data Environment (CDE) and the BIM Model. Not all are required for the implementation of a strategy but understanding what is available can help in deciding what would be relevant to your company and your strategy. Below we detail what supports are provided by the different enablers.

Communication and Collaboration Platforms

- Online meetings
- Collaboration platform
- Onboarding virtually
- Video communication
- Online whiteboard spaces
- Workplace chat
- Application integration

Common Data Environment

- One central location for project information
- Workflow approval process
- Avoid disputes of misinformation

The BIM Model

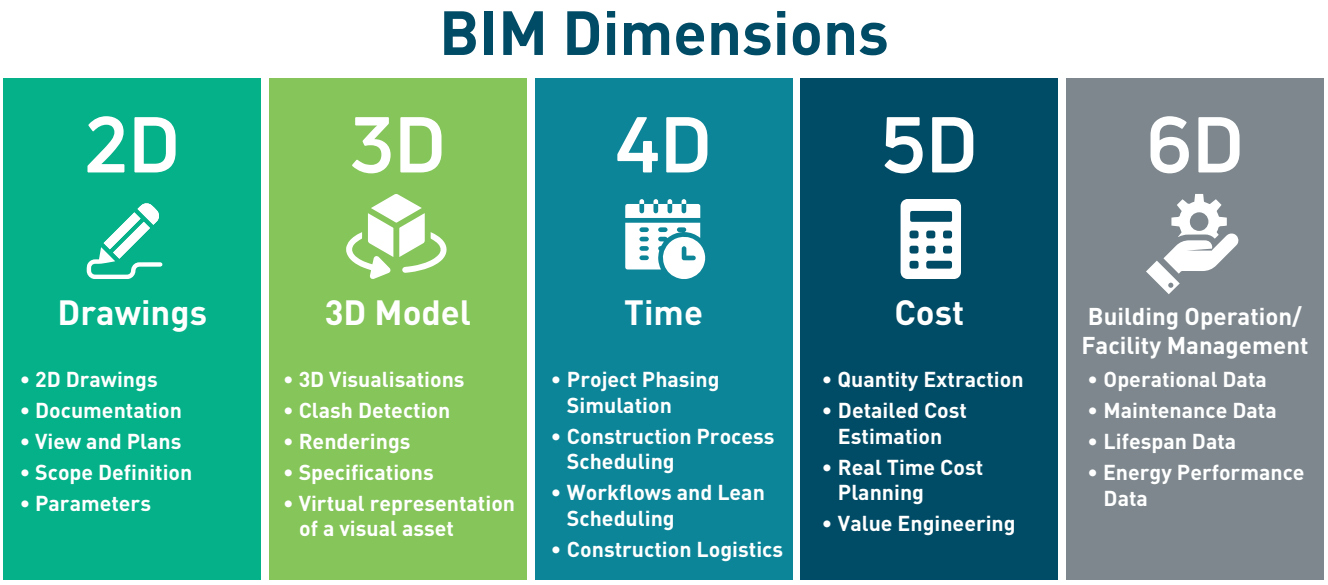


Figure 8: BIM Dimensions (DCT)

BIM has a number of dimensions, termed 2D, 3D, 4D, etc. Figure 8 indicates what each dimension covers. The BIM model can be a critical factor in being successful. For projects that are operating in 2D this may be an opportunity to develop the project in 3D. (Please see further information detailed in this section to support your digital strategy);

3D BIM Coordination

- Online coordination meetings
- Design coordination
- Pre-fabrication
- IFC – Issue for Construction Review
- Virtual Reality (VR) - Virtual walk down with client/project team
- Augmented Reality (AR) to access the site in a virtual environment

4D BIM Construction Sequence

- Logistics planning
- Construction Methodology
- Construction Optioneering
- Progress Reporting
- Planned Vs Actual Reporting

5D BIM Cost

- Quantity extraction
- Cost estimation
- Cost planning
- Value engineering

6D BIM Building Operation

- Operational data
- Maintenance data
- Lifespan data
- Energy performance

In addition there are several other technologies and practices that rely on technology that can also be considered for inclusion in your digital strategy. Some examples and what they provide are listed in Table 7.

DFMA – Design for Manufacture and Assembly » Offsite Construction » Design for Manufacture » Design for Assembly » Rapid Build » Right first-time construction	**Drone Footage** » Progress Reporting » Logistics » Traffic Management » Health and Safety Overview
Live Time Lapse Camera » Review construction progress » Progress tracking » Mobile access » Progress reporting	**Progress Photos and Video Footage** » Multiple people accessing the project remotely. » Progress Walk » Safety Walks » Virtual Snagging
Mobile Access to Project in Tablets » Communication on the go » Seamless collaboration » Access anywhere, anytime 24-7	

Table 7: Technologies to consider as part of your digital strategy.

2.8 Digital strategy – some lessons learned

As part of their digital strategy companies should focus on creating the right conditions for their teams to succeed. Some lessons learned that companies should be mindful of are as follows;

- Technology is always changing — knowing where to start is not obvious and the learning process never ends.
- For most people, implementing/using technology requires learning a new set of skills and the learning curve can be steep. Resistance will occur; ensure opportunity for resistance is removed.
- Embracing and implementing technology does not guarantee future success; in fact, most tech professionals and innovators will recommend the "fail fast" model — fail fast, learn, move on.
- There are no right answers — just educated bets based on calculated risk and perceived rewards.

Section 3:

Digital Construction Starter Pack Guide

Section 3 Digital Construction Starter Pack Guide

3.1 Introduction

Organisation development is an effort that is company-wide and managed from the top to increase company effectiveness and operational health through planned interventions in the company's processes using behavioural science knowledge. Introducing new technologies can be considered to be part of organisational development. In this section we investigate how to best ensure that your company evolves and implements digital project delivery within your company.

This section is for Directors, Senior Management and BIM Managers in main and sub-contracting companies.

This section covers:

- What is digital project delivery?
- Digital project delivery strategy
- Supports available for upskilling
- BIM Certification
- Digital starter pack checklist

3.2 What is digital project delivery?

Digital project delivery in construction refers to the use of digital technologies, such as Building Information Modelling (BIM) (See example in Figure 9), Virtual Reality (VR) and cloud-based project management tools, to streamline and optimise the design, construction and operation of building and infrastructure projects. Digital project delivery aims to increase collaboration, communication and efficiency throughout the construction process by providing stakeholders with access to up-to-date, real-time information.

Figure 9: Example of a Building Information Model (DCT)

Building Information Modelling (BIM), for example, is a digital representation of the physical and functional characteristics of a building that integrates design, construction and operational information into a single system, providing a virtual representation of the built environment. This allows stakeholders to visualise the project and identify potential problems before construction begins, reducing the need for rework and improving project outcomes.

Digital project delivery also supports collaboration by providing all project stakeholders with access to the same information, regardless of location. This helps to ensure that everyone is working with the most up-to-date information and reduces the risk of miscommunication or misunderstandings.

In short, digital project delivery in construction is an innovative approach that leverages technology to improve the overall efficiency, quality and sustainability of building and infrastructure projects.

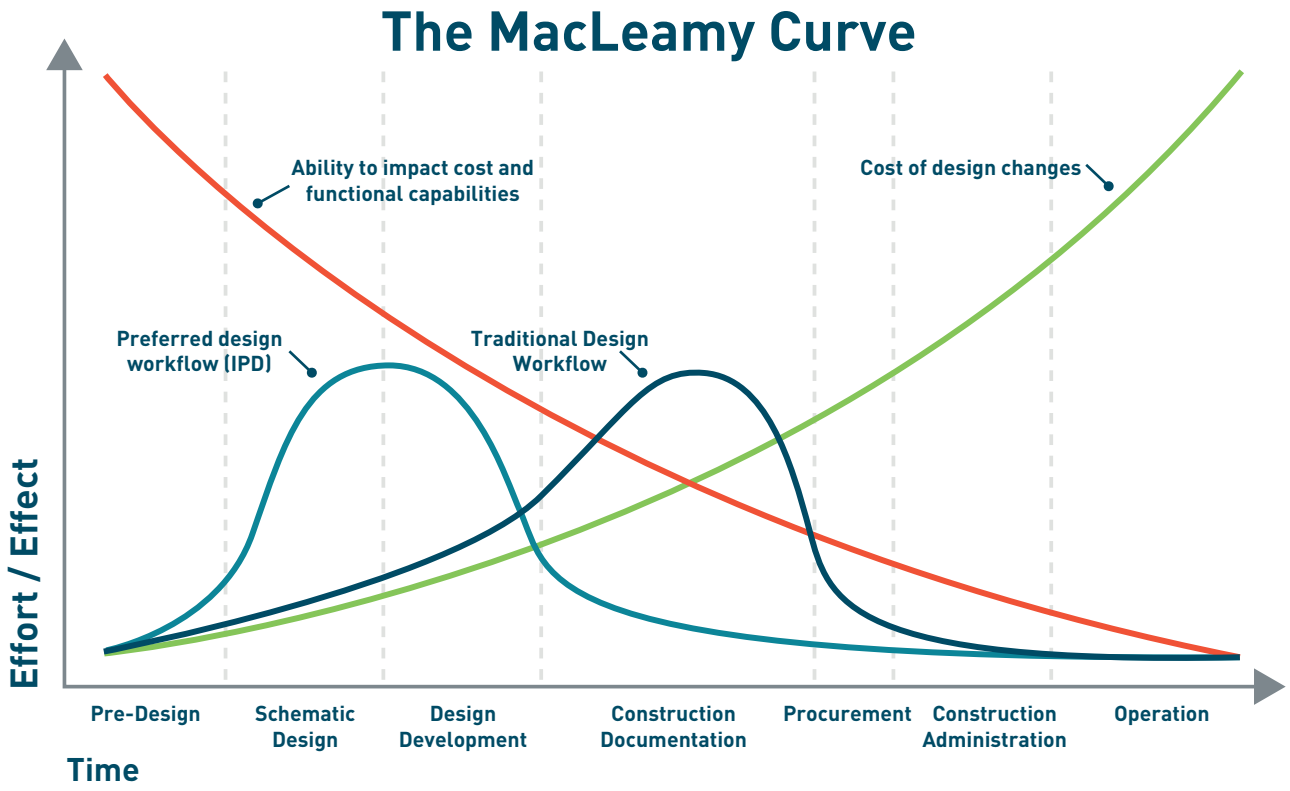


Figure 10: The MacLeamy Curve diagram (Patrick MacLeamy)

The MacLeany curve in figure 10 highlights that the further you are through the design process, the higher the cost of design change. This also has a direct correlation with potential project delays, wastage and increased delivery costs. For this reason, the BIM process brings the project stakeholders together earlier so that the individual parties can coordinate their design input, encouraging a more integrated approach to project design and delivery.

3.3 Why digital project delivery has become important to construction companies?

It has been observed that the delivery of construction projects is becoming more complex, with shorter delivery programmes and larger scale projects, and that digital technologies are becoming more advanced and helpful for construction professionals. Using technology and implementing digital processes and procedures enables construction professionals to work faster, more accurately, efficiently and more effectively with less environmental impact. Consequently, this is considered a motivation for construction professionals to invest in digitalisation. Data management is central to digitalisation for construction and it supports the journey towards full use of BIM, which allows the virtual construction of the building before it is physically built.

There is an increasing demand from clients requesting the digital delivery of their buildings as it is a process that boosts efficiency and quality. They have also become educated that the data produced during the construction stage of the building can be used advantageously during the operational phase of the building's life cycle.

BIM aims to improve the efficiency of project information exchange to ensure maximum information and information value and to minimise waste and reduce risk.

There is also a digital "Push", from the government, regarding the adoption of BIM in construction and a road map for BIM implementation has been developed.

Benefits of BIM

Building Information Modelling (BIM) is a digital representation of the physical and functional characteristics of a building. Utilizing BIM in a construction project can bring numerous benefits, such as:

» Improved Collaboration: BIM provides a centralised platform for all project stakeholders to collaborate and share information in real-time, reducing the risk of miscommunication and increasing efficiency.
» Enhanced Design Coordination: BIM enables designers to coordinate their work more effectively, reducing the risk of clashes between different design elements and improving the overall quality of the design.
» Enhanced Design Coordination: BIM enables designers to coordinate their work more effectively, reducing the risk of clashes between different design elements and improving the overall quality of the design.
» Better Cost Management: BIM allows for accurate cost estimating and budget tracking, reducing the risk of cost overruns and ensuring that the project stays within budget.
» Increased Construction Efficiency: BIM can be used to generate construction schedules, manage resources and track progress, which can help to improve the overall efficiency of the construction process.
» Improved Quality Control: BIM can be used to simulate and test building systems, such as HVAC and electrical systems, which can help to identify potential problems and improve the overall quality of the finished building.
» Better Maintenance and Operation: BIM provides a digital record of a building's components, systems and specifications, which can be used to inform maintenance and operation plans and improve the building's long-term performance.

Table 8: The benefits of BIM

Using BIM in a construction project requires improved collaboration among all stake holders and can deliver improved co-ordination, cost management and quality control, leading to higher efficiencies, better value in the delivery of the project and the long-term performance of the completed building.

Using digital tools enables a lean approach to construction, bringing added value to the customer by reducing waste and introducing continuous improvement. Using Information Communication Technology (ICT) and other digital tools, companies can improve information, material and financial flows by speeding up processes, removing human error and bringing visibility in real time to the entire supply chain,

The Sustainability Imperative

The construction and built environment sectors account for 37% of Ireland's carbon emissions, equalling agriculture.

Recently, sustainability and nearly zero energy buildings (NZEB) have become an important issue on the international policy agenda for the construction sector. There has been a significant worldwide effort to reduce carbon emissions (CE) from buildings. The energy in buildings can be classified into two categories: operational energy (OE) and embodied energy (EE).

The Building in a Climate Emergency (BIACE) Research Lab, which is based in the UCD School of Architecture, developed a Planning and Environmental Policy for the Irish Green Building Council and have produced a roadmap to net-zero in their report. This report pointed out that the whole life of carbon in construction and the built environment in Ireland was unquantified.

The road to net-zero report aimed to complete this task and present their estimations for the whole life of carbon in construction and the built environment in Ireland.

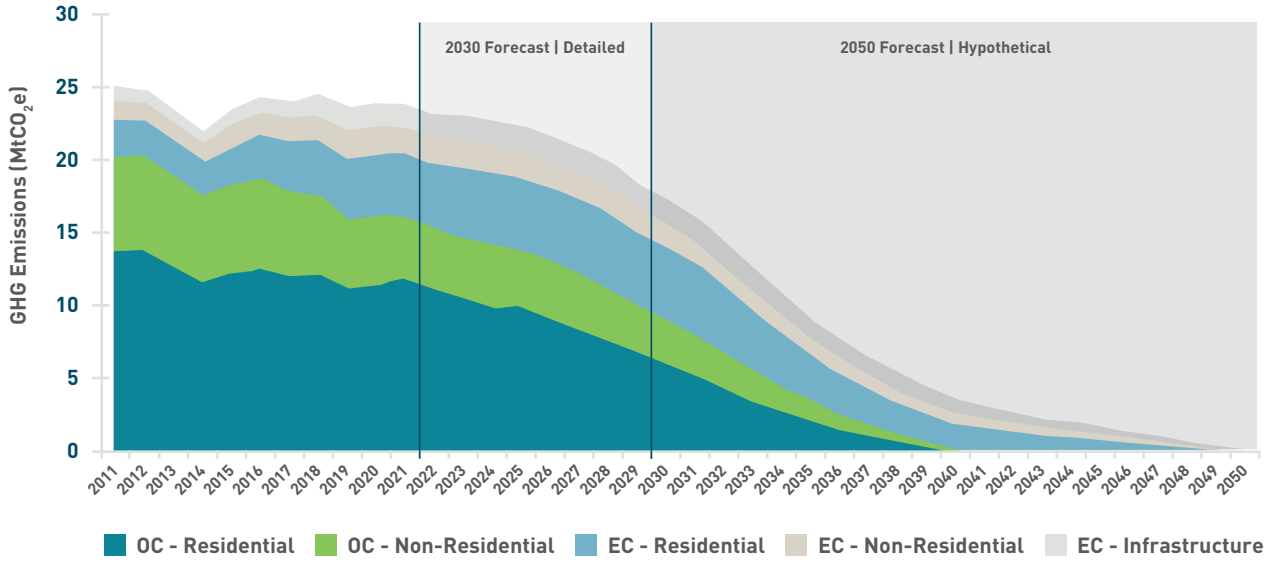


Figure 11: Projections of Green House Gas (GHG) for the built environment to 2050 (Irish Green Building Council)

- OC – Operational Carbon
- EC – Operational Emissions

Following the completion of the report it presented a roadmap demonstrated in Figure 11 in which the built environment in Ireland could reduce emissions by 51% by 2030 and to be net-zero by 2050.

Digital delivery can support sustainability. For example, energy analysis for Autodesk Revit, which is one of the BIM authoring software's available, can be used to perform energy simulation for the architectural models created in Revit, and this can be done at an early stage e.g. the conceptual design phase. The simulation results are useful in understanding building energy use and for iterating the designs to make their sustainability ratings better.

Resource

https://www.igbc.ie/wp-content/uploads/2022/10/WLC-UCD-IGBC_30.09.22_V4.0_MidRes.pdf

Figure 12 demonstrates the whole building energy simulation which is created by Autodesk software Green Building Studio. The software platform allows you to run building performance simulations to optimize energy efficiency and to work toward carbon neutrality earlier in the design process. Green Building Studio supports the user's ability to design high performance buildings at a fraction of the time and cost of conventional methods.

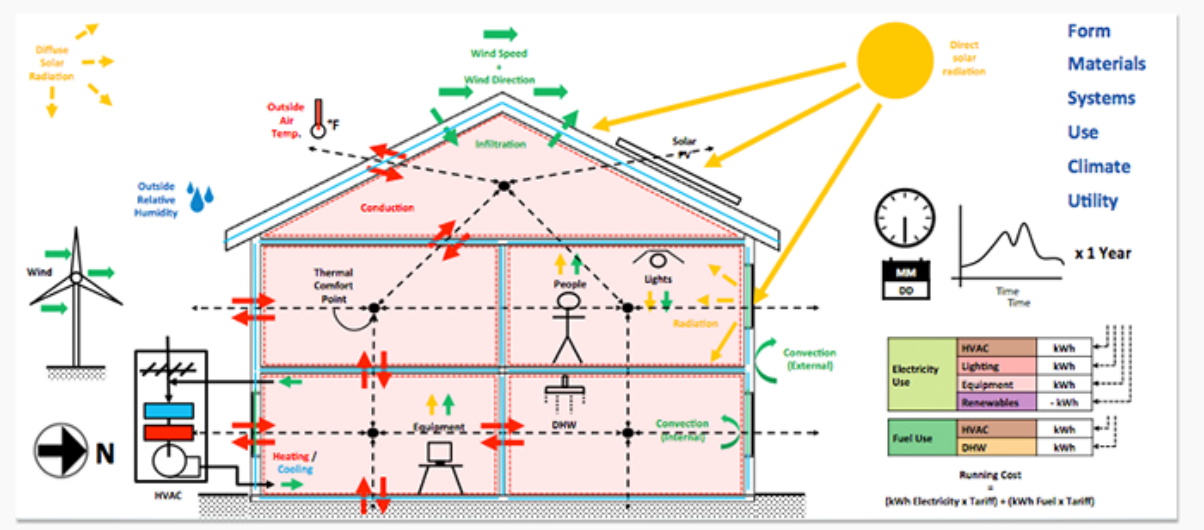


Figure 12: Dynamic whole building energy simulation (Autodesk)

Resource

https://gbs.autodesk.com/gbs

3.4 What do digital project delivery studies show?

If we investigate recent studies conducted in relation to digital project delivery and information management, it enables us to build a better picture of the value of using digital project delivery.

Cost savings can be achieved by using a digital delivery process on a construction project but can vary widely, as it depends on several factors such as the scale and complexity of the project, the level of BIM adoption and the efficiency of the project team.

However, multiple studies have shown that the use of BIM modelling and information management processes can lead to a significant reduction in waste, rework and programme enabling cost savings in construction. Some of the findings include:

- A study by the UK government found that using BIM on government construction projects resulted in an average cost savings of 3.2%.
- According to a survey by the UK BIM Task Group, over 70% of construction companies reported cost savings from using BIM.
- A report by the McKinsey Global Institute estimated that the use of BIM could result in cost savings of 5-15% for large construction projects.

- A study by the Construction Industry Institute found that using BIM can result in cost savings of 2-3% for contractors and 1-2% for owners.
- It is important to note that these are general estimates, and the actual cost savings will vary depending on the specific project and the level of BIM adoption.

Resource

https://www.rics.org/news-insights/digitalisation-in-construction-report-2022

Top 10 reasons to use digital project delivery

Apart from the reduction of costs in the delivery of a construction project, the following have been documented to be the top ten results of using digital delivery on a project:

1. Improved collaboration and coordination between project stakeholders
2. Increased efficiency and productivity through automation of tasks
3. Enhanced accuracy and consistency of project information
4. Greater ability to simulate and analyse building performance
5. Better decision-making through access to real-time project information
6. Improved communication and visualization of building design and construction
7. Reduced errors and rework
8. Increased sustainability and energy efficiency through analysis of building performance
9. More accurate cost estimating and budgeting
10. Improved safety and quality control through better coordination and communication.

According to the annual BIM report issued in 2020 by NBS in the UK, it has been detected that BIM adoption has grown substantially since 2011, when 43% of respondents had not heard of BIM. Currently, awareness is almost global, with 73% using BIM. Similarly, the benefits are recognised as:

- Improved coordination of information
- Better productivity
- Reduced risk
- Increased profitability.

In the report, a survey of design and construction professionals about BIM shows that:

- 70% say that it will improve health and safety
- 69% see its potential to address sustainability
- 81% anticipate productivity improvements.

Resource

https://www.thenbs.com/knowledge/national-bim-report-2020

3.5 Blockers to digitalisation

The type of blockers that may appear must be taken into consideration when companies are trying to implement digital project delivery.

In a 2023 global survey conducted and presented in the Royal Institution of Chartered Surveyors (RICS) Digitalisation of Construction Report the blockers to digital project delivery are ranked, with cost, effort and changes needed highest and recent graduates not equipped with the correct digital capabilities as the lowest ranking. See Figure 13.

This report also highlights the cost and effort to make the changes, shortage of skilled persons and a fundamental lack of clear demand from clients or stakeholders as the most significant barriers to going digital for construction companies. As is true with many change initiatives, there is an issue with the realisation of improvements which is compounded by the fragmented nature of the construction sector and limited use of data standards.

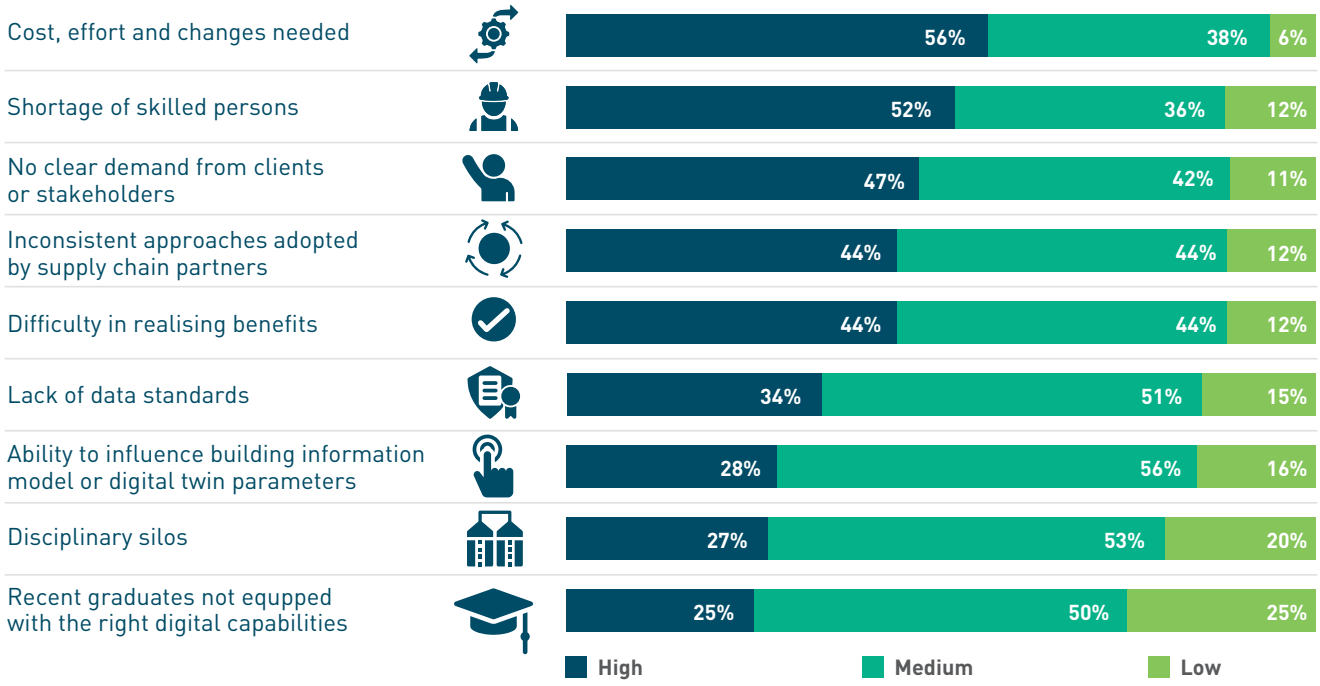


Figure 13: Blockers by function (Royal Institution of Chartered Surveyors)

3.6 What if digital project delivery is not used?

If a digital project methodology is not used on a construction project, it may:

- Prevent a contractor winning new projects
- Reduce the opportunity to reduce inefficiencies
- Reduce the opportunity to improve the quality of delivery of your construction project
- Increase the risk of human error.

Working without digital delivery on a construction project can result in several problems, such as:

- Poor Collaboration - different project stakeholders may be working with different sets of information, increasing the risk of miscommunication and errors.

- Design Clashes - difficulties in coordinating the design of different elements of a building, which can lead to design clashes and problems during construction.
- Cost Overruns - difficulty in accurately estimating the cost of a construction project, leading to budget overruns and unexpected expenses.
- Inefficient Construction Process – difficulty managing resources and tracking progress, leading to inefficiencies and delays in the construction process.
- Quality Control Issues - difficulty identifying potential problems with building systems, such as HVAC and electrical systems, which can lead to quality control issues and rework.
- Maintenance and Operation Challenges - it can be difficult to maintain and operate a building effectively, as important information about the building's components and systems may be missing.
- Limited Data Availability - important data about a building may not be easily accessible, making it difficult to make informed decisions about the building's design, construction, maintenance and operation.

Overall, not using digital project delivery in a construction project can result in poor collaboration, design clashes, cost overruns, an inefficient construction process, quality control issues, maintenance and operation challenges and limited data availability.

3.7 What actions need to be take to introduce technology to your company?

When change occurs within a company, resistance to this change will inevitably occur and given that the construction sector is a traditional industry the implementation of new processes and procedures within a company is more likely to incur resistance.

It is helpful for a company to ask itself what it is that they wish to achieve by adopting new technologies. This allows the company to start the process with a clear picture or roadmap of where they want to go and assists them in making clear and informed decisions to get from where they currently are to where they aim to be. This can be an iterative process, where the digital journey is ongoing.

Construction companies need to inform themselves as much as possible about the available digital technologies and determine the steps that they need to take to approach it. Trying to adopt digital technologies within a company without knowing what it entails can do more harm than good and can result in wasted time, resources and a loss of faith in the technology.

The following outlines some initial considerations for the first steps on your digital journey:

- Where are we now?
- Where do we want to be?
- How are we going to get there?

Where are we now?

Before commencing on the journey, it is critical to complete a current state analysis. This focuses on either the entire company or a specific process within a team. The key is to conduct research that involves data collection, interviews with staff, observation and analysis.

Other important questions that must be investigated include:

Processes and Procedures -

Are all processes and procedures documented?

How is information shared between departments?

Technology -

What is the company wide IT structure?

Review the current hardware used.

Review the current software used.

People -

Are all staff roles and responsibilities documented?

Are staff with digital delivery experience in the company?

Are external companies used to deliver certain services?

The implementation and use of new technologies is more than applying a new piece of hardware to the existing processes with the goal that this will solve all the issues. It requires a re-evaluation of the current business processes and procedures. To allow for growth several elements are required to be aligned to ensure that change can occur.

Where do we want to be?

A clear vision is key to ensuring the success of implementing a digital project delivery strategy. The vision comes from the executive leadership or senior management team and describes what the digital project delivery business transformation will achieve for the company, what the principal elements of the transformation are and what this evolution will look like at various stages. This is not just a vision statement; it is a narrative of where implementing digital tools will take the company.

How do you get there?

Becoming digitally ready is not about buying the latest software, training your staff and then assuming your company is prepared to engage in digital project delivery or information management projects, it's a journey that will require a significant change for people, processes and the technology used with your company.

To ensure a viable and successful digital implementation strategy the following should be taken on board:

Research -

- Ensure the senior management team onboard
- Ensure the vision of the digital strategy is communicated to all staff

Creating the business strategy -

- Appoint a digital implementation champion
- Create a digital implementation plan

- Investigate fundamentals of digital project delivery
- Investigate the required hardware and software
- Allocate a budget for the required hardware, software, training
- Set up a company steering group
- Document current processes and procedures
- Investigate grants available for digital implementation

Upskilling and implementation -

- Hire an external consultant to support this process
- Agree on new hardware and software to use in company
- Develop a staff upskilling strategy
- Pilot a number of projects
- Take lessons learned from pilot projects
- Align the new processes and procedures due to digital implementation

Digital project delivery evolution -

- Roll out updated processes and procedures companywide
- Communicate the value of the digital implementation to all staff
- Continuously review the available technology to improve the digital delivery
- Continuously review the digital processes and procedures to ensure they evolve over time.

3.8 Digital project delivery case studies

Digital project delivery enables a collaborative process, as having a 3D virtual model with detailed data and information about the building can be accessed by all team members. The benefits of this collaborative work were recognised in many projects. Highlighted here are three case studies which gained significantly by using digital project delivery.

Figure 14: NHS Louisa Jordan Hospital in the SEC Centre. (Scottish Futures Trust)

NHS Louisa Jordan Hospital, SEC Scotland

In the experience of NHS Louisa Jordan Hospital, SEC Glasgow, technology enabled improved collaboration and outcomes. Due to Covid-19, the project was required to be delivered swiftly with a two-week transformation of the SEC into an extra 1,000-bed hospital ready to treat patients.

The critical service infrastructure was the most challenging to deliver, with new below-ground drainage installations, 35,000m of network cabling, 135,000m of lighting and power cabling and bespoke ventilation and oxygen supply systems. The facility was divided into 1,200 spaces that each had a unique identification code (QR) to support the data management process.

Therefore, Autodesk BIM 360, a construction field management software and cloud-based collaboration system, was used to capture live data and coordinate and report the progress in construction to all site contractors and the client, NHS National Services Scotland. The centralised and cloud-based digital solution enabled senior managers and planners to monitor progress 24/7, clients to approve and site teams to action almost immediately. This allowed the delivery of the facility more quickly and with higher quality than would have otherwise been possible and so enabled the delivery of a better building in a cost-effective manner.

Resource

https://www.scottishfuturestrust.org.uk/storage/uploads/nhslouisajordanhospital.pdf

Figure 15: The Central Bank of Ireland (CITA)

Central Bank of Ireland, Ireland

In the Irish construction sector, another success of using BIM, is recognised in the Central Bank of Ireland, North Wall Quay.

Working with an existing structure brings several challenges to both the design and construction phases of a project. The client set an aspirational requirement for the project to be delivered in BIM, however, no clear definitions or protocol documents formed part of the design team procurement.

Once appointed the design team developed a BIM execution plan and agreed on the level of BIM integration on the project. The construction phase of the project would be procured under a GCCC government form of contract and, as such, BIM would not form part of any contractual obligations of a construction team. Tender documentation for the main contract works incorporated several BIM protocols and aspirational requirements for its use at the construction stage.

Resource

http://www.bicp.ie/irish-bim-case-studies

Figure 16: Image of the Raith Interchange project in Scotland. (Scottish Futures Trust)

Raith Interchange, Scotland

A significant digital project delivery benefit was demonstrated in the £600m M8/M73/M74 Motorway Improvements Project, which is a major transport infrastructure scheme in the UK. Due to construction programme pressures, the project team including Joint Venture delivery partners – Amey/Ferrovial/RPS adopted a traditional CAD-based design and a BIM-based one in parallel for the Raith Interchange section of the project. The results demonstrate the benefits of using BIM as a core approach in the project. The key benefits were outlined as follows:

- Minimise the coordination risk between teams, establishing a collaborative framework.
- Maximise the experience, knowledge and resource pool that can be applied to the BIM activity, including sharing the lessons learnt on other similar projects delivered by RPS and Amey. The lessons learnt can be summarised in the following points:
  - Reduction in design time in adopting 3D design software. The project suggests traditional CAD takes 5 times longer in comparison to 3D design software when resolving a design issue.
  - The use of 4D and 5D models helped optimise construction programming besides being a powerful visualisation and communication tool which enabled the identification of problems in advance of construction and helped extract material quantities much more efficiently.
  - The project team found that the use of BIM and Common Data Environment (CDE) made it easier to control the paperwork. It also helped keep all stakeholders in the loop regarding what was the current state of the design or works.
  - Greater efficiencies in joint working for both the client and consultants were achieved.

Resource

https://www.scottishfuturestrust.org.uk/storage/uploads/bimcasestudyraithinterchangeapr18.pdf

3.9 Creating a digital project delivery strategy

The digitalisation of the construction industry is introduced to create efficiency and effectiveness in operations in this sector. Digitalisation is promoting the transformation of the built environment and creating a domain for digital and physical built assets interaction, Building Information Modelling (BIM) being at the core of this transformation. The implementation of BIM is more than applying a new technology to existing processes within the construction industry. It requires a rethink of business processes and procedures.

Companies need to inform themselves as much as possible about BIM and its relevance to them and then to determine the steps that they need to take to approach it. It is helpful for a company to ask themselves what it is that they wish to achieve by adopting BIM. This allows the company to start the process with a clear picture of where they want to go and assists them in making clear and informed decisions to get from where they currently are.

Then, they can develop a structured BIM Implementation Plan and make sure that it aligns with the goals of their company.

Developing a plan for the implementation of BIM enables a company to create a clear and structured map that allows all stakeholders to see how each process and change fits into the bigger BIM picture. This BIM Implementation Plan can then be used to formulate goals and objectives, enabling the company to progress in the required direction.

Figure 17: Benefits of using a digital project delivery on a construction project.

Resource

https://theaecassociates.com/blog/3-advantages-vertical-integration-bim-implementation-bim-modelling-services/

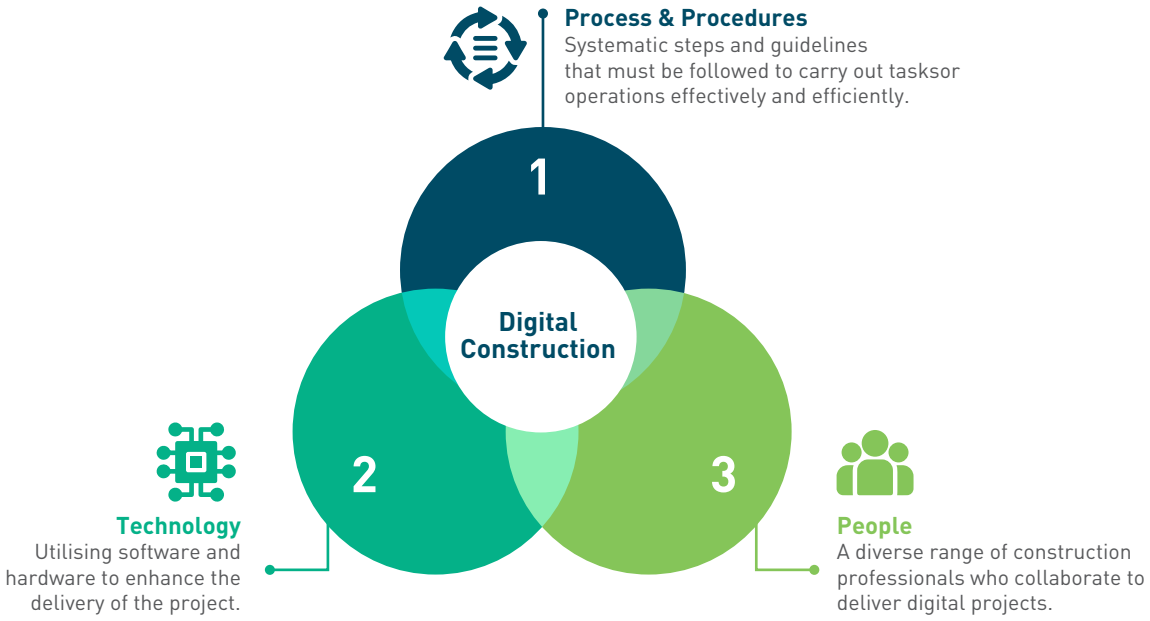


Figure 18: Synergy of processes, procedures, technology and people. (DCT)

To successfully implement digital project delivery, it will require a strategy to be applied to the following three key areas:

01. Processes and Procedures
02. Technology
03. People

Digital project delivery facilitates the expansion of traditional methods of working to take advantage of new technologies, solutions, formats and processes. Traditional design meetings can be enhanced by collaboration. Collaboration using the 3D models makes the resolution of clashes, constructability, sequencing, cost reduction, health and safety, etc. easier to achieve.

However, without both the skilled staff or the correct technology it is difficult to take advantage of the benefits that might otherwise be available. Having these three key elements in harmony, and implemented strategically within a company, can ensure the successful transition from traditional processes and procedures to ones that use BIM models and are digitally enhanced.

3.10 Processes and procedures

It is useful to review your current project delivery processes and procedures prior to making any modification due to a new hardware or software being introduced. The new technology should embed into the company rather that the company changing all their processes and procedures to suit the new technology for a number of reasons, the biggest being the resistance to change that may come from staff.

One of the key processes to be addressed in the move to digital project delivery is that of information management. I.S. EN ISO 19650 is an international standard for managing information over the whole life cycle of a built asset using building information modelling (BIM). It contains all the same principles and high-level requirements to ensure you are commencing a project with the foundations necessary for digital project delivery. Smaller projects don't necessarily need such an extensive BIM process, but the same principles apply.

As previously mentioned, it is becoming more common for clients to require projects to be delivered using ISO19650 and to deliver a project according to I.S. EN ISO 19650, a company will be required to properly plan for BIM on a project. In this section, essential elements that affect the success of BIM on a project are reviewed.

Your company will be required to interface with several documents associated with managing the BIM process. These documents would require the reader to understand the implications of each document.

Project planning

When setting out on a digital delivery journey, we need to be mindful of several key items:

- Identify the key contact people, roles and responsibilities of the project team
- Create BIM objectives/uses of the project
- Assess the BIM capability/skills of the project team and provide training where it is necessary
- Monitor workflow in the project
- Appoint a digital champion to ensure BIM is approached as should be
- Align the standards that will be used in the project
- Ensure the hardware and software match the BIM requirements
- Ensure having a collaborative platform/common data environment to ease the collaboration among the project team
- Create the required BIM documents to be created by the project team
- Ensure the project BIM deliverables are clear to all parties
- Ensure the client/appointing party requirements are clear to the project team
- Set up an information delivery strategy
- Ensure the timeline of the project is clear and the deliverable of each milestone is understood by the project team
- Set up a quality control procedure and the federation strategy of the model
- Choose a pilot project when embracing the new technology/digital strategy
- Outsource if required a specific project and adopt lessons learned

These are true no matter the size of company.

Project Federation

Project federation is how a project is broken down. To effectively manage the Information Model, it needs to be divided into its component parts, i.e. mechanical, electrical, architectural etc..for example. This is defined as an information breakdown structure which is a pre-determined method to identify manageable units of information to be used across a project or asset life cycle.

Project Document Flow Chart

Depending on the timeframe in which a company is on-boarded into a project, there are several project documents that the company need to familiarise itself with when taking part in a project that is working to the required standard according to ISO 19650.

The below diagram illustrates a high-level definition of project document requirements to successfully work on a project and meet the required project standard.

Document	Appointing Party	Lead Appointed Party	Appointed Party
Project Level			
Appointment Level (per appointment)			
Appoint party's EIRs	✔		
Tender response requirements & evaluation criteria	✔		
Pre-appointment BIM execution plan		✔	contributing
High-level responsibility matrix (HLRM)		✔	
Risk register		✔	
Confirmed BIM execution plan	contributing	✔	contributing
Detailed responsibility matrix (DRM)		✔	contributing
Task information delivery plan(s) (TIDP)			✔
Master information delivery plan(s) (MIDP)		✔	contributing
Lead appointed party's EIRs		✔	

Figure 19: ISO 19650 document requirements (https://www.12dsynergy.com/)

The figure uses the terminology of ISO19650. For those more familiar with the Publicly Available Specification (PAS), the role equivalents are as follows:

Project roles

- Appointing party = Client/client representative
- Lead appointed party = Designer lead/Contractor lead
- Appointed party = Task Teams

Project requirements

Figure 20 identifies a typical workflow structured resource requirement based on the project stage in terms of Royal Institute of British Architects (RIBA) work stages and the project size in terms of cost. This is aimed to give users an idea in terms of resources. However, due to all projects being unique, it is best advised to allocate resources after understanding the roles and responsibilities that have been identified and set out in the BIM Execution Plan in more detail.

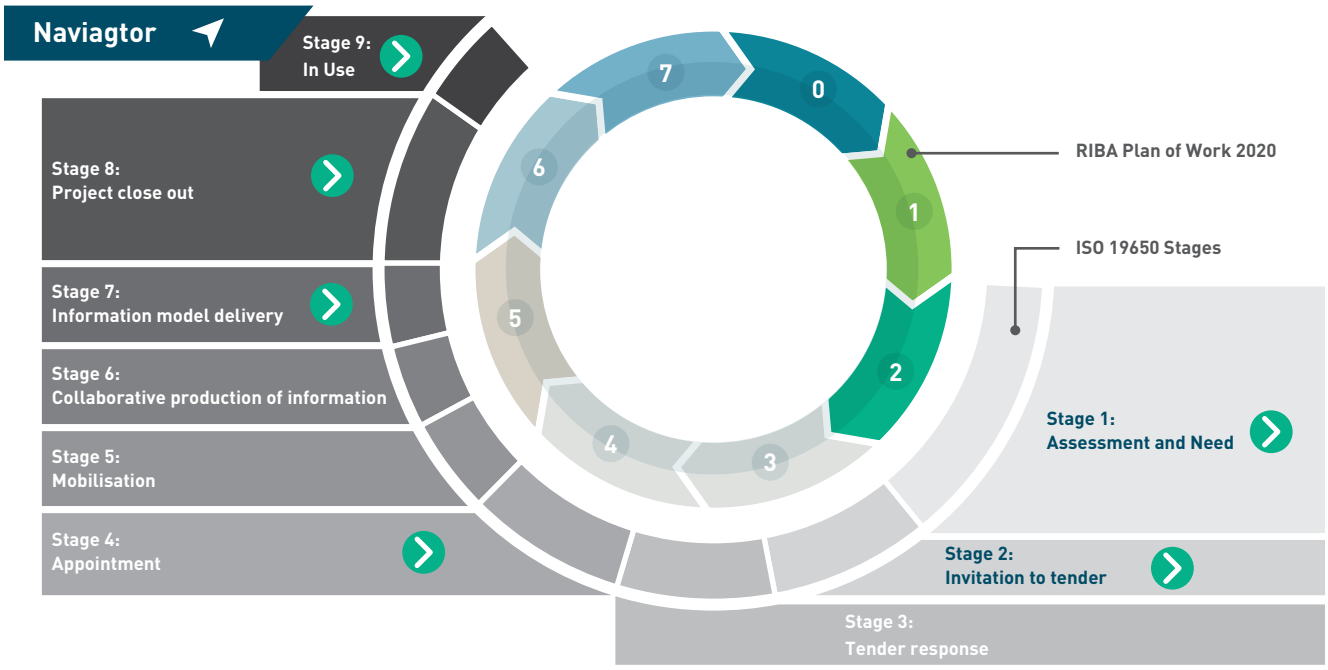


Figure 20: Navigator wheel - Aligning RIBA work stages with ISO 19650 activities. (NHS National Services Scotland)

Resource

https://www.nss.nhs.scot/publications/guidance-iso-19650-navigator-v01/

Foresight

Ensure to stay in constant communication with the senior management /commercial/estimating team to ensure the digital lead within the company has foresight on projects in the pipeline and can allocate to required resources accordingly.

Resource tracker

Creating a resource tracker in relation to digital project delivery resource management provides better visibility of your resources. The practice involves closely monitoring resource utilization, so you always know what you have at any given time. This, in turn, helps you make well-informed decisions on how to use and allocate construction resources.

Time management system

Implementing a time management system will provide vital data on future projects if used correctly to build a picture of a project requirement based on past projects, of similar sectors, size, disciplines etc.

Standards

For a more detailed explanation on BIM standards please refer to section 4 – Standards, Policies and Guides, of this document the BIM Standards, Policies and Guides, which provides the required information.

3.11 Technology

Having looked at streamlining your processes, the next thing you need to do is decide on the technology needed by your company to achieve your goal. Evolving technologies encompasses both hardware and software within a company.

Changing processes and procedures to meet that of a new software application or common data environment may face resistance within a company. Not everyone likes to change. This may then impact on the success of the digital development of the company. The company must ensure that software chosen aligns as close as possible to company processes and procedures to create a smooth transition.

BIM is not just a 3D model but a way of working, and to ensure that success is attained the three key strategic areas of processes and procedures, people and technology must be implemented accordingly.

The construction industry is experiencing a fast-paced digital revolution in order to align itself with current technology advancements. The value of staff productivity can quickly offset the cost of providing high performance PCs. The recommendations below reflect the appropriate high-performance level of specification for using BIM. BIM technicians and consumers will require a higher specification than model reviewers and this should be considered in IT purchasing plans and budgets.

Hardware

Below are the minimum hardware requirements to run BIM software and access 3D BIM files which would be issued from a client/contractor.

Important note

This is the minimum hardware requirements and if you require multiple software packages, please check with your software provider on the preferred hardware requirements as the spec below would not be sufficient.

Below is the spec for BIM hardware for staff viewing/authoring BIM models or processing data:

Standard Desktop

- 32 Gb Ram
- 64Bit Operating System
- Minimum Intel Xeon W Processor
- Windows 11
- Graphics card - NVIDIA Quadro® RTX 6000
- Storage M.2 SSD 500GB

Standard Laptop

- 32 Gb Ram
- 64Bit Operating System
- Minimum i7 Core processor
- Windows 11
- Graphics card
- Storage M.2 SSD 500GB

BIM Desktop

- 64 Gb Ram
- 64Bit Operating System
- Minimum Intel® Xeon® W-2225 4-core processor
- Windows 11
- Graphics card
- Storage M.2 SSD 2TB

BIM Laptop

- 64 Gb Ram
- 64Bit Operating System
- Minimum i7 Core processor
- Windows 11
- Graphics card - NVIDIA GeForce GTX 1660 Ti | 6 GB GDDR6
- Storage M.2 SSD 2TB

High specification processing desktop

- 128 Gb Ram
- 64Bit Operating System
- Minimum Intel Xeon Gold
- Windows 11
- Graphics card - NVIDIA RTX A2000 12 GB GDDR6 ECC
  - Storage M.2 SSD 2TB x 2
  - Hard drive 16TB

Tablets

The utilisation of tablet devices will depend on the set up of your company. This is generally driven by the software and what operating system that it requires. Prior to purchasing tablets ensure the operating systems on the tablets work with the software application you aim to use. A list of the main operating systems are below:

- Android – Android OS
- Apple – IOS, IPadOS
- Google – ChromeOS
- Windows – Windows RT

A durable tablet is recommended for construction sites, i.e. ones that include reinforced frames and glass, seals protecting against water and debris, as well as anti-glare layers suitable in bright sunlight. There are certain standards that tablet computers should be certified by, to guarantee their durability. They include:

- IP65 standards – prevents damage from water spillage, falling from heights as well as entry of the smallest dust and dirt particles.
- humidity, altitude and vibration (gunfire and random vibration).
- high and low temperatures plus sudden temperature shock
- fungus, leakage and rain (including wind-blown and freezing rain)
- sand and dust exposure
- explosion
- acceleration
- shock and transport shock

Software

Below is a list of free software to view and access 3D Building Information Models using desktops and laptops:

BIM Use	Software	Cost	Download
View and Access 3D BIM	Autodesk viewer	Free	https://viewer.autodesk.com/
View and Access 3D BIM	Bentley Viewer	Free	https://www.bentley.com/software/bentley-view/
View and Access 3D BIM	Dalux Viewer	Free	https://www.dalux.com/
View and Access 3D BIM	BIMCollab Zoom	Free	https://www.bimcollab.com/en/products/bimcollab-zoom
View and Access 3D BIM	Navisworks Freedom	Free	Navisworks 3D Viewer | Download Free Navisworks Freedom | Autodesk
View and Access 3D BIM	Trimble Connect	Free	https://www.tekla.com/products/trimble-connect
View and Access 3D BIM	Solibri Model Viewer (SMV)	Free	Solibri | Download Solibri Anywhere
View and Access 4D BIM	Synchro Open Viewer	Free	https://www.bentley.com/resources/

Table 9: 3D model software for desktop (DCT)

Below is a list of free software to view and access 3D Building Information Models for use with a Standard tablet:

BIM Use	Software	Cost	Download
View and Access 3D BIM	Autodesk viewer	Free	https://viewer.autodesk.com/
View and Access 3D BIM	Dalux Viewer	Free	https://www.dalux.com/
View and Access 3D BIM	BIM 360 Glue (Free viewer only	Free	Autodesk BIM 360 Glue on the App Store (apple.com)
View and Access 2D BIM	Bluebeam vu (Free viewer only)	Free	Bluebeam Vu for iPad on the App Store (apple.com)

Table 10: Other software examples (DCT)

Below is a list of software used in the industry by contractors across the industry today.

Important note
This is NOT a recommended list. This is only a list of software currently in use in the industry currently.

BIM Use	Software		
Common Data Environment (CDE)	Viewpoint	Aconnex	Procore
Architectural Design	Autodesk Revit	Archi CAD	
Structural Design	Autodesk Revit	Tekla	Bentley
Mechanical Design	Autodesk Revit	Autodesk Plant 3D	CAD WORX
Electrical Design	Autodesk Revit		
Civil Design	Autodesk Revit		
Landscape Design	Autodesk Revit	Civil 3D	
2D PDF Drawings -Models	Export from Revit		
Schedules	Export from Revit		
Design Review	Revizto	BIMCollab	BlueBeam Revu
3D Coordination	Navisworks/ BIM 360	Solibri	Revizto
Clash Detection Issue Management	iConstruct	BIM Collab	BIMTrack
Subcontractor Authoring	Autodesk Revit	Archicad	
Program / Scheduling	Microsoft Project	Asta	P6
Point Clouds	Leica Truview	Trimble Realworks	

4D Sequencing	Synchro Professional	Fuzor	
5D Costing - QTO	Costx	Vico	
OandM's	Autodesk Construction Cloud Build	Procore	Viewpoint
QAQC	Autodesk Construction Cloud Build		
Snagging	Autodesk Construction Cloud Build	Procore	Fieldview
Facilities/ Asset Management	Autodesk Construction Cloud Operate	Zutec	
Virtual Reality	Fuzor	Enscape	Iris VR
Data Analytics	Microsoft Power BI	Google Sheets	Tableau

Table 11: BIM software and use examples (DCT)

Additional free software

Laser scanning viewing tool

» Leica – Truview viewer - https://leica-geosystems.com/products/laser-scanners/software/leica-truview/leica-truview-live

PDF Viewer

» Bluebeam - https://www.bluebeam.com/

» Adobe - https://get.adobe.com/reader/

Document renaming

» Advance renamer - https://www.advancedrenamer.com/

Common Data Environment

When we deal with technology and information it is essential to have it in a structured manner and easily accessible to all members of a company.

A fundamental component of the BIM Level 2 process, which has migrated to ISO 19650 Building Information Modelling using information management, is the requirement to work with a Common Data Environment or CDE. This is also now a requirement for some projects. The CDE provides a process for sharing information in a structured format to establish a single source of the truth.

The CDE requires technology to provide a repository for information to be shared and published using a designated process. Different technology solutions claim to be CDEs, but many do not fully incorporate the requirements identified to remove risk and waste from the process. Careful use of a manual process must then be carried out to ensure successful information delivery,

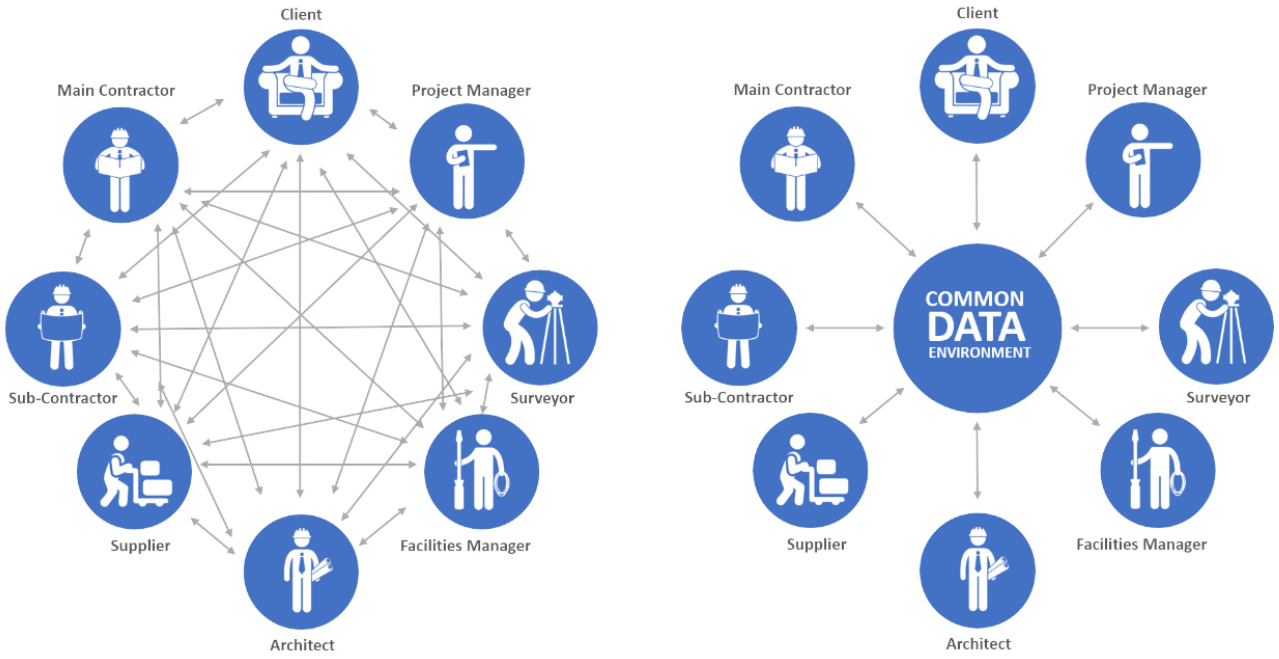


Figure 21: Traditional information sharing vs Common Data Environment (CDE). (Scottish Future Trust)

Resource

https://www.scottishfuturestrust.org.uk/storage/uploads/cdeimplementaionresearchaug18.pdf

When procuring a CDE for a project the following aspects should be considered:

- Cost
- Security
- Uptime
- File formats
- BIM software integration
- Auditability
- Usability
- Workflow

There are four functional sections with relevant gateways identified with a CDE. These are shown in the illustration below:

Figure 22: Common Data Environment (CDE) structure (Paul Oakley)

Supporting the CDE process is a number of components. These are the:

1. Volume strategy
2. Model breakdown
3. File naming
4. Status codes (suitability)
5. Check, review and approve process
6. Review, authorise and accept process
7. Roles and responsibilities

Further information regarding the CDE process is provided in Section 4 - Standards, Policies and Guides.

Additional Considerations

There are some additional things that should be considered when creating a CDE:

Server configuration – This is a common issue. Will information be held in the cloud or on the server? Will we use a standard server or partition the server? Use a Revit server or purchase BIM360, BIM Collaboration Pro and work in the cloud? Careful consideration is required.

Broadband - Communication between the offices and site will require high speed internet connectivity. The improvement in high-speed broadband should be monitored between the offices and site offices to ensure the best value of service available (real speed/cost) is being received.

Integrating Offices and Sites – Office integration technologies may be worth exploring for particular projects or office expansion in the future. Two specific options that we consider viable depending on circumstances are deploying Revit Server or a high-performance cloud solution.

Security – Cyber and physical security needs to be included in any company's quality management and disaster recovery procedures. Access to the current company infrastructure and digital information needs to be planned and monitored to ensure information is not being transmitted or compromised. ISO 19650 -5: 2020 security requirements should be addressed in any policies and on BIM projects.

Device management - In addition to meet security requirements all companies must be compliant with GPDR legislation. To achieve this an endpoint software package could be used to ensure devices can be tracked, encrypted and remotely wiped if required.

3.12 People

The third element to review is people. People refers to project resourcing, the upskilling of current staff and the potential procurement of new staff, creating new roles and changing the behaviours and mind-sets of the current staff to transition to the new processes and procedures.

Digital project delivery is more than upgrading hardware and purchasing software, it is a shift in the mind-set and the way in which construction companies work together throughout an entire project. It is important to note however that company and management behaviours can impact the successful integration of technology as much as staff behaviours. An environment that is resistant to change and innovation will find it exponentially more difficult to create a collaborative and productive team dynamic.

Implementing digital project delivery requires several staff members taking ownership of the new processes and procedures. They will need to review their current roles and identify the appropriate person in the company to fulfil the responsibilities associated with them. The roles and related responsibilities are outlined below.

Below we highlight the key information management responsibilities of the main parties involved in the digital delivery of a project. Section 5, Bidding for Digital Project Delivery, provides more detail.

Client and Delivery Team Roles (Appointing party)

The responsibilities are identified as functions which are labelled as:

- Client delivery management function
- Client information management function
- Asset information management function
- Security information management function

Main Contractor Roles and Responsibilities (Lead appointed party)

The main contractor is expected to provide the following:

- Project information delivery functions
- Project information management functions

Subcontractor Roles and Responsibilities (Appointed Party/Task team)

The task management roles and responsibilities are:

- Team management
- Information management
- Interface management
- Information authoring

Training and Upskilling

No matter the size of company or project, it is advised that training becomes a key part of the company strategy. Training should not be specific to software but to the company workflows and procedures. If your company does not have any BIM personnel or department, it is recommended to use external consultants for strategic implementation and training. It is important to plan for a soft landing and exit strategy for these consultants once internal staff are up skilled.

Key requirements are as follows:

- Skills gap analysis for current staff members
- Training aligned to staff professional development
- Ensure upskilling becomes part of the weekly process
- Having foresight on upcoming projects will ensure just-on-time training occurs if new projects require specific training requirements
- Ensure to complete assessment of the training provided via feedback forms to continually develop the content

Supports Available for Upskilling

The release of the National BIM Councils 2018 - 2021 roadmap enabled the government's strategy for the increased use of digital technology in the delivery of key public works projects.

The Irish government recognises the importance of BIM and sees the benefit of how it brings together technology, process improvements and digital information to radically improve project outcomes and asset operations. Additional supports available by the Irish government are detailed below.

Figure 23: Built to Innovate information. (Enterprise Ireland)

Built to Innovate Grant Aid packages

Initiated under the Government's Housing for All programme, the Built to Innovate initiative seeks to support Irish companies active within the residential construction sector who wish to enhance the operational performance of their business via:

- Increasing the usage of Modern Methods of Construction
- Implementing Lean training in both manufacturing and onsite environments
- Improving the use of digital tools to drive company-wide productivity benefits
- Advancing research concepts or process innovation ideas

A suite of lean, digitalisation and research and innovation grant aid packages are now available for such projects where the impact will result in homes that are built faster, on time and with less expense.

- Built To Innovate – Lean

Enterprise Ireland's Built to Innovate - Lean offer is designed to encourage the adoption of Lean principles in your company to increase performance and competitiveness.

- Built To Innovate – Digital

Enterprise Ireland's Built to Innovate - Digital offer is about redesigning your business to serve your customers better, starting with a deep understanding of your customer needs and your value stream and then using new technology to improve the customer experience.

- Built To Innovate – Research and Innovation

Enterprise Ireland's Built to Innovate - Research and Innovation supports provide access to their expertise and contacts to increase the levels and value of R and D and innovation in your company.

Resource

https://www.enterprise-ireland.com/en/funding-supports/built-to-innovate/overview.html

Skillnets

Education, innovation and skills are key to building stronger industries. Skillnet Ireland, the business support agency, enables businesses develop their talent in innovative and responsive ways. As champions of life-long learning within industry, Skillnet Networks are perfectly positioned to deliver future proofed, industry-led learning thanks to their partners' industry expertise and extensive connections. There are four construction related Skillnet Networks, namely Construction Professionals Skillnet, CiTA Skillnet, Engineering Skillnet and Industry 4.0 Skillnet. There are also numerous regional Skillnets, all of which can support construction companies.

Resource

https://www.skillnetireland.ie/sector/engineering-construction/

Digital construction courses available in Ireland

Build Digital has created an inventory of all education and training courses related to Digital Construction available in Ireland. When ready it will be accessible via their website: https://www.builddigitalproject.ie/education-training-inventory.

Springboard+

The Springboard+ upskilling initiative in higher education offers free courses at certificate, degree and masters level leading to qualifications in areas where there are employment opportunities in the economy.

Springboard+ is co-funded by the Irish government and the European Social Fund as part of the ESF programme for employability, inclusion and learning 2014-2020. Courses for BIM are currently available throughout the country.

https://springboardcourses.ie/

Education and Training Boards Ireland (ETBI)

Education and Training Boards Ireland (ETBI) is the national representative body established to collectively represent the sixteen Education and Training Boards (ETBs) and promote their interests, which is recognised by the Minister for the purposes of the Education and Training Boards. The aim of ETBI is to lead and advance the continued development of education, training and youth work in Ireland.

ETBI provides plenty of digital courses that help improve skills in terms of the digitalisation. To review the available courses.

https://www.etbi.ie/further-education-training-support/workbased-learning/

https://www.fetchcourses.ie/

Digital Academy for The Sustainable Built Environment (DASBE)

DASBE is a unique collaboration of higher education institutes and industry partners with the shared aim to be agile and responsive to the upskilling needs of the construction industry.

DASBE is a hub focussed on upskilling, capacity building and education in the construction sector. DASBE will deliver green skills in programmes covering the circular economy, energy efficiency and digital skills.

For further information about DASBE can be found here:

Resource
https://dasbe.ie/

Digitalisation of Construction SMEs

The European Innovation Council and SMEs Executive Agency (EISMEA) under the powers delegated by the European Commission, contracted a consortium to support the digitalisation of construction SMEs.

This project was set up to support the digitalisation of construction SMEs, foster their growth, enhance their productivity and efficiency, and prepare them for the challenges of an increasingly connected and digitalised world.

For further information on the Digitalisation of Construction SMEs- the link to the website is provided;

Resource
https://digital-construction.ec.europa.eu/

BIM Certification

From a marketing perspective, attaining BIM certification can be used to demonstrate capabilities to deliver BIM projects. Supply chain assessments may also request that you are capable to deliver the project and this can be forwarded as part of demonstrating that the BIM team conforms to strict processes and procedures. As with all certifications it depends on the company whether it is relevant and useful or not.

Certification of Companies

Main Contractors, as ISO 19650 Lead Appointed Parties, are required to provide clients with an assessment of their BIM capabilities. One method of achieving this is through third party verification using a certification body. In Ireland NSAI provides certification against ISO 19650. In the UK the United Kingdom Accreditation Service (UKAS) have accredited BRE Global Ltd, BSI Assurance UK Ltd, and LRQA Verification Ltd. These accredited certification schemes would also be deemed to satisfy the PAS 91 Table 8 requirements.

The schemes have been designed to enable certified businesses to demonstrate compliance with ISO 19650-2:2018 so that as a company holding BIM Certification you will not have to provide evidence of competence each time you undertake a tender.

Each scheme is slightly different but generally certification with the schemes cover the following areas:

- Company BIM skills / training record
- Software tools–– I.T. strategy and infrastructure
- Compliance with ISO 19650 normative requirements
- CAD / BIM documentation confirming the above
- Compliance with ISO 19650 scheme particulars

Generally, schemes follow a similar process, but it would be necessary to check the requirements of the specific schemes that you are considering. The process usually includes:

- Gap Analysis (Optional): A gap analysis assists BIM providers in preparing for assessment and examines the overall status of an applicant's capability to deliver BIM services to the requirement of ISO 19650-2:2018. Once the BIM provider has addressed all gaps, the certification body will agree dates for FIA.
- Full Implementation Assessment (FIA):
  - Stage 1 - Documentation Check: The document check verifies the required documentation is in place, including the high-level content of each resource in alignment with ISO19650-2:2018.
    - * *For some schemes BIM providers who can demonstrate that they have met the requirements of the certification body and the referenced standards in their management systems and have undertaken the Document Check stage, but do not currently have BIM projects against which they can demonstrate the implementation of those standards, can apply for BIM Ready Status which is valid for a year, after which they must progress to stage 2 – Implementation Assessment.*
  - Stage 2 - Implementation Assessment: The Implementation Assessment validates that the process followed meets the scheme requirements and that the services delivered on an appointment meet the company's systems and procedures and ISO 19650-2:2018 requirements.
- Accreditation: After completing a satisfactory assessment, the recommendation for Certification is made and confirmed via a technical review of the final report.
- Surveillance Visits: The BIM management processes shall be subject to surveillance audits at least once per year during the three-year certification period, with the first surveillance visit held within six months (maximum) of the Certification award.
- Recertification: Most certification body undertake a reassessment at the end of the three-year certification term.

Supply chain members may also carry third party certification which removes any need for further validation of their capabilities.

It should be noted that whilst companies may carry certification the information required to complete supply chain assessment summaries should always be provided.

Certification of Individuals

One aspect of assessing a company's abilities is the capability of their staff members. Professional memberships, qualifications and individual certification can be used as evidence to support this and demonstrate that appropriate training, continued professional development (CPD) and assessment have been undertaken and reviewed by an appropriate body.

3.13 Digital Starter Pack Resources

Checklist 2 Digital Starter Pack

Implementing change is no easy task; it requires creating the climate for change, engaging and enabling the company to evolve and then implementing and sustaining the change so that it becomes business as usual.

Creating the climate for change

The following is a checklist for what needs to be done to create the climate for change and the introduction of digital technology to a company.

Company

- ☐ Create a sense of urgency for implementing change
- ☐ Support from executive senior management team
- ☐ Ensure the vision of the company aligns to the digital implementation strategy

Processes

- ☐ Complete a current state analysis of all processes, procedures, technology and people
- ☐ Document all processes and procedures
- ☐ Investigate fundamentals of digital project delivery
- ☐ Hire an external consultant to support these processes

Engaging and enabling the company

People

- ☐ Communicate the vision
- ☐ Empower action
- ☐ Appoint a digital champion
- ☐ Create a digital implementation strategy
- ☐ Identify the staff who require further upskilling
- ☐ Investigate the required hardware and software
- ☐ Allocate a budget for the required hardware, software, training
- ☐ Set up a company steering group

Technology

- ☐ Software – Do you have the right software in place to meet the needs of the company?
- ☐ Hardware - Do you have the suitable hardware in place?
- ☐ Agree on new hardware and software to use in company
- ☐ Demonstrate quick wins

Implementing and sustaining change

Continual Professional Development

- ☐ Build on change
- ☐ Staff upskilling strategy
- ☐ Has a skills gap analysis been completed to identify areas to further develop the staff?
- ☐ Have appropriate courses/interventions been identified to train the required staff?

Project Plan

- ☐ Do you understand the deliverable on the project?
- ☐ Have you requested all the scope of work documents in terms of digital delivery?
- ☐ Pilot project to delivery need digital project delivery on target project
- ☐ Align the new processes and procedures due to digital implementation
- ☐ Communicate the value of the digital implementation to all staff
- ☐ Roll out updated processes and procedures companywide
- ☐ Continuously review the available technology to improve the digital delivery
- ☐ Complete lessons learned and implemented on new projects
- ☐ Continuously review the digital processes and procedures to ensure they evolve over time
- ☐ Make it stick

Resources

Free Information videos – The B1M

https://www.youtube.com/playlist?list=PLEmWzqc0D6MiVJBgPUMVxEYKi4_oOiFkc

Free Information videos – Nima

https://www.youtube.com/playlist?list=PL2I--FuEJX4hJHkwY766Nyz45czTKL7dQ

Free information Videos - Plannerly

https://www.youtube.com/playlist?list=PLRxOZWDsyG4CvYI7AnjXqGamPsmj1VHWh

BIM Grading Tool – Scottish Futures Trust

https://bimportal.scottishfuturestrust.org.uk/page/bim-grading-tool

BIM Return on Investment Tool – Scottish Futures Trust

https://bimportal.scottishfuturestrust.org.uk/page/roi-calculator

Standard Information Management Plan– Scottish Futures Trust

https://bimportal.scottishfuturestrust.org.uk/page/standard-information-management-plan

ISO 19650 Templates - UKBIM Framework

https://www.ukbimframework.org/resources/

UK BIM Framework ISO 19650 Standard Documents

https://www.ukbimframework.org/standards/

Handbook for the introduction of Building Information Modelling by the European Public Sector – EUBIM Task Group

http://www.eubim.eu/wp-content/uploads/2017/07/EUBIM_Handbook_Web_Optimized-1.pdf

Section 4:

Standards, Policies and Guides

Section 4 Standards, Policies and Guides

4.1 Introduction

This section outlines a present state analysis of the existing standards, policies and guidance documents relating to digital project delivery and information management.

These standards, policies and guides are relevant for any contractor/developer considering their approach to digital project delivery and information management. There are several additional standards required and readers are advised to review these as part the core ISO approach.

This section is for those responsible for project management, information management and BIM Managers in main and sub-contracting companies.

This section covers:

- ISO Standards
- Current British Standards used
- Open Data Standards
- Current policies and supporting documentation
- Available guides
- The Common Data Environment
- Where to find the required standards, policies and guides.

The aim of this section is to give contractors a high-level understanding of existing standards, policies and guidance documents relating to digital project delivery and information management.

This section also helps all those who have been using BS 1192:2007+A2:2016 and PAS 11922:2013, as part of their implementation of BIM Level 2, to transition to the new ISO standards IS EN ISO 196501 and IS EN ISO 196502. As a result of the publication of these new ISO standards, BS 1192 and PAS 11922 have been withdrawn. Any ongoing projects that contractually reference BS 1192:2007+A2:2016 or PAS 11922:2013 should continue as such until completion.

Figure 24: Standards authority pyramid (DCT)

What is ISO?

ISO, the International Organization for Standardization, is an independent, non-governmental international company. It aims to deliver international standards that support innovation and provide solutions to global challenges. In essence it is about facilitating free and fair global trade. It is made up of 163 national standards bodies, including the Irish standards body, NSAI (National Standards Authority of Ireland).

What is CEN?

The European Committee for Standardization (CEN) brings together the national standard bodies of 34 European countries. It has an agreement for the technical co-operation with ISO. This means that CEN and ISO jointly plan the development of new standards, and where an ISO meets European legislation and market requirements, the ISO standard will be adopted, replacing any corresponding CEN standard. The reason being you cannot have two competing standards.

What is the NSAI?

NSAI (National Standards Authority of Ireland) is Ireland's official standards body.

They operate under the National Standards Authority of Ireland Act (1996) and are accountable to the Minister for Business, Employment and Retail at the Department of Enterprise, Trade and Employment.

The annual reports of NSAI's BIM committee are available online here:

https://www.nsai.ie/standards/standards-committees/annual-reports/

What is BSI?

The British Standards Institution is the national standards body of the United Kingdom. BSI produces technical standards on a wide range of products and services and also supplies certification and standards-related services to businesses.

What is a Publicly Available Specification (PAS) document?

A PAS is a fast-track standardisation document – the result of an expert consulting service from BSI. It defines good practice for a product, service or process. It is a powerful way to establish the integrity of an innovation or approach.

4.2 Standards - ISO Standards

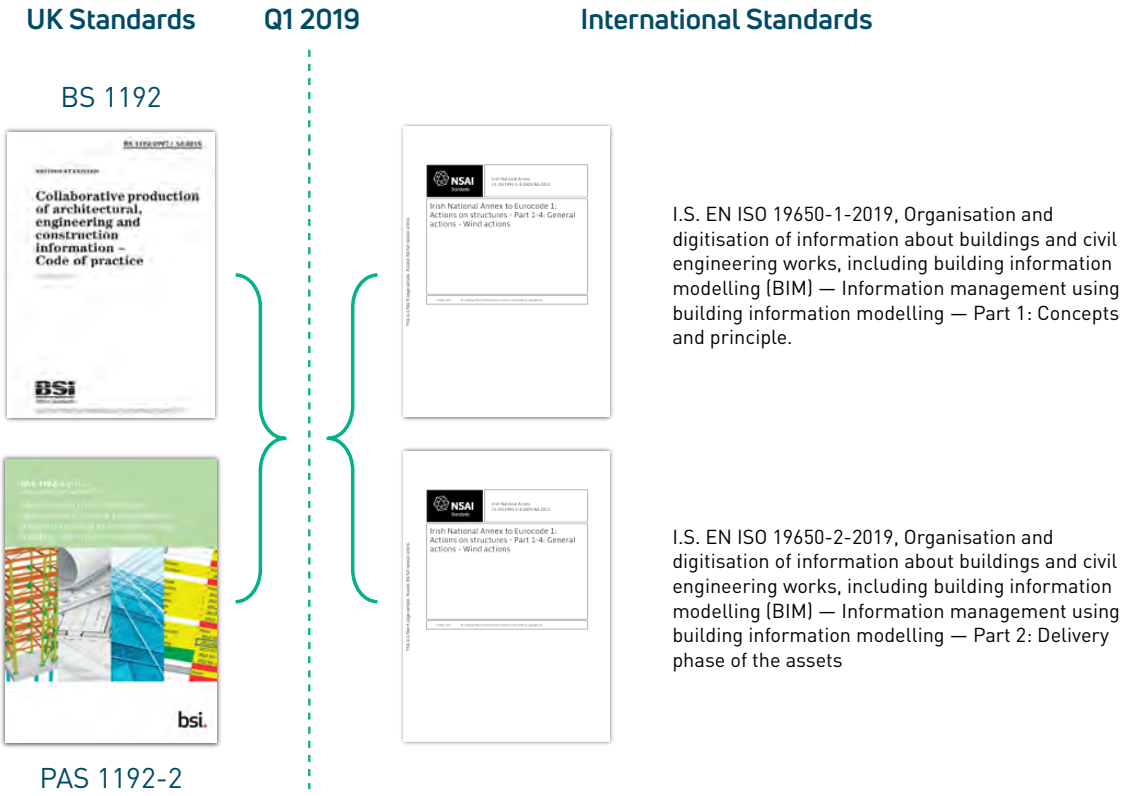


Figure 25: Overview of the standard transition from the UK standards to the internationalised ISO Standards. (DCT)

The original BIM Level 2 standards and documents identified in the 1192 series have now been replaced at international ISO level with the ISO 19650 series. Figure 25 indicates the transition from the UK standards to the international ISO Standards.

4.2.1 ISO 19650 Series

Figure 26: Overview of the ISO 19650 suite of documents (12d Synergy)

The ISO 19650 is a series of standards that provides the requirements for BIM as information management using building information modelling. The series of standards included are outlined in Figure 26. The details of what each ISO 19650 document covers are as follows:

I.S. EN ISO 19650-1:2018

Organisation and digitisation of information about buildings and civil engineering works, including building information modelling (BIM). Information management using building information modelling - Part 1: Concepts and principles.

» Takes the principles of Information Management that was initially developed in BS 1192:2007, PAS 1192-2:2013, and PAS 1192-3:2014 covering the entire lifecycle of an asset. The ISO abstract describes the document as one that:

- Outlines the concepts and principles for information management at a stage of maturity described as "building information modelling (BIM) according to the ISO 19650 series".
- Provides recommendations for a framework to manage information including exchanging, recording, versioning and organising for all actors.
- Is applicable to the whole life cycle of any built asset, including strategic planning, initial design, engineering, development, documentation and construction, day-to-day operation, maintenance, refurbishment, repair and end-of-life.
- Can be adapted to assets or projects of any scale and complexity, so as not to hamper the flexibility and versatility that characterise the large range of potential procurement strategies and to address the cost of implementing these processes.

I.S. EN ISO 19650-2:2018

Organisation and digitisation of information about buildings and civil engineering works, including building information modelling (BIM) -- Information management using building information modelling. Part 2: Delivery phase of the assets.

Part 2 takes the principles of information management that apply to the design and construction stages as set out within BS 1192:2007 and PAS 1192-2:2013. Irish Standard (I.S. EN ISO 19650-2:2018) and British Standard (BS EN ISO 19650-2:2018) both include a National Annex. Details of these are included later in this section. The ISO abstract describes this document as one that:

» Specifies requirements for information management, in the form of a management process, within the context of the delivery phase of assets and the exchanges of information within it, using building information modelling.

» Can be applied to all types of assets and by all types and sizes of companies, regardless of the chosen procurement strategy.

I.S. EN ISO 19650-3:2020

Organisation and digitisation of information about buildings and civil engineering works, including building information modelling (BIM). Information management using building information modelling - Part 3: Operational phase of the assets. ***(Replaces PAS 1192-3:2014)***

Part 3 covers the operational phase of the assets and takes the principles of information management that apply to the operational and maintenance stage as previously set out within PAS 1192-3:2014. The ISO abstract describes this document as one that:

» Specifies requirements for information management, in the form of a management process, within the context of the operational phase of assets and the exchanges of information within it, using building information modelling.

» Can be applied to all types of assets and by companies of all types and sizes involved in the operational phase of assets.

The requirements in Part 3 can be achieved through direct actions carried out by the company in question or can be delegated to another party.

I.S. EN ISO 19650-4:2022

Organisation and digitisation of information about buildings and civil engineering works, including building information modelling (BIM). Information management using building information modelling- Part 4: Information exchange.

Part 4, information exchange takes the exchanging information principles of information management from BS 1192-4:2014. Whilst BS 1192-4:2014 dealt specifically with Construction Operations Building information exchange (COBie), Part 4 is not limited to the COBie exchange methodology.

Part 4 specifies the detailed process and criteria for decision making when executing an information exchange as specified by the ISO 19650 series to ensure the quality of the resulting project information model or asset information model. It details the implementation of the concepts in ISO 19650-1 and is applicable to any information exchange within the delivery stages covered by ISO 19650-2 and operational trigger events covered by ISO 19650-3.

Part 4 is applicable to assets of all sizes and all levels of complexity. This includes portfolios of buildings, campuses, infrastructure networks, individual buildings and pieces of infrastructure. The requirements in this document should be applied in a way that is appropriate to the scale and complexity of the asset. This document makes use of the phrase "shall consider". This phrase is used to introduce a list of items that the person in question is required to think about carefully in connection with the primary requirement described in the subclause. The amount of thought involved, the time taken to complete it and the need for supporting evidence depend on the complexity of the asset, the experience of the person(s) involved and the requirements of any national policy on introducing building information modelling. On a relatively small or straightforward asset, it can be possible to complete, or dismiss as not relevant, some of these "shall consider" items very quickly. One way to help identify which of the "shall consider" statements are relevant can be to review each statement and create templates for assets of different sizes and complexity.

I.S. EN ISO 19650-5:2020

Organisation and digitisation of information about buildings and civil engineering works, including building information modelling (BIM). Information management using building information modelling - Part 5: Security-minded approach to information management. (Replaces PAS 1192-5:2015)

Part 5 takes the security-minded approach to information management previously identified in PAS 1192-5:2015. The onus is on the client to undertake the security triage process which then develops based on the results.

Part 5 specifies the principles and requirements for security-minded information management at a stage of maturity described as "building information modelling (BIM) according to the ISO 19650 series", and as defined in ISO 19650-1, as well as the security-minded management of sensitive information that is obtained, created, processed and stored as part of, or in relation to, any other initiative, project, asset, product or service.

It addresses the steps required to create and cultivate an appropriate and proportionate security mindset and culture across organisations with access to sensitive information, including the need to monitor and audit compliance.

The approach outlined is applicable throughout the lifecycle of an initiative, project, asset, product or service, whether planned or existing, where sensitive information is obtained, created, processed and/or stored.

Part 5 is intended for use by any organisation involved in the use of information management and technologies in the creation, design, construction, manufacture, operation, management, modification, improvement, demolition and/or recycling of assets or products, as well as the provision of services, within the built environment. It will also be of interest and relevance to those companies wishing to protect their commercial information, personal information and intellectual property.

I.S. EN ISO 19650-6:2020

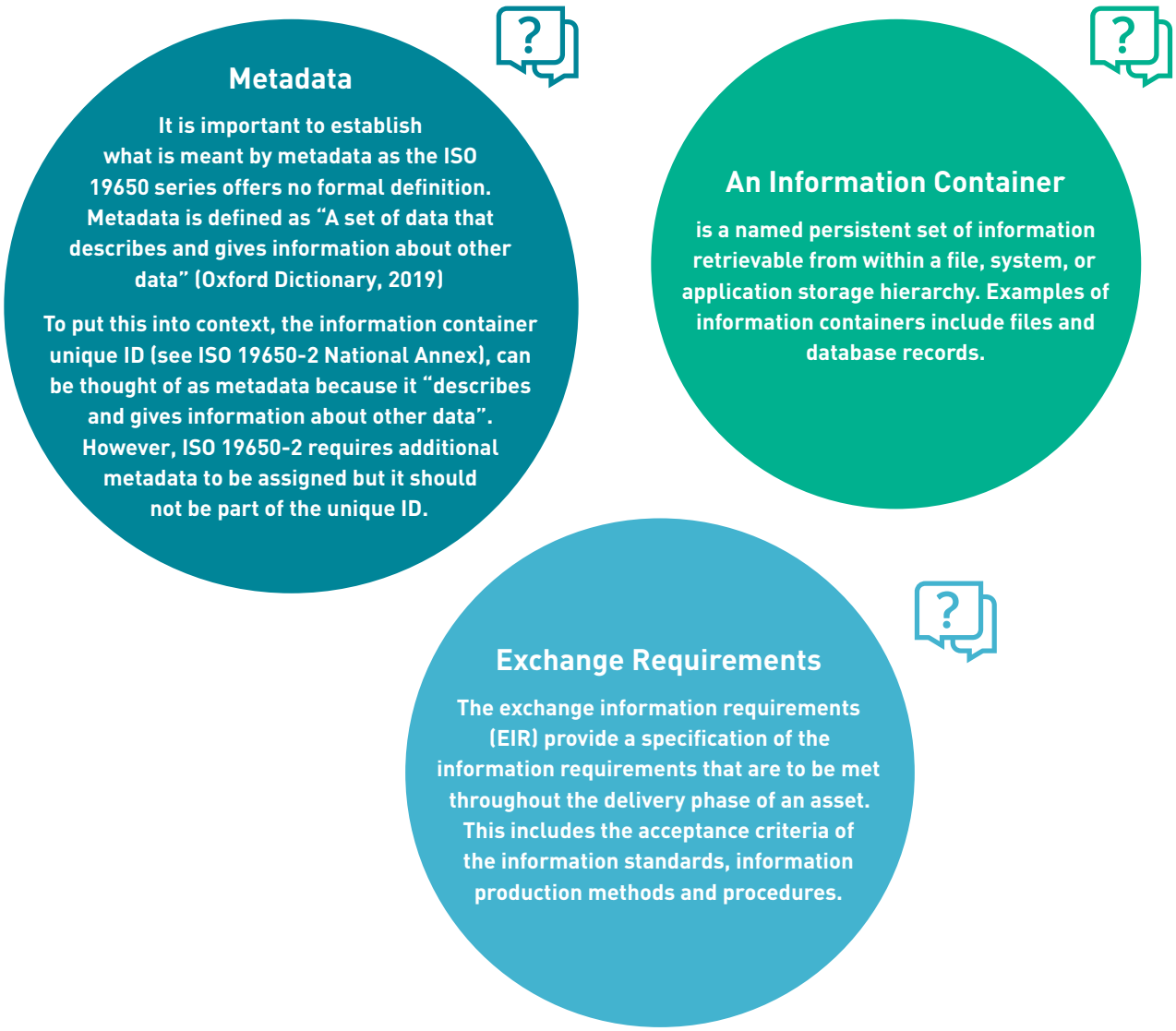
Organisation and digitisation of information about buildings and civil engineering works, including building information modelling (BIM). Information management using building information modelling – Part 6: Health and Safety.

Part 6 takes the Health and Safety approach to information management previously identified in PAS 1192-6:2018. The ISO standard is currently under development as of December 2022 by the Technical Committee ISO/TC 59/SC 13.

I.S. EN ISO 19650-2:2018 National Annex

This I.S. EN ISO 19650-2:2018 National Annex gives guidance for the implementation of ISO 19650-2:2018, within the Irish national context of construction projects. It does not preclude reliance on other agreements or international cooperation.

The document provides the structure for field identification and the metadata for information containers and information exchange requirements.



4.2.2 ISO 19650 Information Management Process

Figure 27 summarises the stages and phases of ISO information management and also indicates the responsible parties.

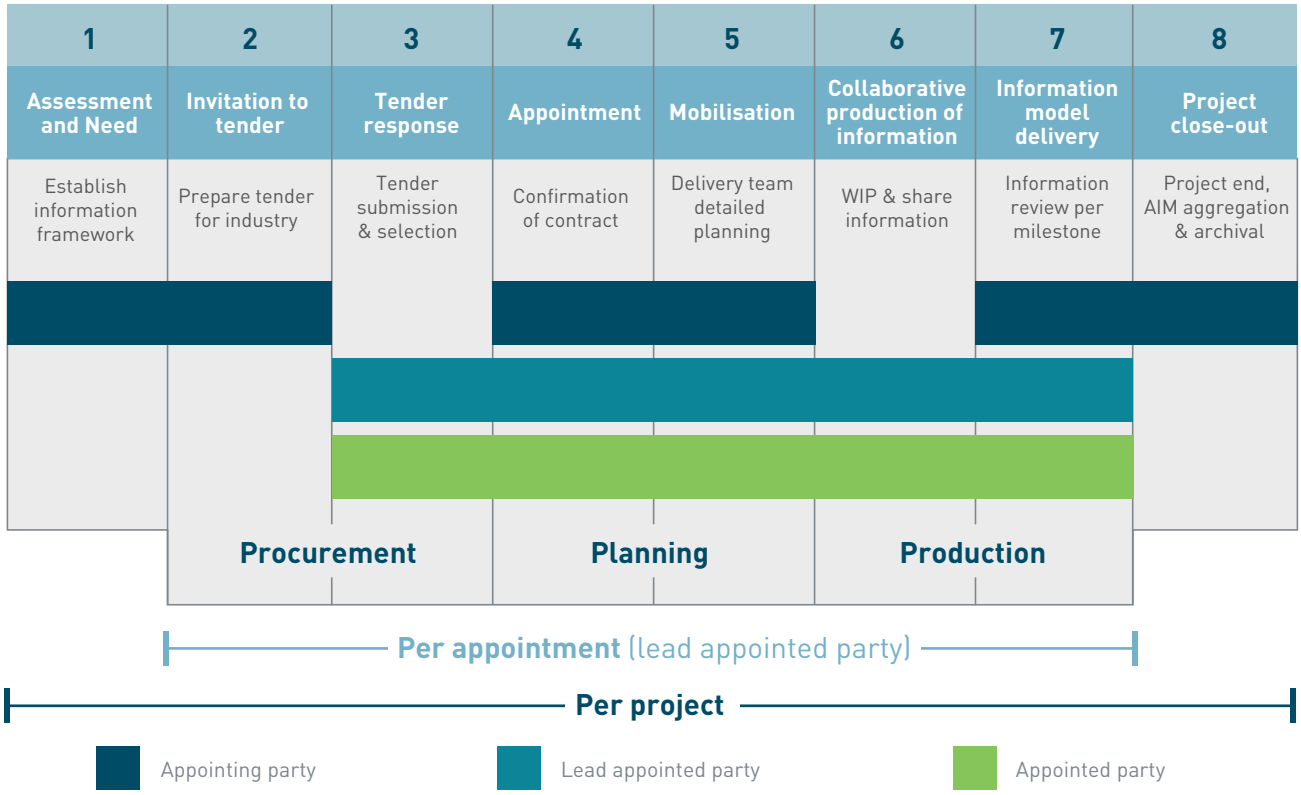


Figure 27: Summary of the ISO 19650 Information Management stages, phases and responsible parties. (12d Synergy)

With the transition from projects working to the old PAS 1192 and now transitioning to the current standard on projects where information management is delivered according to the ISO 19650 series, all activities within the information management process are to be undertaken by a single 'Information Management Function', aspects of which are assigned to whichever persons or organisations are best placed to fulfil them.

This process differs from that of the previous PAS 1192 project cycle and is more focused.

Stages 2 to 7, as can be seen in Figure 27, are repeated for each appointment on the project. For example, once for an appointment with an engineering consultancy for the design phase and then again, for another appointment, with a contractor for the construction phase. Steps 1 and 8 occur only once per project.

The information management process is characterised by three phases, as outlined below. Figure 27 also demonstrates the following at the given stages:

- The procurement stage at activities 2 to 3
- The planning stage occurs at activities 4 to 5
- The production stage occurs at activities 6 to 7

4.3 Information Container ID

As more and more information is shared digitally, the use of structured, consistent and understandable naming conventions for information becomes vital. ISO 19650 uses the term 'information container' to denote files, models, documents, datasets, etc. See figure 28.

4.3.1 What is an Information Container?

An Information Container is a "named persistent set of information retrievable from within a file, system or application storage hierarchy".

The aim of the ISO 19650 series was to standardise the way in which we delivery our projects and information. The role of a National Annex is to clarify its implementation within a country, but it should not preclude international cooperation and agreement.

4.3.2 National Annex

But the introduction of each country having the option of introducing a National Annex depending on their country's requirements is a contradiction to this harmonisation.

In Ireland, prior to the release of ISO 19650 series, the UK BS 1192:2007 naming convention was used which was then consumed into the BS EN ISO 19650-2:2018. Due to this the Information Containers for projects in the UK and Ireland were generally aligned.

Each country must provide their suggested Information Containers in a National Annex. While there are differences between the Irish National Annex and the UK National Annex, both are compliant with the ISO standard. The difficulty for companies working in both the UK and Irish markets now is we have two different National Annexes.

Figure 28 demonstrates the difference between the four different information container IDs.

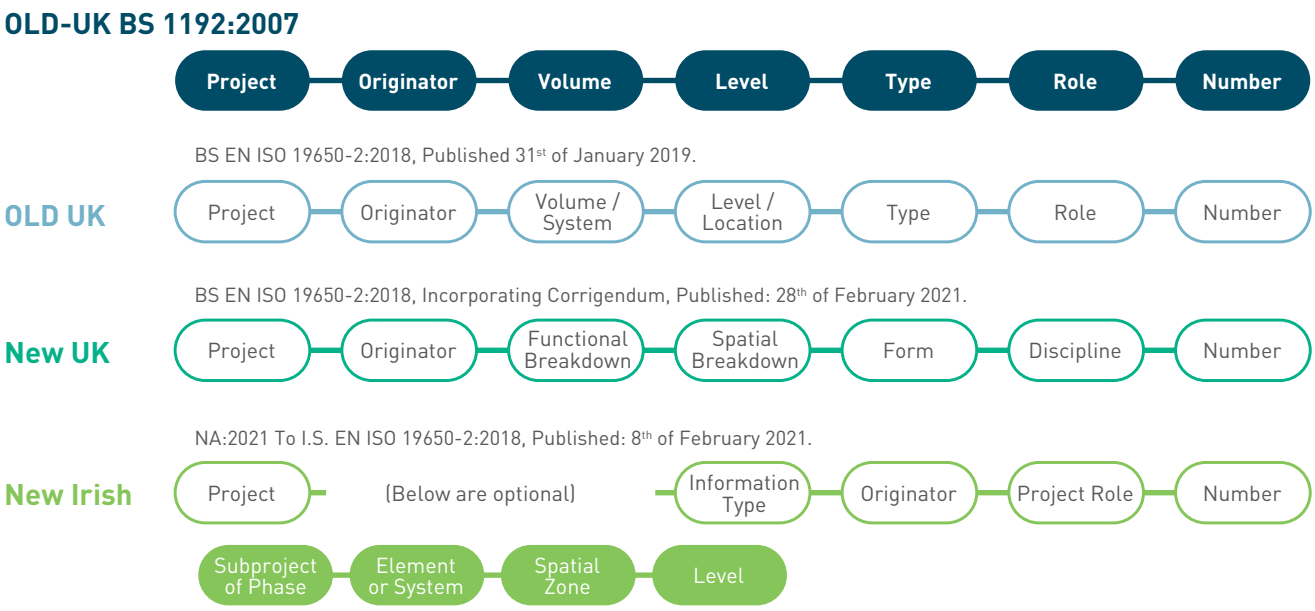


Figure 28: Container identifications. (DCT)

4.3.3 Information Container Identification

There follows a comparison of the different container naming conventions in the different standards.

Project

The Project container ID is detailed within the Irish National Annex (NA) as the following: *A unique project code should be determined at the initiation of a project. The project field code should be a maximum of six characters in length and should relate to project, campus, or site identification conventions.*

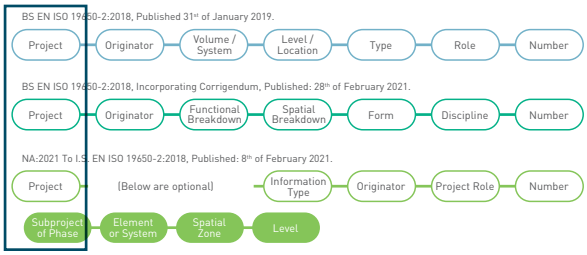


Figure 29: Project and sub-project container ID comparison. (DCT)

Subproject or Phase (Optional field)

The subproject or phase container ID is detailed within the Irish National Annex (NA) as the following:

A unique subproject or phase code should be defined at the initiation of a project. Subproject or phase codes should be aligned with the project's supply chain procurement structures and the identifications conventions. This should be a maximum of six characters in length.

UK National Annex

Description
A single common project identifier.

Standard Codes
• N/A

Length
• 2 - 6 characters

Additional Comments
• A project can be divided into sub-projects within the project identifier. Where a project involves several parts, each part can be assigned a different project identifier.

UK National Annex V.2

Description
A single common project identifier.

Standard Codes
• N/A

Length
• N/A

Additional Comments
• A project can be divided into sub-projects within the project identifier. Where a project involves several parts, each part can be assigned a different project identifier.

Irish National Annex

Description
A single common project identifier.

Standard Codes
• N/A

Length
• 6 characters max

Additional Comments
• An optional proceeding field may be used for Subproject or Phase, with the code 'Z' used for multiple or 'X' for not applicable.

Figure 29a: Project and sub-project container ID comparison. (DCT)

Originator

The Originator container ID is detailed within the Irish NA as: *A unique code should be defined for the organisation that authored the information container. The code for the originator field should be a minimum of three to a maximum of six characters in length.*

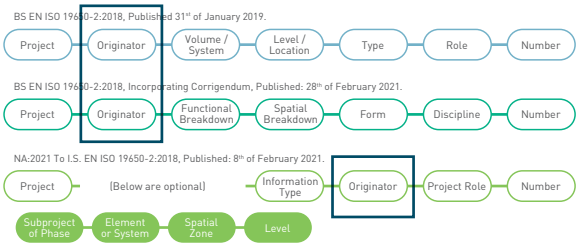


Figure 30: Originator container ID comparison. (DCT)

UK National Annex

Description
Unique identifier should be defined for each organization on joining the project.

Standard Codes
- N/A

Length
- 3 - 6 characters

Additional Comments
- Used to identify the organization responsible for producing the information within the information container.

UK National Annex V.2

Description
Unique identifier should be defined for each organization on joining the project.

Standard Codes
- N/A

Length
- N/A

Additional Comments
- Used to identify the organization responsible for producing the information within the information container.

Irish National Annex

Description
Unique identifier should be defined for each organization on joining the project.

Standard Codes
- N/A

Length
- 3-6 characters max

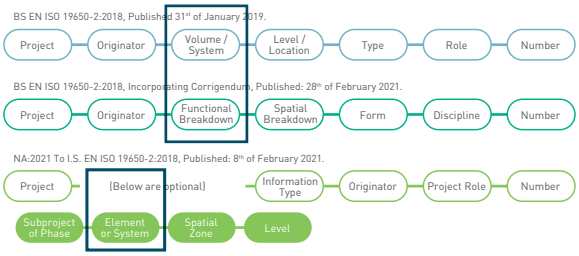
Additional Comments
- Used to identify the organization responsible for producing the information within the information container.

Figure 30a: Originator container ID comparison. (DCT)

Volume/Element/System

The Element or System Container ID is detailed within the Irish NA as: *Element or System codes should be chosen from an established industry or project defined codification system and used.*

Figure 31: Volume/Element/System Container ID Comparison. (DCT)



UK National Annex

Description
A unique identifier should be defined for each volume/system and fixed within the project information standard.

Standard Codes
- 'ZZ' - all
- 'XX' - N/A

Length
- 2 characters

Additional Comments
- Volume / System.

UK National Annex V.2

Description
A unique identifier should be defined for the functional aspects of the information container breakdown structure.

Standard Codes
- 'ZZ' - multiple
- 'XX' - N/A

Length
- N/A

Additional Comments
- Functional Breakdown. This can be based on physical subdivision or notional subdivision.

Irish National Annex

Description
A unique code should be defined for each element or system and fixed within the project information standard.

Standard Codes
- 'Z' - multiple
- 'X' - N/A

Length
- N/A

Additional Comments
- Element or System. Now optional.
- Codes should be chosen from an established industry or project defined codification system.

Figure 31a: Volume/Element/System Container ID Comparison. (DCT)

Level/Location/Spatial

The Spatial Zone Container ID is detailed within the Irish NA as: *A unique project code should be determined for each spatial zone. The spatial zone code should be a maximum of six characters in length.*

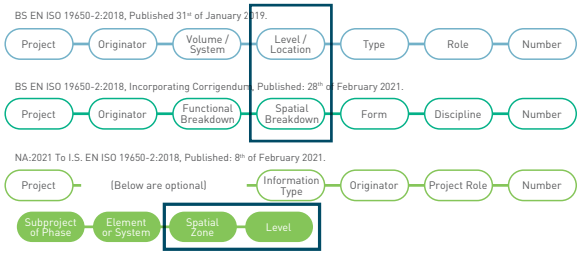


Figure 32: Level/Location/Spatial Container ID Comparison. (DCT)

The Level Container ID is detailed within the Irish NA as: *A unique code should be defined for each level. The level code should be three characters in length.*

UK National Annex

Description
A unique identifier should be defined for each level/location.

Standard Codes
- 'ZZ' - multiple
- 'XX' - N/A
- 01, 02, etc.

Length
- 2 characters

Additional Comments
- Level / Location.

UK National Annex V.2

Description
A unique identifier should be defined for each spatial subdivision.

Standard Codes
- 'ZZ' - multiple
- 'XX' - N/A
- No more defined.

Length
- N/A

Additional Comments
- Spatial Breakdown.

Irish National Annex

Description
A unique code should be defined for each spatial zone and/or level.

Standard Codes
- 'Z' – multiple (spatial zone)
- 'X' - N/A (spatial zone)
- 'ZZZ' – multiple (level)
- 'XXX' - N/A (level)
- L00, L01, L02, etc.

Length
- 6 characters max (spatial zone)
- 3 characters (level)

Additional Comments
- Element or System. Now optional.
- A unique code should be defined for each level.

Figure 32a: Level/Location/Spatial Container ID Comparison. (DCT)

Information Type/Type/Form

The Information Type Container ID is detailed within the Irish NA as: *A unique code should be defined for each information type associated with an information container. The code should be two characters in length.*

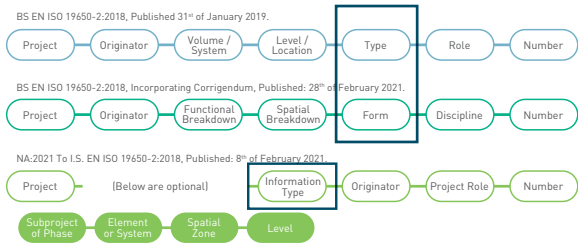


Figure 33: Information Type/Type/Form Container ID Comparison. (DCT)

UK National Annex

Description
A unique identifier should be defined for each type of information.

Standard Codes
- 'M3' – 3D model
- 'DR' – drawing
- Etc.

Length
- 2 characters

Additional Comments
- Type.
- Uniclass 2015 FI Table generally used for codes.

UK National Annex V.2

Description
A unique identifier should be defined for each form of information.

Standard Codes
- 'D' - drawing
- 'M' - model
- Etc.

Length
- N/A

Additional Comments
- Form.
- BS ISO 29845 used for codes to avoid duplicating the classification metadata.

Irish National Annex

Description
A unique code should be defined for each information type.

Standard Codes
- 'M3' – 3D model
- 'DR' – drawing
- Etc.

Length
- 2 characters max

Additional Comments
- Information Type.
- A unique code should be defined for each information type.

Figure 33a: Information Type/Type/Form Container ID Comparison. (DCT)

Project Role/Role/Discipline

The Project Role Container ID is detailed within the Irish NA: *A unique identifier should be defined for each project role (s) of an organisation. The code for the role field should be a maximum of two characters in length. The project field code should be a maximum of six characters in length and should relate to project, campus, or site identification conventions.*

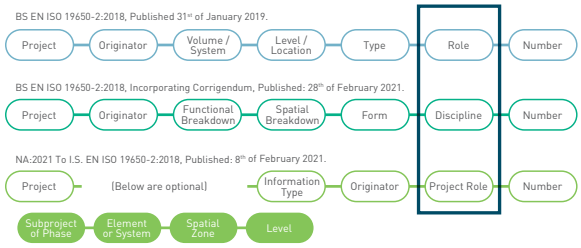


Figure 34: Project Role/Role/Discipline Container ID Comparison. (DCT)

UK National Annex

Description

A unique identifier should be defined for each role on the project that an organization is assigned.

Standard Codes

- 'A' – architect
- 'B' – building surveyor
- Etc.

Length

- 1 or 2 characters

Additional Comments

- Role.
- Uniclass 2015 RO Table generally used for codes.

UK National Annex V.2

Description

A unique identifier should be defined for each discipline to which information is related on the project.

Standard Codes

- 'A' – architecture
- 'B' – building surveying
- Etc.

Length

- N/A

Additional Comments

- Discipline. If produced by a team within the appointing party (client), then this field is used to denote the technical specialism of that team.

Irish National Annex

Description

A unique identifier should be defined for each project role(s) of an organisation.

Standard Codes

- 'AR' – architect
- 'BS' – building surveyor
- Etc.

Length

- 2 characters max

Additional Comments

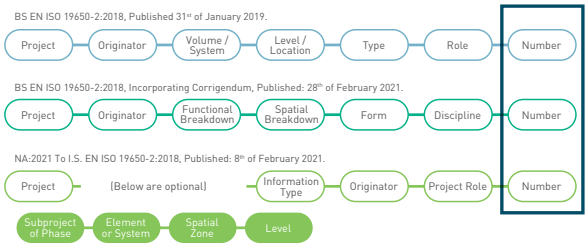
- Project Role.
- New two character roles in the National annex - Table NA.3

Figure 34a: Project Role/Role/Discipline Container ID Comparison. (DCT)

Number

The Number Container ID is detailed within the Irish NA as: *A sequential number should be defined for each information container. The number code should be a minimum of three to a maximum of six digits in length. Leading zeros should be used.*

Figure 35: Number information container comparison. (DCT)



UK National Annex

Description

A sequential number should be assigned to each information container when it is one of a series.

Standard Codes

- N/A

Length

- 4 – 6 integer numeric digits

Additional Comments

- Leading zeros should be used and care should be taken not to embody information that is present in other fields.

UK National Annex V.2

Description

When an information container ID is not unique using all the other fields, then this should be achieved using a sequential number

Standard Codes

- N/A

Length

- Fixed within Project Info. Standard

Additional Comments

- Leading zeros should be used and care should be taken not to embody information that is present in other fields.

Irish National Annex

Description

A sequential number should be defined for each information container.

Standard Codes

- N/A

Length

- 3 – 6 digits

Additional Comments

- Leading zeros should be used and care should be taken not to embody information that is present in other fields. Numbers may be grouped to facilitate project requirements.

Figure 35a: Number information comparison. (DCT)

Status codes

The Status metadata is detailed within the Irish NA as: *The status (suitability) codes are made up of two parts; purpose codes and acceptance codes.*

The purpose codes in the Irish National Annex Table NA.4 and the acceptance codes in Table NA.5 should be applied.

These tables can be found in the Irish National Annex NA:2021to I.S. EN ISO 19650-2:2018 (or see page 76).

The UK National annex just deals with Status code. Page 80 of this document provides an overview to the changes made to the amended status codes in the updated 2021 UK National Annex.

Container Name	Description	Status	Revision	Author	Submittal Date	Container Classification
7001-BBH-ZZ-ZZ-DR-A-00301	First Floor Plan	S3	P04	Joe Blogs	12/11/2017	PM_40_30 : Design Information
7001-BBH-ZZ-ZZ-DR-A-00312	West Elevation	A3	C06	Joe Blogs	12/11/2017	PM_40_30 : Design Information

Container Name / ID Field — Additional Container Metadata Assignments

Figure 36: Status codes metadata example. (UK BIM Framework)

Further guidance can be found here:
https://ukbimframeworkguidance.notion.site/ISO-19650-Guidance-C-Facilitating-the-CDE-workflow-and-technical-solutions-ff3bdbcf1c1349c1a98c586943d0a9f1

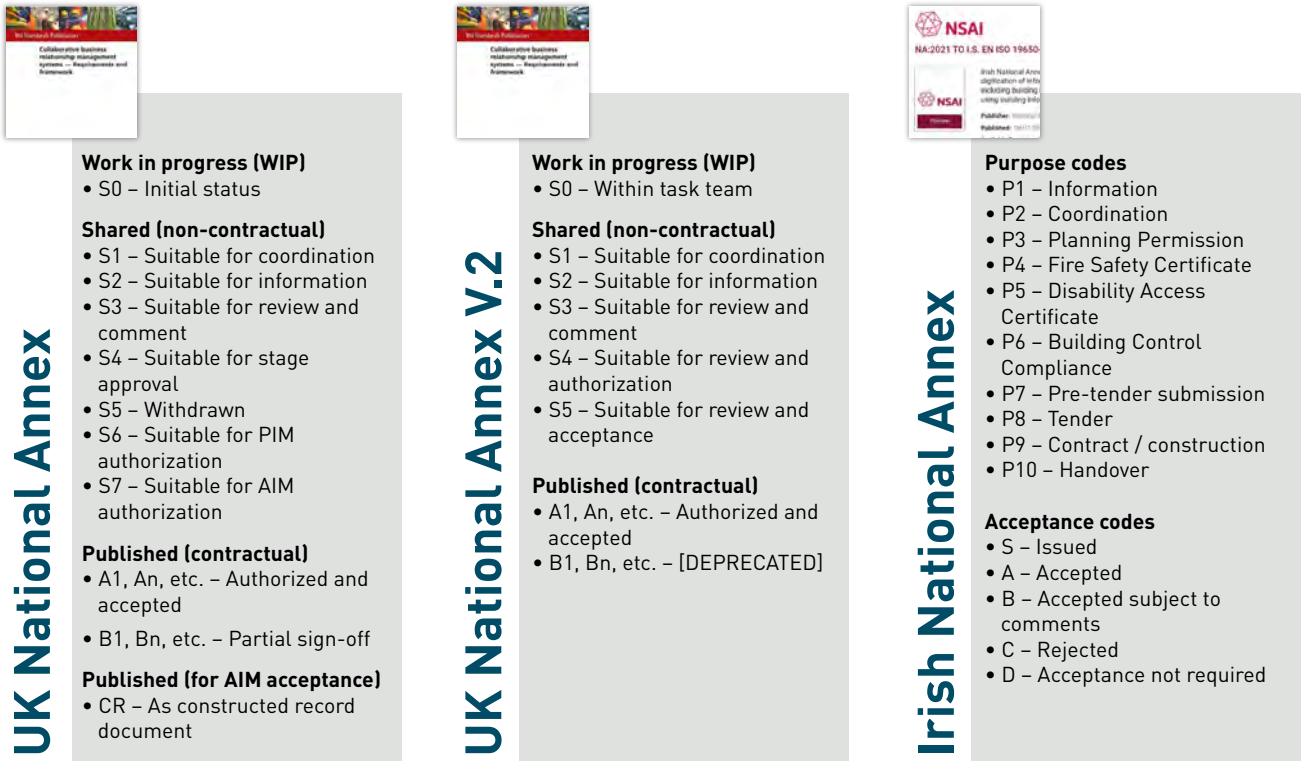


Figure 36a: Status codes metadata comparison. (DCT)

Revision Codes

The revision code metadata is detailed within the Irish NA as the following- *A sequential number should be used to identify the revision of an information container.*

It should be noted both the Irish and UK national annex Revision codes are different.

Container Name	Description	Status	Revision	Author	Submittal Date	Container Classification
7001-BBH-ZZ-ZZ-DR-A-00301	First Floor Plan	S3	P04	Joe Blogs	12/11/2017	PM_40_30 : Design Information
7001-BBH-ZZ-ZZ-DR-A-00312	West Elevation	A3	C06	Joe Blogs	12/11/2017	PM_40_30 : Design Information

Container Name / ID Field — Additional Container Metadata Assignments

Figure 37: Revision codes metadata example. (UK BIM Framework)

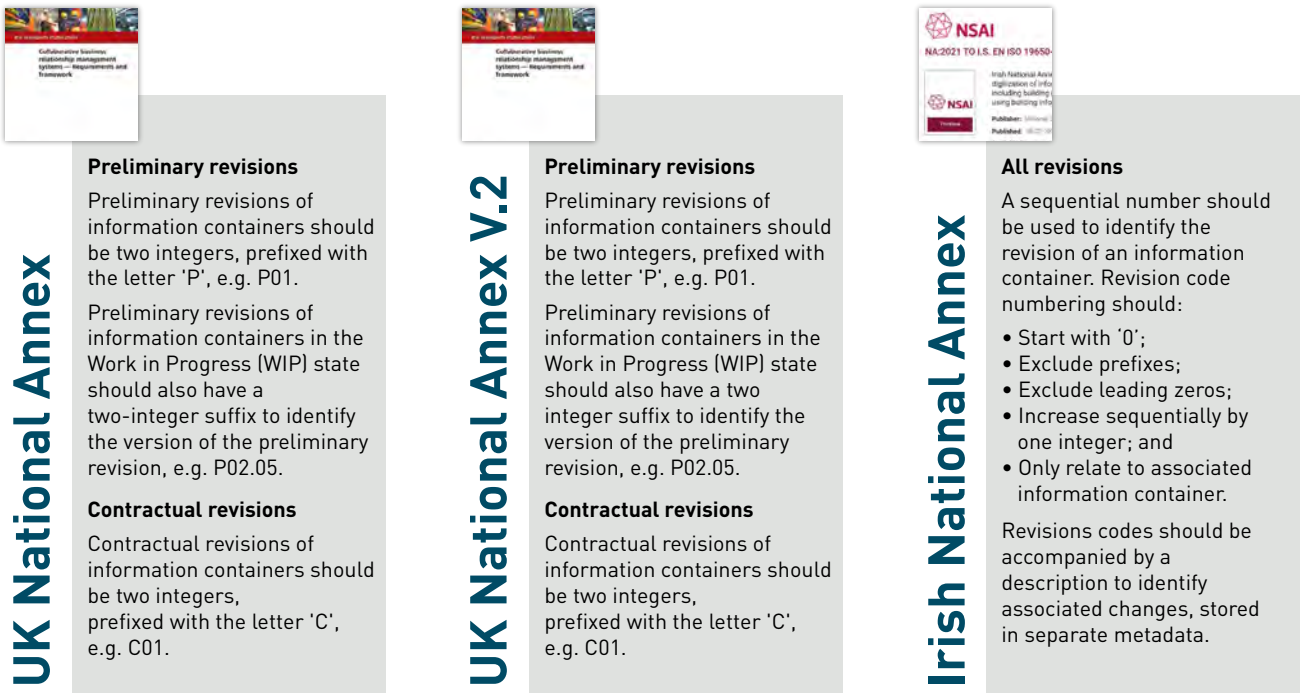


Figure 37a: Revision codes metadata information comparison. (DCT)

Further guidance can be found here:
https://ukbimframeworkguidance.notion.site/ISO-19650-Guidance-C-Facilitating-the-CDE-workflow-and-technical-solutions-ff3bdbcf1c1349c1a98c586943d0a9f1

Information Container Identification Examples

Current Irish National Annex NA:2021 to I.S. EN ISO 19650-2:2018

The I.S. EN 19650-2:2018 National Annex (NA) proposes the method shown in Table 12 for producing unique identifiers for information containers to be used with a Common Data Environment. These are the file names to be used along with a file format such as .pdf. It should also be remembered that in accordance with ISO 7200, as well as a unique identifier, files should also include other metadata such as a Title and Supplementary Title.

Field	Title	Summary
Field 1	Project	A unique project code should be determined at the initiation of a project. The project field code should be a maximum of six characters in length and should relate to project, campus or site identification conventions.
Field 2	Sub Project or Phase	Unique subproject or phase codes should be defined at the initiation of a project. Subproject or phase codes should be aligned with the project's supply chain procurement structures and identification conventions. The subproject or phase field code should be a maximum of six characters in length. The code 'Z' should be used for information containers associated with multiple subprojects or phases. The code 'X' should be used for information containers that are not associated with any subprojects.
Field 3	Element or System	Element or system codes should be chosen from an established industry or project defined codification system.

Field 4	Spatial Zone	A unique code should be defined for each spatial zone. The spatial zone code should be a maximum of six characters in length.
Field 5	Level	A unique code should be defined for each level. The level code should be three characters in length.
Field 6	Information Type	A unique code should be defined for each information type associated with an information container. The code should be two characters in length.
Field 7	Originator	A unique code should be defined for the organisation that authored the information container. The code for the originator field should be a minimum of three to a maximum of six characters in length.
Field 8	Project Role	A unique identifier should be defined for each project role(s) of an company. The code for the role field should be a maximum of two characters in length.
Field 9	Number	A sequential number should be defined for each information container. The number code should be a minimum of three to a maximum of six digits in length. Leading zeros should be used.

Grey coloured cells denote optional fields as applicable.

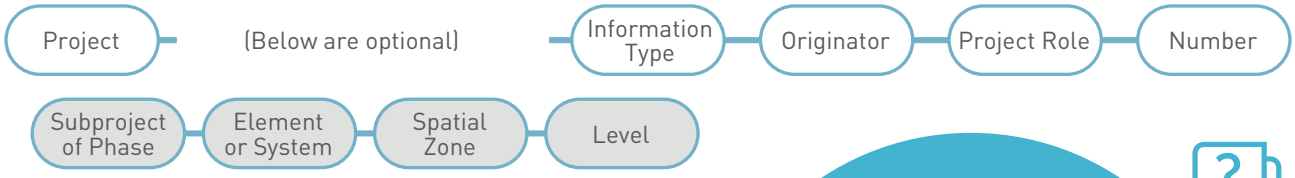


Table 12: I.S. EN ISO 19650-2:2018 Unique Identifier Fields (NSAI)

Project Federation

Project federation is how a project is broken down. To effectively manage the Information Model, it needs to be divided into its component parts, i.e. mechanical, electrical, architectural etc., for example. This is defined as an information breakdown structure which is a pre-determined method to identify manageable units of information to be used across a project or asset life cycle.

Example

Container ID	Example	Comment	Reference
Project	PRO	Project (PRO) has been selected as the unique code for the project.	This field uses the project code, suffixed by a subproject code aligned to the federation strategy.
Subproject/Phase (Optional)	01	Building 01 on the Project (Pro)	Portion of the project coded for phasing, procurement, and/or identification.
Spatial zone (Optional)	01	Spatial Zone 01	Please ensure the spatial zones have been created with the full project team requirement in mind.

Level (Optional)	L00	Ground floor. Letter and number required.	A unique code should be defined for each level used by all on the project.
Information Type	DR	Drawing	This should be defined for each information type.
Originator	CIF	Construction Industry Federation is the Originator of the Information.	An organisation's abbreviated name is used here, which should be as concise as is possible. Construction Industry Federation may use CIF.
Project role	FO	Facility owner has been selected (FO)	Should be a maximum of two characters.
Number	00001	Leading zeros should be utilised. 00001 has been used for this example.	

Project		Subproject/ phase		Spatial zone		Level		Information Type		Originator		Project Role		No.
PRO	-	01	-	01	-	L00	-	DR	-	CIF	-	FO	-	00001

Table 13: Sample information to conform to Irish National Annex container identification (ID)

Information Container metadata

It is important to establish what is meant by metadata as the ISO 19650 series offers no formal definition. Metadata is defined as "A set of data that describes and gives information about other data" (Oxford Dictionary, 2019)

Status

The status (suitability) codes are made up of two parts: purpose codes and acceptance codes. The purpose codes in Table NA.4 and the acceptance codes in Table NA.5 should be applied.

These tables can be found in the Irish National Annex NA:2021to I.S. EN ISO 19650-2:2018.

Purpose code	Definition	Explanation
P1	Information	Information container distributed to project stakeholders for the purpose
P2	Coordination	Information container distributed to project stakeholders for the purposes of coordinating design and construction models, deliverables and activities
P3	Planning Permission	Information container related to planning regulation statutory submission activities
P4	Fire Safety Certificate	Information container related to fire safety statutory submission activities
P5	Disability Access Certificate	Information container related to access and use statutory submission activities
P6	Building Control Compliance	Information container related to building control statutory submission activities
P7	Pre-tender submission	Information container related to pre-tender submission activities
P8	Tender	Information container related to tender preparation and submission
P9	Contract / construction	Information container that is to be included as a contract document
P10	Handover	Information container that is to be included in handover activities

Table 14: Table NA4 Purpose Codes from ISO 19650.

Acceptance Codes

Files that have undertaken the ISO review and approval process should be identified with the following acceptance codes:

Purpose code	Definition	Explanation
S	Issued	Information that is issued for a particular purpose
A	Accepted	Accepted for a particular purpose
B	Accepted subject to comments	Accepted for a particular purpose subject to comment
C	Not Accepted	Rejected for a particular purpose
D	Acceptance not required	Statue *Suitability) update not required for a particular purpose

Table 15. Table NA5. Acceptance Codes from I.S. EN ISO 19650-2:2018

Revision

Each file should be identified with a revision index and a sequential number should be used to identify the revision of an information container. Revision code numbering should be in accordance with the following:

- start with '0'
- exclude prefixes
- exclude leading zeros
- increase sequentially by one integer

and

- and only relate to the associated information container.

Revision codes should be accompanied by a description to identify the changes associated with the revision of the information container. The description should be stored in separate metadata.

Superseded UK File Identifiers from BS 1192:2007

The UK BS 1192:2007 file naming convention was the original format and developed through the Avanti programme in the early 2000's and was then incorporated into BS 1192:2007, PAS 1192:2013 and later the original ISO 19650-2:2018 National Annex. The solution was based upon seven variable length fields separated by a hyphen (-). This provided the ability to search through the file identifier using standard search patterns. See Figure 38 for an example.

Project		Originator		Volume		Level		Type		Role		No.
PRO01	-	CIF	-	ZZ	-	01	-	DR	-	X	-	0001

Table 16: Sample information of field usage from BS 1192:2007. (BSI)

Figure 38: File Identifiers from BS 1192:2007

Within this approach the project code can incorporate both a project and sub-project if this is required. The original version also included a classification code for systems between role and number, which was generally used with the specified classification. However, as Uniclass 2015 came into use, the field was dropped as the system table was not appropriate for use in this context.

Superseded UK Standard - BS EN ISO 19650-2: 2018

ISO 19650-2 provides the opportunity to create a National Annex to detail specific country implementation requirements. As well as the Irish National Annex, the UK, through BS EN 19650-2: 2018, have their own National Annex.

Project		Originator		Volume/ System		Level/ Location		Type		Role		No.
PRO	-	CIF	-	ZZ	-	01	-	DR	-	XE	-	00001

Table 17: NA.1 — Identification of information containers within a common data environment example. (BSI)

Current UK Standard - BS EN ISO 19650-2: 2018 incorporating Corrigendum (28th February 2021)

This originally National Annex to BS EN ISO 19650-2:2018 followed the BS 1192:2007 approach but in February 2021 a revised UK National Annex was issued. The format of this National Annex was further developed and is as follows:

Field	Title	Summary
Field 1	Project	A single common project identifier should be defined at the initiation of the project in the project's information standard. It should be independent and recognizably distinct from any lead appointed party's or appointed party's internal job number.
Field 2	Originator	A unique identifier should be defined for each organisation on joining the project, to identify the organisation responsible for producing the information within the information container. This unique identifier should be fixed within the project's information standard.
Field 3	Functional Breakdown	A unique identifier should be defined for the functional aspects of the information container breakdown structure. This can be based on physical subdivision (such as major design elements or systems) or notional subdivision (such as security classification).
Field 4	Spatial Breakdown	A unique identifier should be defined for each spatial subdivision and fixed within the project's information standard.
Field 5	Form	A unique identifier should be defined for each form of information held within the information containers and be fixed within the project's information standard.
Field 6	Discipline	A unique identifier should be defined for each discipline to which information is related on the project and fixed within the project's information standard.
Field 7	Number	When an information container ID is not unique using all the other fields, then this should be achieved using a sequential number, which could be within a series/grouping. Such a grouping should be documented within the project's information standard. The length of the number field for standard coding should be fixed within the project's information standard. Leading zeros should be used within this fixed length and care should be taken not to embody information that is present in other fields.

Table 18: NA.1 — Identification of information containers within a common data environment. (BSI)

Figure 39: BS EN ISO 19650-2: 2018 incorporating Corrigendum.

Example

Container ID	Example	Comment	Reference
Project	PRO01	Project (PRO01) has been selected as the unique code for the project.	
Originator	CIF	Construction Industry Federation is the Originator of the Information.	
Functional Breakdown	12	Functional Breakdown 12	This code can now be used for a system-based sub-division of the project, with codes fixed on a project-by-project basis. However, it can still be used for the volume-based sub-division if required.
Spatial Breakdown	00	Ground floor. The Spatial Breakdown field has been assigned a two-digit code. (00) for the ground floor.	The standard codes related to building levels have been removed as there were many comments that these did not allow suitable ordering of information containers in lists. But the previous codes can be reinstated at a project level.
Form	D	Drawing	This is consistent with an existing standard (BS ISO 29845) for forms of information
Discipline	O	Other discipline. This list can be expanded with two-character project specific codes.	This is so that Disciplines align with technical activities rather than job titles or contractual designations (such as subcontractor). Again, this list can be expanded if required
Number	00001	Leading zeros should be utilised. 00001 has been used for this example.	The length of the number field for standard coding should be fixed within the project information standard.

Project		Originator		Functional Breakdown		Spatial Breakdown		Form		Discipline		No
PRO01	-	CIF	-	12	-	00	-	D	-	0	-	00001

Table 19: Example showing the UK National Annex container identification (ID)

The status (suitability) codes as a file's purpose are defined by combining its Status and Revision. The table 20 below lists the codes for the Status of a given stage of a project.

Code	Use of the code	Type of Revision
Work in progress (WIP)		
S0	Information container being developed within a task team	Preliminary revision and version
Shared (noncontractual)		
S1	Information containers that are suitable for geometrical and/or nongeometrical coordination within a delivery team	Preliminary revision
S2	Information containers that are suitable for information/reference by other task teams within a delivery team	Preliminary revision
S3	Information containers that are suitable for review and comment within a delivery team	Preliminary revision
S4	Information containers that are suitable for review and authorization by a lead appointed party	Preliminary revision
S5	Information containers suitable for review and acceptance by an appointing party	Preliminary revision
Published (contractual)		
A1, An, etc.	Information containers where there are no comments from the party being invited to either: » authorise them (if they are in response to a lead appointed party exchange information requirement); or » accept them (if they are in response to an appointing party exchange information requirement).	Contractual revision
B1, Bn, etc.	Information containers that are partially signed off where there are comments from the party being invited to authorize or accept them	Preliminary revision

Table 20: ISO 19650-2 clause NA.4.2 Status codes from the UK National Annex. (BSI)

Information container metadata

Revision

Revisions will either be identified as preliminary revisions prefixed with a P or contractual revision prefixed with a C. Revision shall be two integers and include leading zeros, i.e. P02

Information containers identified as WIP may also include a version where options or alternatives are being developed. They should use a full stop and two integers, i.e, P02.01.

Contractual revisions of information containers should be two integers, prefixed with the letter 'C' for example C01.

Unique File Identifiers

The ability to find files such as documents, models, schedules etc. has been identified as a cause of poor productivity in many industry reports going back decades. The use of file identifiers incorporating a series of fields containing the required data to be able to search on was therefore developed through the UK Avanti programme and then BS 1192:2007 as a crucial part of the CDE process.

It should be recognised that the file identifier is only one of several data requirements that should be associated with a file and the others are identified within ISO 7200:2004 Data field requirements and ISO Industry Foundation Classes or IFC (ISO 16739-1:2018). Further information is available at the end of this section.

No international agreement on file identifiers was defined when writing ISO 19650-2 and therefore the UK, followed by Ireland, produced their own under a National Annex. The UK initially adopted the BS 1192 approach, but then renamed the fields in a further corrigendum to the standard. The complete list of fields across the different standards is generally as detailed in table 20 above.

4.4 Other ISO standards

The following ISO standards may also be relevant to work undertaken on digital delivery projects:

ISO 128 - Technical drawings — General principles of presentation

Provides a series of technical drawing standards covering line types, text, dimension, referencing and internationally agreed methodology for providing technical drawings. These standards form the basis for most best drawing practice and this includes drawings produced using BIM software.

ISO 4157 - Construction drawings - Designation systems

- Part 1: Buildings and parts of buildings
- Part 2: Room names and numbers
- Part 3: Room identifiers

The ISO 4157 standards covers designation systems or numbering of levels, rooms and components within a building crucial to the delivery of structured data. For the delivery of structured data, specifically COBie, the principles outlined within these standards should be followed.

ISO 5456 - Technical drawings — Projection methods

- Part 1: Synopsis
- Part 2: Orthographic representations
- Part 3: Axonometric representations
- Part 4: Central projection

The ISO 5456 series covers the type of drawing views and projections use for construction drawings. Most BIM software will already adopt these principles.

ISO 6707-1, Buildings and civil engineering works — Vocabulary — Part 1: General terms

This document contains the terms and definitions of general concepts to establish a vocabulary applicable to buildings and civil engineering works. It comprises:
a) fundamental concepts, which can be the starting point for other, more specific, definitions;
b) more specific concepts, used in several areas of construction and frequently used in standards, regulations and contracts.

ISO 12006 - Building construction — Organisation of information about construction works

- Part 2: Framework for classification

  ISO 12006 Part 2 defines the standard for classification systems upon which Uniclass and Omni class, etc. have been developed.

- Part 3: Framework for object-oriented information

  ISO 12006 Part 3 is the standard for defining interoperable data dictionaries and forms the basis upon which the buildingSMART data dictionary has been built. Other solutions such as BRE Templater, Lexicon, BIM4Housing Templater also follow this approach.

ISO 13567-1 - Technical product documentation — Organisation and naming of layers for CAD

- Part 1: Overview and principles
- Part 2: Concepts, format and codes used in construction documentation

ISO 13567 provides the international standard for CAD layers. This standard using a fixed field length approach to defining layers. The UK previously used a variable length CAD layer standard as set out in BS1192:2007. This has now been withdrawn and a UK National Annex to ISO 13567 produced.

ISO 167571:2019 Data structures for electronic product catalogues for building services

The primary purpose of ISO 16757 is the provision of data structures for electronic product catalogues to transmit building services product data automatically into models of building services software applications. This includes a meta model for the specification of product classes and their properties and a meta model for the product data which is exchanged in product catalogues. Product data has to follow the specifications for their product groups.

ISO16767-2 Data structures for electronic building services product catalogues — Geometry

ISO 16757-2:2016 describes the modelling of building services product geometry. The description is optimised for the interchange of product catalogue data and includes:

- shapes for representing the product itself
- symbolic shapes for the visualization of the product's function in schematic diagrams
- spaces for functional requirements
- surfaces for visualization
- ports to represent connectivity between different objects

ISO 23386 - BIM and other digital processes used in construction — Methodology to describe, author and maintain properties in interconnected data dictionaries.

Aimed predominantly at those implementing data dictionaries as identified in ISO 120006-3.

ISO 23387 BIM - Data templates for construction objects used in the life cycle of built assets — Concepts and principles

Standard for defining standardised data templates that can be hosted on data dictionaries to facilitate standardised manufacturers product information.

Unified Modelling Language

In object-oriented programming, graphic techniques are used to describe entity types which are characterised by certain properties and behaviour. The Unified Modelling Language (UML) is a widely used formal language which can be used for all kinds of object modelling (information modelling, data modelling, etc.).

ISO 24156-1 - Graphic notations for concept modelling in terminology work and its relationship with UML -Part 1: Guidelines for using UML notation in terminology work

ISO 24156-1:2014 gives guidelines for using a subset of UML symbols independent of their normal UML meaning, to represent concepts in concept models that result from concept analysis. It describes how UML symbols can be used for that. A UML profile designed for this purpose is used to represent concepts and concept relations in terminology work.

ISO 29481-1 - Building information models — Information delivery manual — Part 1: Methodology and format

Standard developed following the buildingSMART approach to developing information delivery manuals as construction processes that can be replicated using software.

ISO 55000 - Asset management, overview, principles and terminology

International asset management standard developed from the UK PAS 55000 standard.

ISO 80000-1 - Quantities and units — Part 1: General

Gives general information and definitions concerning quantities, systems of quantities, units, quantity and unit symbols and coherent unit systems, especially the International System of Quantities(ISQ) and the International System of Units(SI).

IEC 81346-1 - Industrial systems, installations and equipment and industrial products — Structuring - principles and reference designations — Part 1: Basic rules

Establishes general principles for the structuring of systems including structuring of information about systems. Based on these principles, rules and guidance are given for the formulation of unambiguous reference designations for objects in any system. The reference designation identifies objects for the purpose of creation and retrieval of information about an object and, where realised, about its corresponding component.

IEC 81346-2 - Industrial systems, installations and equipment and industrial products — Structuring - principles and reference designations — Part 2: Classification of objects and codes for classes

Establishes classification schemes with defined object classes and their associated letter codes and is primarily intended for use in reference designations and for designation of generic types.

ISO 81346-12 - Industrial systems, installations and equipment and industrial products — Structuring

This document establishes rules for structuring of systems and the formulation of reference designations and provides classes for systems in the field of construction works and building services. This document also specifies a classification of objects and corresponding letter codes for use in reference designations of object occurrences.

ISO 27001 - Information security, cybersecurity and privacy protection. Information security management systems – Requirements

This provides a framework and guidelines for establishing, implementing and managing an information security management system.

ISO 7200:2004 - Technical product documentation - Data fields in title blocks and document headers

ISO standard identifying the fields or properties associated with drawing title blocks and document meta data. This standard makes it possible for electronic document management systems and similar solutions that can read document meta data to upload and resolve appropriate data requirements.

I.S. EN 17412-1:2020 - Building information modelling - level of information need. Concepts and principles

This document sets out the concepts and principles for defining the level of information need and information deliveries being part of the information exchange processes during the life cycle of built assets when using building information modelling (BIM). Those concepts and principles can deliver clear benefits to all participants in the various life cycle phases of built assets as they provide a common understanding on the right level of information needed at a certain time. One purpose of defining the level of information need is to prevent delivery of too much information. Information exchange should ensure the right information to be delivered for the agreed purpose to facilitate verification and validation processes.

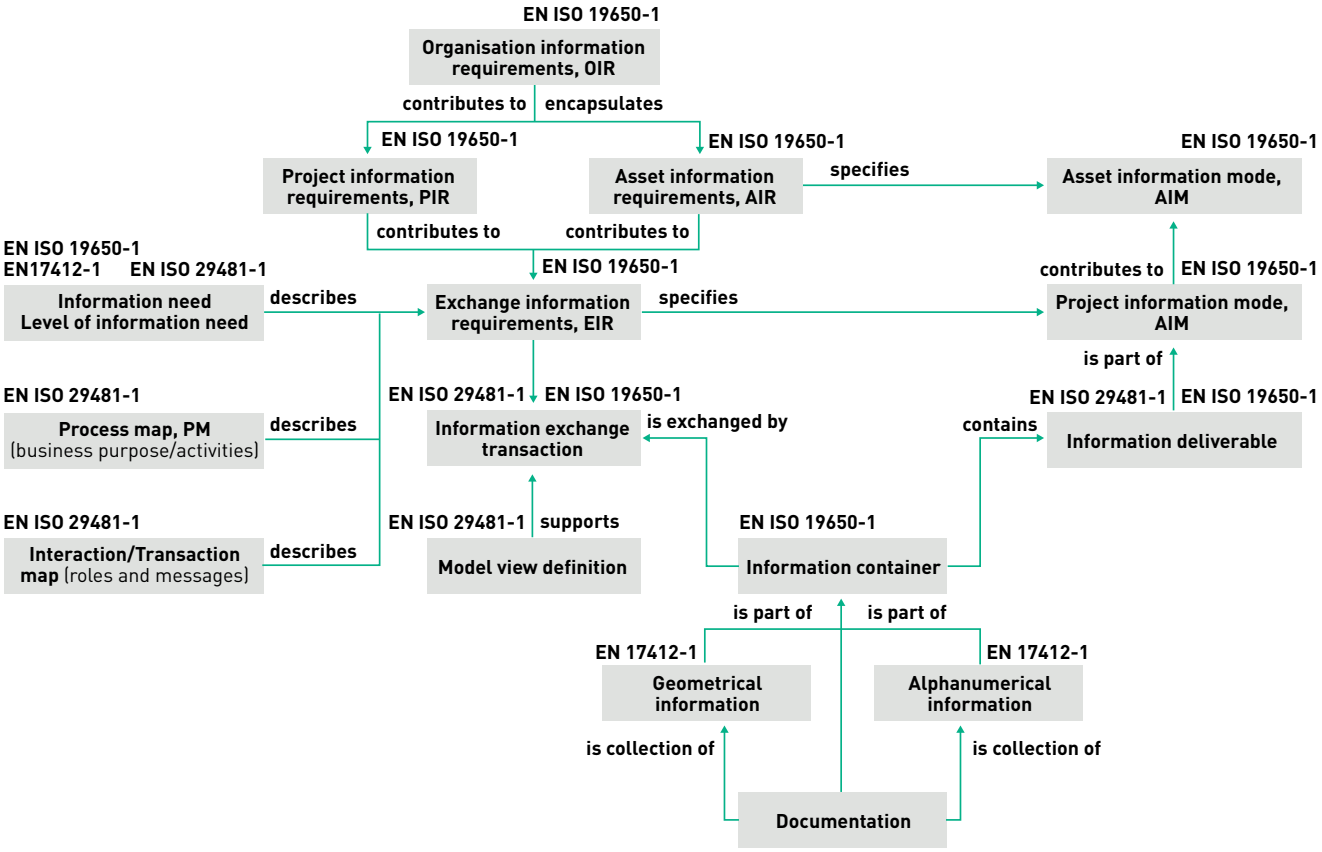


Figure 40: clarifies the main relationships between the ISO standards.

Resource

I.S. EN 17412-1:2020 Building information modelling — Level of information need — Concepts and principles.

https://shop.standards.ie/en-ie/standards/I-S-EN-17412-1-2020-1203631_SAIG_NSAI_NSAI_2906858/

Figure 40 explains the main concepts related to information exchange included in the document I.S. EN 17412-1:2020 Building information modelling — Level of information need — Concepts and principles: I.S. EN ISO 19650-1 and in EN ISO 29481-1.

Figure 40 represents the relations, at the time of the publication, of I.S. EN 17412-1:2020 Building information modelling — Level of information need — Concepts and principles.; it may change in the future as the ISO standards evolve.

Level of information need, process maps and interaction/transaction maps describe exchange information requirements (EIR). The exchange information requirements (EIR) define information exchanges/transactions which result in information deliverables being exchanged by information containers. The model view definition schema supports the information exchanges.

Level of information need can be broken down into geometrical information, alphanumerical information and documentation.

The level of information need can be used in the processes as described in the EN ISO 29481-1 but is not limited to those. The level of information need can be used also to describe other more informal information exchanges.

4.5 Standards - British Standards

Whilst the core BIM Level 2 documents produced by British Standards have now moved to ISO standards, there are several British Standards which provide a crucial role in the delivery of structure information and the life cycle approach to using information in the built environment.

The following standards are applicable today and can be utilised in parallel with the ISO 19650 series of documents including:

- BS 8541 Series
- BS8536:2002 - Design, manufacture and construction for operability – code of practice

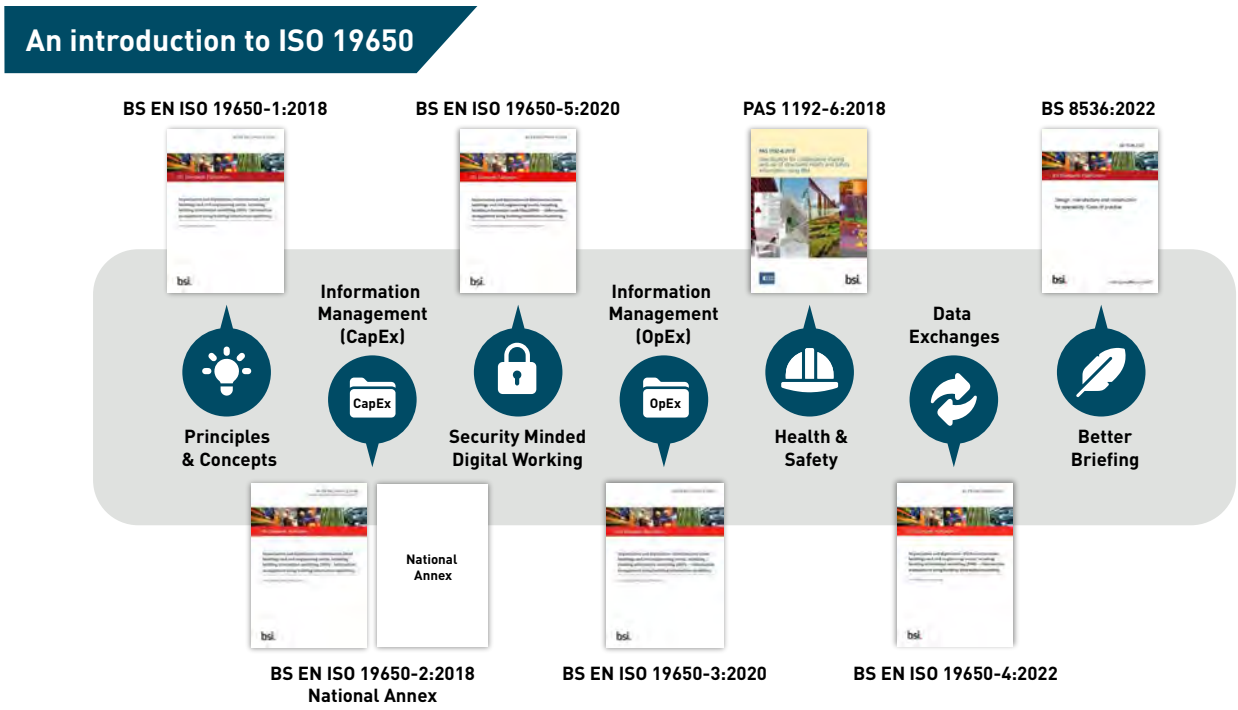


Figure 41: ISO Documents and BSI documents currently used.

4.5.1 BS 8541 Series

BS 8541-Series Library objects for architecture, engineering and construction consists of :

- Part 1 Identification and classification. Code of practice
- Part 2 Recommended 2D symbols of building elements for use in building information modelling
- Part 3 Shape and measurement. Code of practice
- Part 4 Attributes for specification and assessment. Code of practice
- Part 5 Assemblies. Code of practice
- Part 6 Product and facility declarations. Code of practice

The BS 8541 series provides the standards against which BIM library objects should be developed and includes naming of objects, their properties, graphical representation and configuration. These standards should be referenced to ensure that consistent BIM objects are delivered, specifically where an Industry Foundation Class(IFC) or COBie delivery is required.

4.5.2 BS 8536:2022 - Design, manufacture and construction for operability - code of practice

As a code of practice, BS 8536:2022 gives recommendations on design, manufacture and construction for asset operability that considers the required performance of the asset over its planned operational life.

This British Standard supersedes BS 8536-1:2015 and BS 8536-2:2016, which are withdrawn.

The standard is a consolidation and full revision of the earlier two-part standard–part 1 relating to facilities management and part 2 relating to asset management–but with an expanded scope. The updated title emphasises the importance of achieving the required operational performance of built assets.

The changes in BS 8536:2022 relating to its relationship with other standards include:

- aligning with the requirements of the BS EN ISO 19650 series of standards on information management using building information modelling and with PAS 1192-6:2018 on health and safety using building information modelling
- aligning with the requirements of BS 40101:2022 on building performance evaluation
- applying the principles for sponsoring, directing, managing and transitioning projects
- individually (see BS 6079:2019) or as part of a programme or portfolio
- increased consideration of risk management through the project life cycle (see BS ISO 31000:2018) and
- further application of the principles and practices contained within The Soft Landings Framework and the UK Government Soft Landings.

BS 8536:2022 maintains its focus on promoting the smooth transition through the stages of delivery and operation of assets from a process that embeds soft landings, building performance evaluation and information management, using building information modelling. The growth of modern methods of construction is reflected in the standard's many recommendations, as well as in its title, to emphasise the increasing role of manufacturing within construction.

BS 8536:2022 outlines the primary activities, data and information, issues and deliverables to be addressed by the project team and each delivery team to support their work through the asset life cycle. In this way, it provides a common basis for owners, sponsors, operators and their teams to plan for and achieve the required functional and operational performance from their assets.

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

BS 8536:2022 reflects improvements to soft landings principles gained from feedback on projects and their outputs (i.e. operational assets). These are, in effect, a fine-tuning of validated practices and can be summarized as follows:

- setting project success criteria at the outset
- protecting and promoting the success criteria throughout the project

and

- evaluating performance against the set success criteria

BS 8536:2022 can be applied to all types of built assets and by organisations of all kinds and sizes involved in the delivery of operational assets. As a code of practice, it sets out recommendations and guidance on how to embed the key principles and practices of a project-managed approach to asset delivery, soft landings, building performance evaluation and building information modelling into a seamless, coherent whole that serves the interests and needs of all stakeholders in the delivery and operational phases of an asset.

Soft Landing

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

BS 8536:2022 is, therefore, not a standard for owners, sponsors or operators, designers or constructors, or asset managers and facility managers, but one standard for all of them. Implementing this standard's recommendations and guidance will help to create a built environment at a lower cost that can be operated and maintained for better performance over a longer life than experienced in the past.

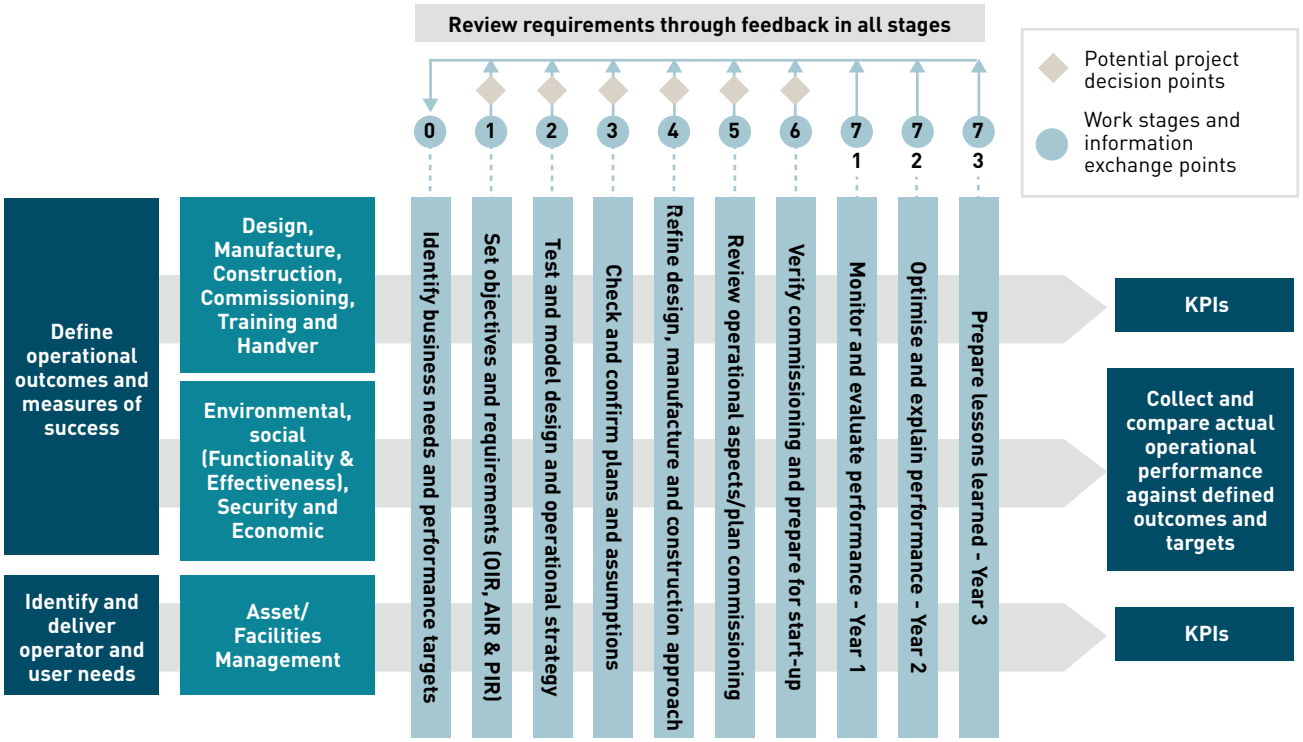


Figure 42: The overall approach and the importance of performance reviews and feedback. (The British Standards Institution)

Figure 42 summarizes the overall approach processes and information flows in a manner that is analogous to swim lanes. The inputs on the left-hand side progress through all work stages to the outputs on the right-hand side. The text aligned with each work stage summarizes its primary purpose.

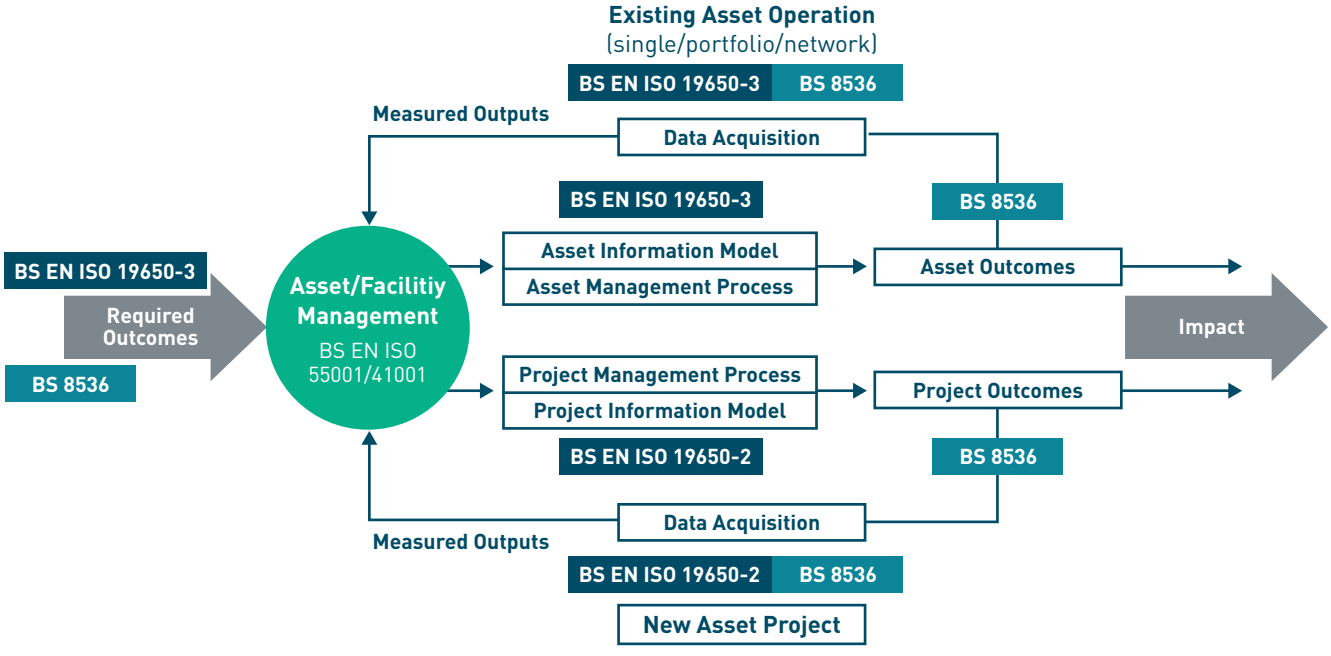


Figure 43: The asset-project systems and feedback system. (The British Standards Institution)

Figure 43 illustrates the relationship between assets and projects. A common failing in practice is that the systematic feedback that occurs in the asset management process is not mirrored in the project management process. The result is that project outcomes are not acquired and analysed, and so cannot be transferred to the owner's asset management system. The figure also emphasises the important relationship between this British Standard and those standards supporting information management, using building information modelling and which are cited as normative references.

4.5.3 Standards, BIM Open Data Standards

BIM Open Data Standards (ODS) are a set of guidelines and protocols for the sharing and use of Building Information Models (BIM) in a collaborative environment. The purpose of BIM ODS is to enable effective communication and collaboration between different stakeholders in the construction industry, by providing a common language and framework for the exchange and integration of BIM data.

BIM ODS provides a consistent and interoperable method for exchanging information between different software applications and platforms used in the construction industry, including those used by architects, engineers, contractors and owners. BIM ODS is typically used to ensure that BIM data is structured in a consistent manner and that it can be easily shared and integrated across different systems.

BIM ODS provides a standardised way of exchanging data that can be used by all stakeholders in a construction project, regardless of the specific software or tools that they use. This helps to ensure that everyone is working from the same information, which reduces errors and misunderstandings and increases efficiency and productivity.

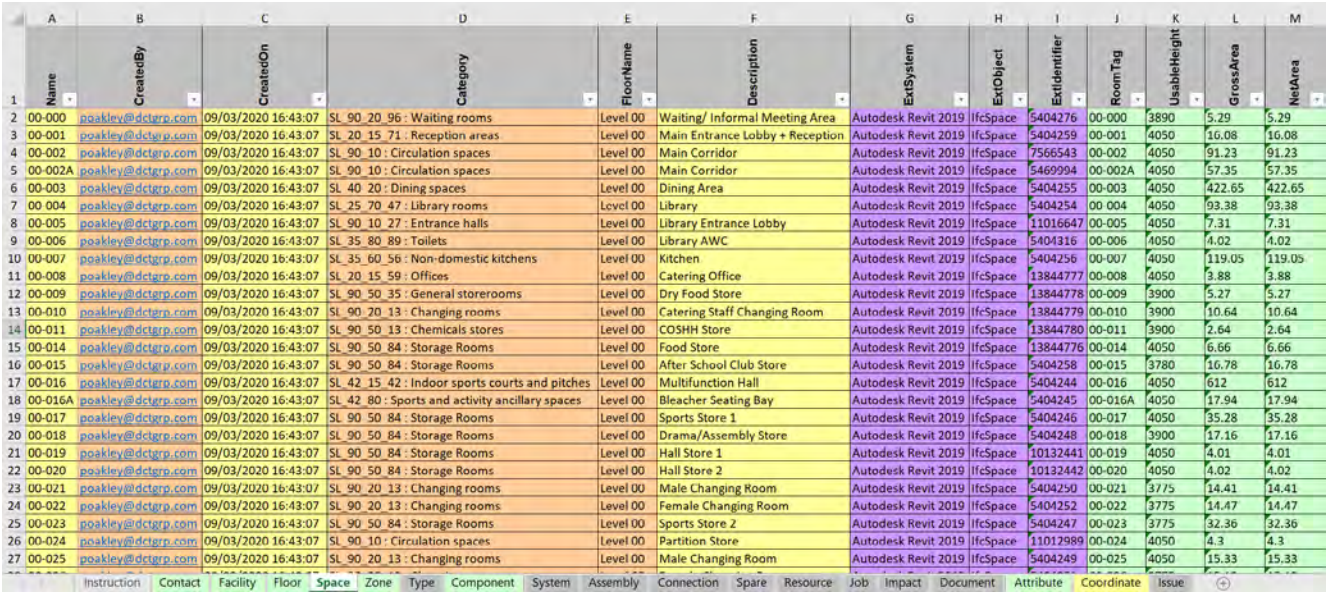
BIM ODS is typically developed and maintained by industry, companies, standards bodies and government agencies. These standards are constantly evolving as new technologies and practices emerge in the construction industry. Some examples of BIM ODS include the Industry Foundation Classes (IFC) and the Construction Operations Building Information Exchange (COBie).

4.5.4 Construction Operations Building information exchange (COBie)

COBie was an identified deliverable under the BIM Level 2 approach and has been identified as a method of information delivery against ISO 19650-4. Developed by the US Army Corps of Engineers COBie has become the agreed open data format for exchanging information between constructors and operators.

However, COBie requires a structured approach to creating a building information model. This includes standard naming of files, objects and their properties, as well as designation providing unique identifiers.

COBie What is it?



	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Name	CreatedBy	CreatedOn	Category	FloorName	Description	ExtSystem	ExtObject	ExtIdentifier	RoomTag	UsableHeight	GrossArea	NetArea
2	00-000	poakley@dctgrp.com	09/03/2020 16:43:07	SL_90_20_96 : Waiting rooms	Level 00	Waiting/ Informal Meeting Area	Autodesk Revit 2019	IfcSpace	5404276	00-000	3890	5.29	5.29
3	00-001	poakley@dctgrp.com	09/03/2020 16:43:07	SL_20_15_71 : Reception areas	Level 00	Main Entrance Lobby + Reception	Autodesk Revit 2019	IfcSpace	5404259	00-001	4050	16.08	16.08
4	00-002	poakley@dctgrp.com	09/03/2020 16:43:07	SL_90_10 : Circulation spaces	Level 00	Main Corridor	Autodesk Revit 2019	IfcSpace	7566543	00-002	4050	91.23	91.23
5	00-002A	poakley@dctgrp.com	09/03/2020 16:43:07	SL_90_10 : Circulation spaces	Level 00	Main Corridor	Autodesk Revit 2019	IfcSpace	5469994	00-002A	4050	57.35	57.35
6	00-003	poakley@dctgrp.com	09/03/2020 16:43:07	SL_40_20 : Dining spaces	Level 00	Dining Area	Autodesk Revit 2019	IfcSpace	5404255	00-003	4050	422.65	422.65
7	00_004	poakley@dctgrp.com	09/03/2020 16:43:07	SL_25_70_47 : Library rooms	Level 00	Library	Autodesk Revit 2019	IfcSpace	5404254	00_004	4050	93.38	93.38
8	00-005	poakley@dctgrp.com	09/03/2020 16:43:07	SL_90_10_27 : Entrance halls	Level 00	Library Entrance Lobby	Autodesk Revit 2019	IfcSpace	11016647	00-005	4050	7.31	7.31
9	00-006	poakley@dctgrp.com	09/03/2020 16:43:07	SL_35_80_89 : Toilets	Level 00	Library AWC	Autodesk Revit 2019	IfcSpace	5404316	00-006	4050	4.02	4.02
10	00-007	poakley@dctgrp.com	09/03/2020 16:43:07	SL_35_60_56 : Non-domestic kitchens	Level 00	Kitchen	Autodesk Revit 2019	IfcSpace	5404256	00-007	4050	119.05	119.05
11	00-008	poakley@dctgrp.com	09/03/2020 16:43:07	SL_20_15_59 : Offices	Level 00	Catering Office	Autodesk Revit 2019	IfcSpace	13844777	00-008	4050	3.88	3.88
12	00-009	poakley@dctgrp.com	09/03/2020 16:43:07	SL_90_50_35 : General storerooms	Level 00	Dry Food Store	Autodesk Revit 2019	IfcSpace	13844778	00-009	3900	5.27	5.27
13	00-010	poakley@dctgrp.com	09/03/2020 16:43:07	SL_90_20_13 : Changing rooms	Level 00	Catering Staff Changing Room	Autodesk Revit 2019	IfcSpace	13844779	00-010	3900	10.64	10.64
14	00-011	poakley@dctgrp.com	09/03/2020 16:43:07	SL_90_50_13 : Chemicals stores	Level 00	COSHH Store	Autodesk Revit 2019	IfcSpace	13844780	00-011	3900	2.64	2.64
15	00-014	poakley@dctgrp.com	09/03/2020 16:43:07	SL_90_50_84 : Storage Rooms	Level 00	Food Store	Autodesk Revit 2019	IfcSpace	13844776	00-014	4050	6.66	6.66
16	00-015	poakley@dctgrp.com	09/03/2020 16:43:07	SL_90_50_84 : Storage Rooms	Level 00	After School Club Store	Autodesk Revit 2019	IfcSpace	5404258	00-015	3780	16.78	16.78
17	00-016	poakley@dctgrp.com	09/03/2020 16:43:07	SL_42_15_42 : Indoor sports courts and pitches	Level 00	Multifunction Hall	Autodesk Revit 2019	IfcSpace	5404244	00-016	4050	612	612
18	00-016A	poakley@dctgrp.com	09/03/2020 16:43:07	SL_42_80 : Sports and activity ancillary spaces	Level 00	Bleacher Seating Bay	Autodesk Revit 2019	IfcSpace	5404245	00-016A	4050	17.94	17.94
19	00-017	poakley@dctgrp.com	09/03/2020 16:43:07	SL_90_50_84 : Storage Rooms	Level 00	Sports Store 1	Autodesk Revit 2019	IfcSpace	5404246	00-017	4050	35.28	35.28
20	00-018	poakley@dctgrp.com	09/03/2020 16:43:07	SL_90_50_84 : Storage Rooms	Level 00	Drama/Assembly Store	Autodesk Revit 2019	IfcSpace	5404248	00-018	3900	17.16	17.16
21	00-019	poakley@dctgrp.com	09/03/2020 16:43:07	SL_90_50_84 : Storage Rooms	Level 00	Hall Store 1	Autodesk Revit 2019	IfcSpace	10132441	00-019	4050	4.01	4.01
22	00-020	poakley@dctgrp.com	09/03/2020 16:43:07	SL_90_50_84 : Storage Rooms	Level 00	Hall Store 2	Autodesk Revit 2019	IfcSpace	10132442	00-020	4050	4.02	4.02
23	00-021	poakley@dctgrp.com	09/03/2020 16:43:07	SL_90_20_13 : Changing rooms	Level 00	Male Changing Room	Autodesk Revit 2019	IfcSpace	5404250	00-021	3775	14.41	14.41
24	00-022	poakley@dctgrp.com	09/03/2020 16:43:07	SL_90_20_13 : Changing rooms	Level 00	Female Changing Room	Autodesk Revit 2019	IfcSpace	5404252	00-022	3775	14.47	14.47
25	00-023	poakley@dctgrp.com	09/03/2020 16:43:07	SL_90_50_84 : Storage Rooms	Level 00	Sports Store 2	Autodesk Revit 2019	IfcSpace	5404247	00-023	3775	32.36	32.36
26	00-024	poakley@dctgrp.com	09/03/2020 16:43:07	SL_90_10 : Circulation spaces	Level 00	Partition Store	Autodesk Revit 2019	IfcSpace	11012989	00-024	4050	4.3	4.3
27	00-025	poakley@dctgrp.com	09/03/2020 16:43:07	SL_90_20_13 : Changing rooms	Level 00	Male Changing Room	Autodesk Revit 2019	IfcSpace	5404249	00-025	4050	15.33	15.33

Instruction | Contact | Facility | Floor | Space | Zone | Type | Component | System | Assembly | Connection | Spare | Resource | Job | Impact | Document | Attribute | Coordinate | Issue

Figure 44: A structured COBie output. (Paul Oakley)

COBie is a performance-based specification for facility asset information delivery. COBie helps the project team organise electronic submittals approved during design and construction and deliver a consolidated electronic O and M manual with little or no additional effort. COBie data may then be imported directly into CMMS and asset management software, again at no cost. The PDF, drawing and building information model files that accompany COBie are organised so that they can be easily accessed through the secure server directories already in place at the facility management office. Figure 44 is an example of COBie output.

Further information can be found from the Whole Building Design Guide.

Resource

Construction-Operations Building Information Exchange (COBie) | WBDG - Whole Building Design Guide - https://www.wbdg.org/bim/cobie

The Owner's View

An owner may require the delivery of COBie from the lead designer and/or lead contractor to support the timely delivery of information to support the management of the facility. A complete COBie export should be expected at the time of handover, but earlier interim deliveries can be used to monitor the business case for the facility and to help plan for taking ownership.

The COBie information can be either kept as delivered, or held in ordinary databases, or it can be loaded into existing facility management and operations applications, either automatically or using simple copy-and-pasting. The owner should be explicit about the purposes for which the information is required and about the timing and content of any interim deliveries.

The Designers and Contractors View

COBie allows the team to document their knowledge about a facility in both its spatial and physical aspects. Spatially it can document the spaces and their grouping into floors/sectors and into other zones. Physically it documents the components and their grouping into product types and into other systems. Usually, the information needed to complete the COBie deliverable will be available already, either in your BIM models or in reports and schedules and in other material prepared for handover.

Some information may be offered to you in unstructured formats (such as paper and scanned documents), but you should arrange to obtain COBie information on specific aspects from other team members and suppliers.

Product Specifiers and Supplier

COBie can be used to document product data to support the specification/selection/replacement process. If the client requirements include this, then the product types should be given the specific attributes appropriate to that type.

4.5.5 Industry Foundation Classes (IFC)

Industry Foundation Classes (IFC) What is it?

In general, IFC, or "Industry Foundation Classes", is a standardised, digital description of the built environment, including buildings and civil infrastructure. Developed by buildingSMART International, it is an open international standard (ISO 16739-1:2018), meant to be vendor-neutral, or agnostic, and usable across a wide range of hardware devices, software platforms and interfaces for many different use cases. The IFC schema specification is the primary technical deliverable of buildingSMART International to fulfil its goal to promote openBIM.

Further information can be found from the buildingSMART website:

Resource

Industry Foundation Classes (IFC) - buildingSMART Technical - https://technical.buildingsmart.org/standards/ifc/

IFC - Why is it important?

IFC is often requested as an open data delivery format identified in requirements, specifically where multiple authoring tools are required, and no other common file format can be found. Throughout Europe government bodies are starting to request IFC as a required delivery schema and format. When IFC is asked for the appropriate IFC file format, version and the model view definition (MVD) should be identified within the Exchange Information Requirements (EIR) to remove any ambiguity.

IFC file formats

IFC is often identified as a file delivery format for sharing information between proprietary software solutions. The three main file format options for delivering IFC are identified below:

Format	Extension	MIME Type	Text	Size	Summary
*STEP Physical File (SPF)	.ifc	Application / x-step	Yes	100%	STEP Physical Format (SPF or IFC-SPF) is the most widely used format for IFC in practice, which is the most compact of the formats listed that can be read as text.
Extensible Markup Language (XML)	.ifcXML	application/xml	Yes	113%	Extensible Markup Language (XML) provides enhanced readability and benefits from a broad range of software tools.
ZIP	.ifcZIP	application/zip	No	17%	IFC data may embedded within a ZIP file. The embedded data may be encoded as either SPF or XML, where the resulting size is typically comparable.

* Recommended IFC delivery format.

Table 21: IFC file formats

Alternate formats such as ifcOWL and candidate formats can be viewed on the building SMART website.

Resource

https://www.buildingsmart.org/

IFC Versions

IFC was initially released in 1999 and continues to be developed. The current official releases of IFC are identified in the table below:

Version	Name	ISO publication	Summary
4.3.0.1	IFC4.3 TC1 (zip)	Under ISO DIS	-
4.0.2.0	IFC4 ADD2 TC1	ISO 16739-1:2018	2017-10
2.3.0.1	IFC2X3 TC1	ISO/PAS 16739:2005	2007-07

Table 22: Official IFC releases Dec 2022

4.5.6 Data Dictionaries

A data dictionary describes the contents, format and structure of data and the relationship between its elements. ISO 12006-3:2022 Building construction — Organisation of information about construction works — Part 3: Framework for object-oriented information is the standard that specifies a language-independent information model which can be used for the development of dictionaries used to store or provide information about construction works. The model is extended by creating content, such as further objects and their relationships, allowing the content to serve as an ontology, taxonomy, meronomy, lexicon and thesaurus.

Data dictionaries such as the buildingSMART Data Dictionary (bSDD) provides an online service that hosts classifications and their properties, allowed values, units and translations. The bSDD allows linking between all the content inside the database. It provides a standardised workflow to guarantee data quality and information consistency.

BIM modellers use the bSDD to have easy and efficient access to all kinds of standards to enrich their model. BIM Managers use the bSDD to check BIM data for validity. Advanced users use the contents from the bSDD to check compliance, automatically find manufacturers' products, extend Industry Foundation Classes (IFC), create Information Delivery Specifications (IDS) and much more.

Besides national classification systems (Uniclass, Minnd, etc) and application specific standards (ETIM, UniversalTypes, IfcAirport, etc) project specific, national and company specific standards can be stored in the bSDD as well. The internal structure can facilitate ISO 12006-3, ISO 23386 and Linked Data publications.

Resource

buildingSMART Data Dictionary Search (bSDD) - https://search.bsdd.buildingsmart.org/

Alternate data dictionaries are being developed in the UK and other countries to meet specific needs. One example is the BIM4Housing data dictionary. Further information can be found on their website:

Resource

Bim4Housing UK - https://bim4housing.com/

4.5.7 Information Delivery Manuals

Information Delivery Manuals (IDMs) have been developed by buildingSMART International in ISO 2948-1:2010 in order to have a methodology to capture and specify processes and information flow during the lifecycle of a facility.

The methodology can be used to document existing or new processes and describe the associated information to be exchanged between parties. IDMs would be provided as a process map identifying objects, gateways and events within pools, lanes and processes that can form the basis for a software development process.

It is important to state that in order to make an information delivery manual operational it must be supported by software. The main purpose of an information delivery manual is to make sure that the relevant data is communicated in such a way that it can be interpreted by the software at the receiving side.

Where there is consideration for producing software solutions to support a construction process, then IDM should be used to validate the proposed solution.

4.6 Policies and Supporting Documentation

Introduction

Given the ISO 19650 series of standards, additional documents must still be used to support the digital project delivery of a project. A number of these supporting documents and how they may be used on a project are presented here.

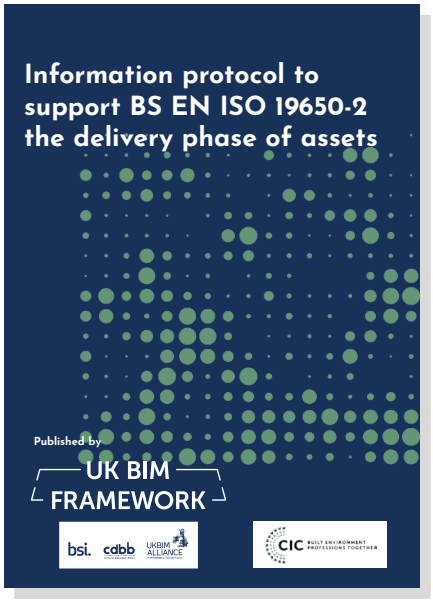


Figure 45: Information Protocol (UK BIM Framework)

4.6.1 Information Protocol

The Information Protocol is designed to be used by construction clients, designers, contractors and their supply chain to ensure that the identified requirements are met by all those authoring information.

The UK BIM Framework published the document *'Information protocol to support BS EN ISO 19650-2 the delivery phase of assets'*. The Information Protocol was created for the UK BS EN ISO 19650-2:2018 standard not the Irish standard which is I.S. EN ISO 19650-2:2018. This should be noted but the core of the document is similar so potentially the content could be used replacing BS EN ISO 19650-2:2018 with I.S. EN ISO 19650-2:2018.

It is the responsibility of the Appointing Party (Client) to establish the project's information protocol, including any associated licence agreements, which will, subsequently and appropriately, be incorporated into the contract.

The Information Protocol is:

- A supplementary legal agreement that is incorporated into professional services appointments and construction contracts by means of a simple amendment.
- Creates additional obligations and rights for the Appointing Party (Client) and the Contracted Party.
- Key principles of the application of Information Protocol are as follows:
  - All parties that are responsible for the production of Building Information Models on behalf of the employer should have the protocol incorporated into their contract/appointment.
  - The same version of the protocol and appendices should be incorporated into each contract.

- The protocol should detail all Building Information Models that are going to be produced by all parties contracted to the employer on the project.
- Changes to the protocol and its appendices should be treated as variations to the contract.

The Information Protocol should include a set of Information Particulars which include the following:

» Appointment description
» Appointing Party
» Lead Appointed Party
» Appointer
» Appointee
» Scope of works
» Level of Information Need
» Exchange Information Requirements
» BIM Execution Plan
» Project's Information Production Methods and Procedures
» Project's Information Standard
» Master Information Delivery Plan
» Task Information Delivery Plan
» Risk Register
» High Level Responsibility Matrix
» Mobilisation Plan
» Security Management Plan

Setting out these terms in the protocol will clarify the intentions of the Appointing Party (Client) and help to avoid conflicts that could have been avoided from the start. Regardless of the requirement, it is always advisable to seek legal advice adding this Information Protocol to a project contract.

Resource

UK BIM Framework Information Protocol and Templates Link - https://ukbimframeworkguidance.notion.site/UK-BIM-Framework-Guidance-20a045d01cfb42fea2fef35a7b988dbc#665f0516978c472bac72a71341829893

4.6.2 NEC 4 – Practice Note

The New Engineering Contracts (NEC) is a UK family of contracts that facilitates the implementation of sound project management principles and practices as well as defining legal relationships created by the UK Institution of Civil Engineers.

All NEC4 contracts, except the short contracts, provide for the creation or modification of an Information Model in secondary Option X10, with the requirements for the model contained in the Information Model Requirements which form part of the Scope.

This practice note explains how the Information Protocol can be used with the NEC4 contracts. The Protocol can be incorporated into the NEC4 ECC by the selection of secondary Option X10 and the inclusion of the relevant parts of the Protocol as the Information Model Requirements in the scope. The model scope entry and guidance notes below are for use when incorporating the Protocol in an NEC4 ECC. They apply to other NEC contracts, with terminology amended to suit the contract.

Figure 46: NEC 4: Engineering and Construction Contract (UK Institution of Civil Engineers)

Resource

Practice-Note-No-6-ISO-BIM-Protocol-2.pdf (neccontract.com) - https://www.neccontract.com/getmedia/9693ee8c-454b-4132-86c3-a2d73f50302a/Practice-Note-No-6-ISO-BIM-Protocol-2.pdf

4.6.3 RIBA Plan of Work

The Royal Institute of British Architects (RIBA) Plan of Work (Figure 47) organises the process of briefing, designing, constructing and operating building projects into eight stages and explains the stage outcomes, core tasks and information exchanges required at each stage.

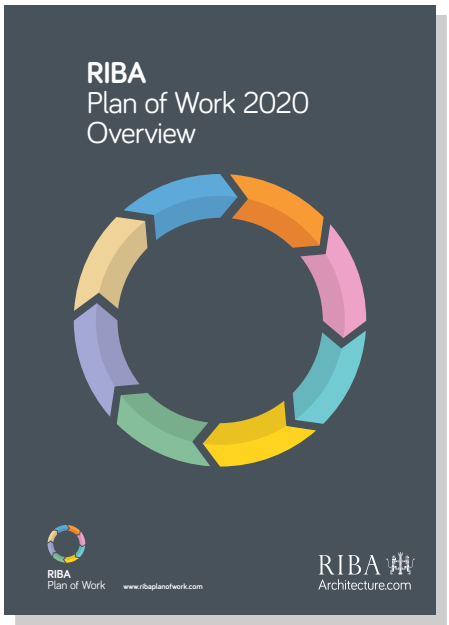


Figure 47: RIBA – Plan of Work 2020 (Royal Institute of British Architects)

Figure 48 (Overleaf): RIBA – Plan of Work 2020 (The Royal Institute of British Architects)

RIBA Plan of Work 2020

The RIBA Plan of Work organises the process of briefing, designing, delivering, maintaining, operating and using a building into eight stages. It is a framework for all disciplines on construction projects and should be used solely as guidance for the preparation of detailed professional services and building contracts.

Stage Boundaries:

Stages 0-4 will generally be undertaken one after the other.

Stages 4 and 5 will overlap in the **Project Programme** for most projects.

Stage 5 commences when the contractor takes possession of the site and finishes at **Practical Completion**.

Stage 6 starts with the handover of the building to the client immediately after **Practical Completion** and finishes at the end of the **Defects Liability Period**.

Stage 7 starts concurrently with Stage 6 and lasts for the life of the building.

Planning Note:

Planning Applications are generally submitted at the end of Stage 3 and should only be submitted earlier when the threshold of information required has been met. If a **Planning Application** is made during Stage 3, a mid-stage gateway should be determined and it should be clear to the project team which tasks and deliverables will be required. See *Overview* guidance.

Procurement:

The RIBA Plan of Work is procurement neutral – See *Overview* guidance for a detailed description of how each stage might be adjusted to accommodate the requirements of the **Procurement Strategy.**

ER Employer's Requirements

CP Contractor's Proposals

	0 Strategic Definition	1 Preparation and Briefing	2 Concept Design	3 Spatial Coordination	4 Technical Design	5 Manufacturing and Construction	6 Handover	7 Use
	◄ Projects span from Stage 1 to Stage 6; the outcome of Stage 0 may be the decision to initiate a project and Stage 7 covers the ongoing use of the building. ►							
Stage Outcome at the end of the stage	The best means of achieving the **Client Requirements** confirmed If the outcome determines that a building is the best means of achieving the **Client Requirements**, the client proceeds to Stage 1	**Project Brief** approved by the client and confirmed that it can be accommodated on the site	**Architectural Concept** approved by the client and aligned to the **Project Brief** The brief remains "live" during Stage 2 and is derogated in response to the **Architectural Concept**	Architectural and engineering information **Spatially Coordinated**	All design information required to manufacture and construct the project completed Stage 4 will overlap with Stage 5 on most projects	Manufacturing, construction and **Commissioning** completed There is no design work in Stage 5 other than responding to **Site Queries**	Building handed over, **Aftercare** initiated and **Building Contract** concluded	Building used, operated and maintained efficiently Stage 7 starts concurrently with Stage 6 and lasts for the life of the building
Core Tasks during the stage **Project Strategies** might include: – **Conservation** (if applicable) – **Cost** – **Fire Safety** – **Health and Safety** – **Inclusive Design** – **Planning** – **Plan for Use** – **Procurement** – **Sustainability** See *RIBA Plan of Work 2020 Overview* for detailed guidance on **Project Strategies**	Prepare **Client Requirements** Develop **Business Case** for feasible options including review of **Project Risks** and **Project Budget** Ratify option that best delivers **Client Requirements** Review **Feedback** from previous projects Undertake **Site Appraisals** No design team required for Stages 0 and 1. Client advisers may be appointed to the client team to provide strategic advice and design thinking before Stage 2 commences.	Prepare **Project Brief** including **Project Outcomes** and **Sustainability Outcomes**, **Quality Aspirations** and **Spatial Requirements** Undertake **Feasibility Studies** Agree **Project Budget** Source **Site Information** including **Site Surveys** Prepare **Project Programme** Prepare **Project Execution Plan**	Prepare **Architectural Concept** incorporating **Strategic Engineering** requirements and aligned to **Cost Plan**, **Project Strategies** and **Outline Specification** Agree **Project Brief Derogations** Undertake **Design Reviews** with client and **Project Stakeholders** Prepare stage **Design Programme**	Undertake **Design Studies**, **Engineering Analysis** and **Cost Exercises** to test **Architectural Concept** resulting in **Spatially Coordinated** design aligned to updated **Cost Plan**, **Project Strategies** and **Outline Specification** Initiate **Change Control Procedures** Prepare stage **Design Programme**	Develop architectural and engineering technical design Prepare and coordinate design team **Building Systems** information Prepare and integrate specialist subcontractor **Building Systems** information Prepare stage **Design Programme** Specialist subcontractor designs are prepared and reviewed during Stage 4	Finalise **Site Logistics** Manufacture **Building Systems** and construct building Monitor progress against **Construction Programme** Inspect **Construction Quality** Resolve **Site Queries** as required Undertake **Commissioning** of building Prepare **Building Manual** Building handover tasks bridge Stages 5 and 6 as set out in the **Plan for Use Strategy**	Hand over building in line with **Plan for Use Strategy** Undertake review of **Project Performance** Undertake seasonal **Commissioning** Rectify defects Complete initial **Aftercare** tasks including light touch **Post Occupancy Evaluation**	Implement **Facilities Management** and **Asset Management** Undertake **Post Occupancy Evaluation** of building performance in use Verify **Project Outcomes** including **Sustainability Outcomes** Adaptation of a building (at the end of its useful life) triggers a new Stage 0
Core Statutory Processes during the stage: Planning Building Regulations Health and Safety (CDM)	Strategic appraisal of **Planning** considerations	Source pre-application **Planning Advice** Initiate collation of health and safety **Pre-construction Information**	Obtain pre-application **Planning Advice** Agree route to **Building Regulations** compliance Option: submit outline **Planning Application**	Review design against **Building Regulations** Prepare and submit **Planning Application** See ***Planning Note*** for guidance on submitting a **Planning Application** earlier than at end of Stage 3	Submit **Building Regulations Application** Discharge pre-commencement **Planning Conditions** Prepare **Construction Phase Plan** Submit form F10 to HSE if applicable	Carry out **Construction Phase Plan** Comply with **Planning Conditions** related to construction	Comply with **Planning Conditions** as required	Comply with **Planning Conditions** as required
Procurement Route								
Traditional	Appoint client team	Appoint design team			Tender / Appoint contractor			Appoint **Facilities Management** and **Asset Management** teams, and strategic advisers as needed
Design & Build 1 Stage					ER / CP / Appoint contractor			
Design & Build 2 Stage			ER	Pre-contract services agreement	CP / Appoint contractor			
Management Contract Construction Management			Appoint contractor					
Contractor-led			ER	Preferred bidder	CP / Appoint contractor			
Information Exchanges at the end of the stage	**Client Requirements** **Business Case**	**Project Brief** **Feasibility Studies** **Site Information** **Project Budget** **Project Programme** **Procurement Strategy** **Responsibility Matrix** **Information Requirements**	**Project Brief Derogations** Signed off **Stage Report** **Project Strategies** **Outline Specification** **Cost Plan**	Signed off **Stage Report** **Project Strategies** Updated **Outline Specification** Updated **Cost Plan** **Planning Application**	**Manufacturing Information** **Construction Information** **Final Specifications** Residual **Project Strategies** **Building Regulations Application**	**Building Manual** including **Health and Safety File** and **Fire Safety Information** **Practical Completion** certificate including **Defects List** **Asset Information** If **Verified Construction Information** is required, verification tasks must be defined	**Feedback** on **Project Performance** **Final Certificate** **Feedback** from light touch **Post Occupancy Evaluation**	**Feedback** from **Post Occupancy Evaluation** Updated **Building Manual** including **Health and Safety File** and **Fire Safety Information** as necessary

RIBA Architecture.com

Core RIBA Plan of Work terms are defined in the *RIBA Plan of Work 2020 Overview* glossary and set in **Bold Type**.

Further guidance and detailed stage descriptions are included in the *RIBA Plan of Work 2020 Overview*.

Guidance in the RIBA Plan of Work is based on years of feedback, gathered by the RIBA, from the construction industry. It now includes an expanded glossary, comparison to international plan of work equivalents and guidance on the following core project strategies:

- Conservation Strategy
- Cost Strategy
- Fire Safety Strategy
- Health and Safety Strategy
- Inclusive Design Strategy
- Planning Strategy
- Plan for Use Strategy - see the RIBA Plan for Use Guide
- Procurement Strategy
- Sustainability Strategy - including detailed tasks aligned to the RIBA Sustainable Outcomes Guide

The plan of works is consistently being developed and information on the latest version should be obtained from the RIBA.

Resource

RIBA Plan of Work (architecture.com) - https://www.architecture.com/knowledge-and-resources/resources-landing-page/riba-plan-of-work

4.6.4 The Building Services Research and Information Association (BSRIA) Design Framework for Building Services 5th Edition (BG 6/2018)

The BG 6 Design Framework for Building Services continues to be the industry standard document for consultants and contractors to help them, and their clients, clarify and define the extent of their design activity and their design deliverables on any specific project.

The guide (Figure 49) contains design activity proformas/model definitions that are used to support contract documentation and encourage efficient collaborative working between building services and other designers such as architects, structural engineers and building supply chains.

Figure 49: BG6/2018 – A Design Framework for Building Services. (The Building Services Research & Information Association)

4.7 Guides

This section outlines a present state analysis of the existing standards and policy guidance relating to digital project delivery. The purpose of the document is to outline what relevant guides exist and to explain the use and purpose of such.

UK BIM Framework ISO 19650 Guidance Documents

https://ukbimframeworkguidance.notion.site/UK-BIM-Framework-Guidance-20a045d01cfb42fea2fef35a7b988dbc

Scottish Futures Trust

https://bimportal.scottishfuturestrust.org.uk/

Centre for Digital Built Britain

https://www.cdbb.cam.ac.uk/Resources

RIAI BIM Pack 2: BIM Update with ISO 19650 Series and BIM Guide for SMEs

https://www.riai.ie/whats-on/news/riai-bim-pack-2-update-iso-19650-series-and-bim-guide-for-smes

RIAI Design for Manufacture and Assembly (DfMA) Guidance

https://www.riai.ie/whats-on/news/riai-design-for-manufacture-and-assembly-dfma-guidance

CIF MODERN METHODS OF CONSTRUCTION

https://cif.ie/wp-content/uploads/2022/01/1271-CIF-Modern-Methods-of-Construction-Report-v4.pdf

4.8 The Common Data Environment

This section provides an overview of the Common Data Environment (CDE) and the ISO 19650 information management process. It aims to condense the key concepts, principles and processes and explain them in simple terms.

What is a Common Data Environment?

A Common Data Environment (CDE) is a single platform or group of integrated IT solutions which provide a centralised repository for the collection, management and dissemination of project and asset information through a managed process.

Why is it important?

To establish the principles of the Common Data Environment (CDE), it has been recognised that digital transmission processes must follow robust procedures, with the advantage that technology can bring to assist in ensuring compliance. The key ingredients are:

- File identification (file properties, naming, title blocks, etc.)
- Suitability of use defined by the author (status code applied)
- Ownership and defined responsibilities (check, review and approve)
- Documentation of all transactions (drawing/model issue sheets)
- Document versioning (revision and version)
- Purpose of issue
- Authorisation and acceptance process applied (authorisation code)
- Record copy of what has been issued (history)

What also needs to be established is who is the intended target for the information delivery. A great deal of information produced on a project is not intended for the client and the requirement for information to be always reviewed and accepted by the client could impact the client capability to review and accept the information that is relevant to them. This is the purpose of the separation of the client's shared environment.

Sharing and Publishing Information

What was also identified with the move to a digital approach was that now there were two forms of information release and these are:

- Sharing of information for collaborative working (non-contractual)
- Publishing of information to meet contractual delivery

What is also recognised is that the delivery format requirements were also different between sharing and publishing information. Shared information was generally required for referencing by other task teams and was often required in proprietary file formats for CAD and BIM software. Published information was predominantly contractual deliverables where the equivalent of electronic paper was required, such as PDF or DWF (immutable) formats. This often had an impact on the software solutions chosen for the CDE provider depending on the technology requirements as the capability for reviewing CAD and BIM files was often limited.

Finding Current Information

The Common Data Environment provides access to the current information. But what should also be recognised is that it is possible to have multiple revisions or versions of a file at differing gateways within the CDE. The published and shared environments may include different revisions of the same information file which could both be current and available in both environments released to meet different needs. What is important is the ability to use the revision, status code and authorisation code along with timestamps to establish which of the current versions is appropriate for the task to be undertaken.

Data Environments and Common Data Environments

A data environment is a concept which considers the repositories, processes and technology requirements of a project to facilitate an information model. The purpose of a data environment is to ensure efficient information management, that information can be trusted and that the information meets the intended use criteria. The predominant use of a data environment is to manage the current Project Information Model (PIM), ensure that robust archiving is undertaken and facilitate the application of the information methods and procedures.

Figure 50: Common Data Environment (CDE) illustration of a central location (Scottish Future Trust)

A Common Data Environment (CDE) is a process supported by a properly configured solution that extends the data environment principles. It should facilitate the use of common file formats and interoperable exchanges, common standards, common methods and common procedures in standardised environments, providing a way of working that reduces waste and ensures robust information management.

The Common Data Environment (CDE) was developed as a project specific solution to meet the common criteria for delivering the Project Information Model (PIM). Where the operations stage either takes on board that common criteria or has contributed to the creation of that common criteria, then the Common Data Environment can continue into the asset management phase. This can then be termed as an Asset Information Model Common Data Environment (AIM CDE).

The AIM CDE takes on board a different use and process than a PIM CDE as its primary role is only to manage the built asset information. Multiple PIM Data Environments over time may contribute to the content of an AIM Data Environment which is intended to support a life cycle data approach.

Why do we need a Common Data Environment (CDE)?

The fundamental requirement for producing information through a collaborative activity is to share information early and to trust the information that is being shared as well as the originator of that information. What is needed is a disciplined auditable process that is transparent and controllable delivering qualified coordinated information, reducing cost and improving timely delivery.

The method for managing a project through a Common Data Environment (CDE) is applicable to all sizes of projects and it prepares teams to be able to work collaboratively. As a standard that is adopted by all, it provides a common way of working that will help to remove the problem of having to constantly retrain on each project, reconfigure resources and tools, plus configuring templates and documentation. If the clients accept the industry agreed procedures for the CDE and make them contractual, then the problems identified disappear.

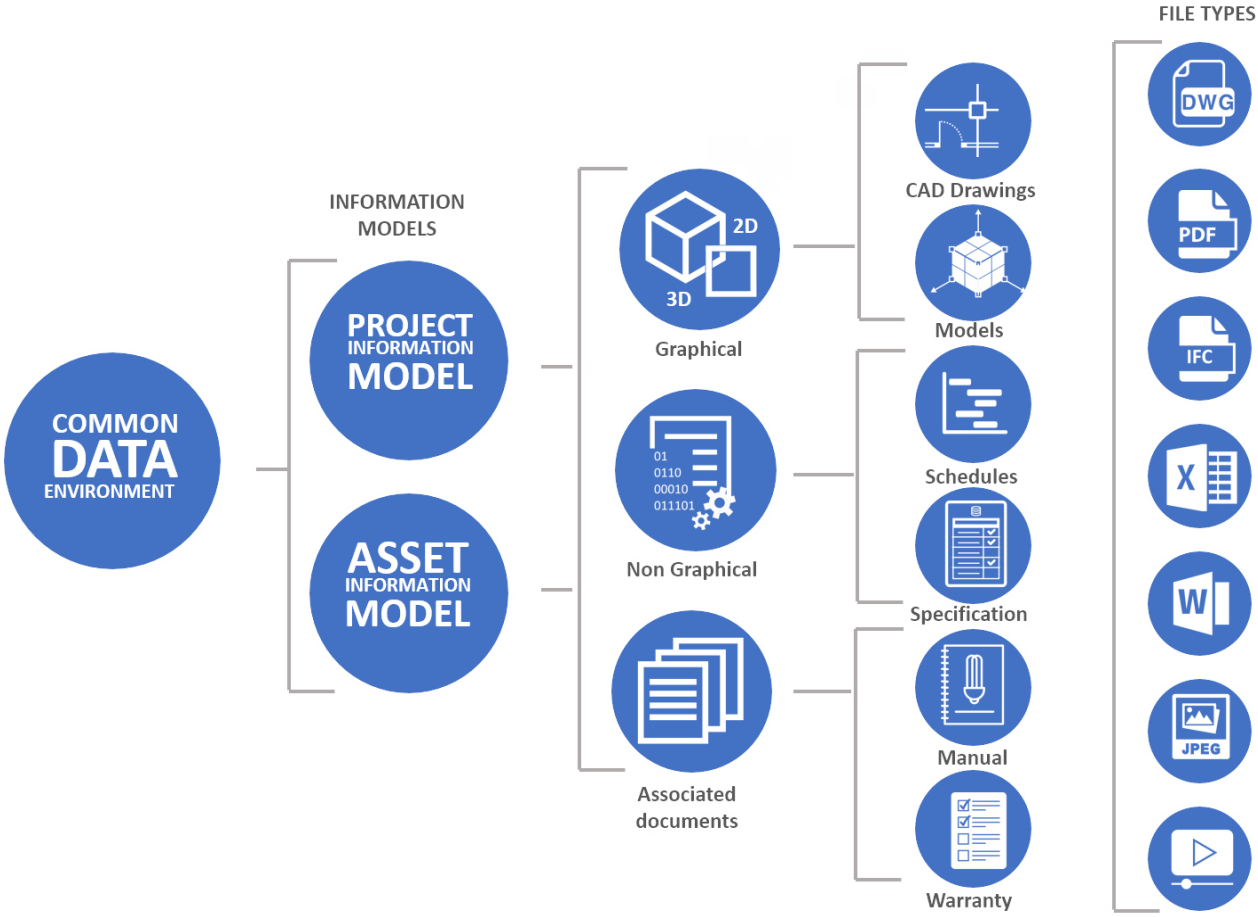


Figure 51: Common data environment types and content summary (Scottish Future Trust)

The CDE is a means of allowing information to be shared efficiently and accurately between all members of the project team – including information that is 2D or 3D graphical models, non-graphical information or documentation. The CDE enables multi-disciplinary design teams to collaborate in a managed environment, where the build-up and development of information follow the design, manufacturing and construction sequence.

The CDE process also ensures that information is only generated once and is then reused as necessary by all members of the supply chain. It also ensures that the information is updated continuously and enriched for final delivery as part of the asset life cycle.

CDEs can be implemented in many ways and the different approaches for the use of a CDE are dependent on the client, procurement and other external factors. The main approach types can be defined as, but are not limited to:

- A single project at a specific stage
- A single project at multiple stages
- A single project full asset life cycle
- A programme of projects (design or construction or asset)
- An enterprise solution

Each of these approaches impacts on the common file formats and interoperable exchanges, common standards, common methods and common procedures in standardised functional sections that need to be adopted. The expansion of the CDE to take on board design requirements, construction requirements and asset management requirements increases the need for functionality from each aspect which is likely to impact delivery formats, project information standards and methods and procedures. A proposed schedule of operating systems and software, including builds and versions, hardware and IT infrastructure to be adopted by the approach should be considered when choosing the CDE solution and documented within the requirements. These will all contribute to the specification of the CDE solution.

The CDE is there to improve collaboration and the recognised advantages of adopting such a CDE include:

- Ownership of information remains with the originator, although it is shared and reused
- Shared information using reference files reduces the time and cost of producing coordinated information
- If the procedures for sharing information are consistently used by the design teams, spatial co-ordination is a by-product of using the CDE processes and will deliver production information that is right first time
- Any number of documents can be generated from different combinations of model files
- Information can subsequently be used once, authorised for multiple purposes, including construction planning, estimating, cost planning, facilities management and other downstream activities
- Spatial coordination should be achieved because of the detailed design production process. This provides a clash avoidance process instead of the additional cost and time of services associated with clash detection
- Data within a CDE is finely granulated and structured to enable its re-use. It provides the ability to produce traditional drawings or documents as views of multi-authored data within the CDE. It also gives greater control over the revisions and versions of that data

The structured use of a CDE requires strict discipline by all members of a design team in terms of adherence to agreed approaches and procedures, compared with a more traditional approach. The benefits listed above can only be realised with a commitment to manage the CDE in a disciplined and consistent manner throughout a project. Information managed in the CDE should be viewable by all identified parties, depending upon security needs with information formats and delivery formats being agreed to support this.

The CDE and Gateways

A high-level functional view of the CDE shown in Figure 52 is adapted from ISO 19650. This provides an overview of the functional sections and gateways but provides little information regarding the processes involved.

The CDE contains four identified functional sections under the headings of:

- Work in Progress (WIP)
- Shared
- Published
- Archive

The shared environment may also be split into Shared (Delivery Team) and Client Shared (Appointing Party) depending on the procurement, contractual and appointment processes. The CDE also contains the predefined sign off gateways of:

- Check, Review, Approve by Task Team;
- Review, Authorise by Lead Consultant; and
- Review, Accept by Clients (Implied).

These gateways may also be expanded to take on board the requirements of a Client Shared functional section if required and the Gateway for Review, Accept by the Clients.

What are gateways?

A gateway is a term to ensure that information has a sign off procedure prior to the information passing from one functional section to another.

The CDE workflow is a gated process where transition from one state to another is subject to approval and authorisation at each information container level.

Access is controlled at each state by the CDE solution, ensuring the right people have the right access to the right information at the right time. This safeguards against the misuse of information, such as draft information being used for coordination or decision making.

Figure 52: Common Data Environment (CDE) Concept from ISO 19650-1 (Paul Oakley)

Work in Progress (WIP)

Why is Work in Progress (WIP) required?

To ensure compliance with existing copyright, intellectual property, insurance, appointment and contract requirements clear ownership of information and associated responsibilities needs to be established.

Therefore, organisations responsible for the authoring or delivery of information need to clearly establish that they are the only party that has authored, deleted, edited or amended information that could impact on the project and that they have undertaken the appropriate quality management procedures in relation to that information delivery.

The safest method for doing this is to carry out the information authoring and editing roles within an environment where other parties do not have access to this information. Therefore, only information released by the authoring parties in accordance with the quality management procedures will be shared or published for use by the client or other delivery team members.

The Work in Progress (WIP) Environment

Each task team should establish their own WIP solution which is traditionally held on a company server or cloud storage solution as part of their Local Area Network (LAN) or Wider Area Network (WAN). Where members of different task teams belonging to the same company are working on the same project, each must have their own separate identified work in progress (WIP) location. Task teams must only link to other task team information that has been shared or published and ideally directly from the Common Data Environment repository. The WIP Environment is the only place where files shall be created, authored or modified.

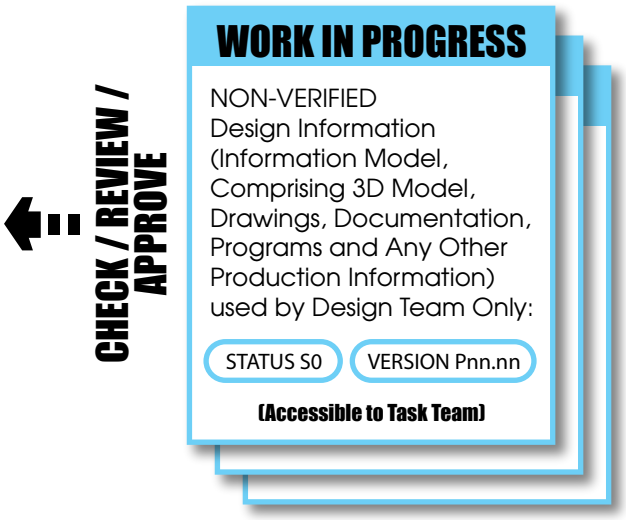


Figure 53: Work in Progress (WIP) and WIP Gateway. (Paul Oakley)

WIP Gateway

Once information is identified as suitable for an information release, the authors shall initiate the upload of the information to the Common Data Environment in the agreed delivery file format and using the processes as defined within the project information production method and procedures. The author shall then undertake the gateway information check process as identified within the common workflows, a review shall then be undertaken by the BIM Coordinator and finally the information shall be approved by the Task Team Lead. Each of these steps shall be undertaken by an identified role that has the appropriate competence and authority required as documented within the BEP.

Figure 54: WIP Gateway. (Paul Oakley)

Review

The Review step is used throughout the CDE process to ensure that deliverables meet the information requirements, comply with the project information standards and are coordinated with the referenced information. There are multiple reviews identified in the information management process including:

- Task Team Review, Internal (Approve)
- Information Model Review (Delivery Team Approve)
- Review Information (Authorised)
- Client Review (Accept)

Whilst most authors will carry out their coordination check within their authoring software, this is unlikely to be the solution used for project or client review. It is therefore recommended that the identified check, review and approval process from task teams use the same solutions, method and procedure for the reviews at task team, project and client level.

WIP Check, Review and Approve

The common workflow requirements for the WIP Gateway environment include a Check, Review and Approve process prior to the release of information. The requirements of each of these elements of the task team process are as follows:

Checklist 3 Check to be carried out by the information authors

- ☐ File identification check
- ☐ Coordination check with latest shared resources
- ☐ Check against standards, methods and procedures
- ☐ Spatial coordination check
- ☐ Checking of file links for naming, status, revisions, versions and authorisation
- ☐ Nomenclature check
- ☐ Revision/version check
- ☐ Approval or rejection decision
- ☐ Application of authoring stamp including author name, timestamp (digital signature)
- ☐ Release for review

Checklist 4 Review to be carried out by the BIM coordinator

- ☐ Confirmation of author's check stamp
- ☐ Visual review/comment and mark-up
- ☐ Level of Information Need (LOIN) review
- ☐ LOIN-Geometrical verification
- ☐ LOIN-Information verification
- ☐ LOIN-DOC verification
- ☐ Project Information standard review (nomenclature, objects, layers etc.)
- ☐ Spatial coordination
- ☐ Approval or rejection decision
- ☐ Application of status code/suitability
- ☐ Application of rejection stamp including reviewer name, timestamp (digital signature) or application of review stamp including reviewer name, timestamp (digital signature)
- ☐ Release for approval

Checklist 5 Approve to be carried out by the task team lead

- ☐ Confirmation of review stamp
- ☐ Technical approval of content
- ☐ Visual review/comment and mark-up
- ☐ Approval or rejection notice
- ☐ Application of rejection stamp including approver name, timestamp (digital signature) or application of approve stamp including approver name, timestamp (digital signature)
- ☐ Approval of status code/suitability
- ☐ Release for sharing or publishing

The check, review and approve process ensure that information has undertaken a quality control approval by the authoring task team who have also identified what information, version and status they have coordinated their information against.

When information is uploaded to the CDE, the task team will also identify whether the information is required to be authorised. The status code of the information provided may indicate whether subsequent information authorisation is required and if this is a project review and authorise process or client review and accept process. See 4.4.2 Status Code (Suitability) for how this is applied.

Shared

Why do we share information?

Architects, engineers and designers were often reticent in using other teams released information quoting reasons such as:

- » I do not want to use other teams' information because it is inevitably incorrect
- » I do not want to share information because others may use it for a purpose not intended
- » I do not know if this is the latest information

Purpose of the shared area

To resolve these issues the concept of the shared environment was established to allow the use of current information that had been released for an identified purpose with a known level of risk associated with it.

One of the main benefits of the shared environment is that it reduces the time and therefore cost in producing coordinated information and facilitates a clash avoidance process. If the procedures for sharing information are consistently used by the design teams, spatial co-ordination is a by-product and will deliver production information that is right first time.

Throughout the project life cycle, there are multiple requirements for sharing information with other team members and clients to either show progress, gather feedback or collaborate on options as well as obtaining initial approvals etc. There are proven benefits to sharing information early; it does not have to be complete, but it shall be correct and this provides a disciplined auditable process. It speeds up the iterative and collaborative process.

The shared environment includes information released suitable for different needs which is identified by the status code. Information within the shared area may be both non-authorised and authorised information which will be indicated by the authorisation code. Associated with the suitability of the information and the authorisation are different levels of risk. The delivery team members should establish amongst themselves and document what are the appropriate codes for information use at project stages.

For contractual published documentation, the models used should be at least 'suitable for coordination' and have been authorised as meeting this requirement. The inclusion of the referenced model files, their version status and authorisation facilitate the understanding that the documentation is based upon authorised models and identifies the level of risk for those using the information.

Shared Unauthorised Information

In order that information is made available, when uploaded to the Common Data Environment solution, there needs to be established workflows and permissions which ensure that only those with the appropriate rights may undertake the required actions whether this is carrying out a review or having access to sync / link information to their task team's WIP requirements.

To facilitate this, the CDE solution shared environment has some specific common requirements, which include:

- Security based file access and permission control for access, viewing, linking, syncing and download, etc.
- Common file format viewing, mark-up and commenting
- Customised meta data fields definitions

The shared section of the CDE will hold the shared resources provided and verified by the client for use on the project as well as additional resources provided by the lead consultant. The predominant information will be produced by each task team which has undertaken the check, review and approve process prior to uploading to the shared section and identified with a status code and revision.

Figure 55: Shared Environment. (Paul Oakley)

Depending upon the security status of a project the ability to view and access information may be restricted to specific identified roles. The project federation strategy may also indicate solutions relating to information access and the Shared section must be able to facilitate these requirements.

Project Federation

Project federation is how a project is broken down. To effectively manage the Information Model, it needs to be divided into its component parts, i.e. mechanical, electrical, architectural etc., for example. This is defined as an information breakdown structure which is a pre-determined method to identify manageable units of information to be used across a project or asset life cycle.

Authorisation Gateway

The Authorisation Gateway is conceptually shown between the Shared and Published Sections of the CDE, approved or authorised non-contractual model files will also have a state of Shared, but may require either a lead approved or lead authorised code applied to them. The purpose of this approval or authorisation of the models is to facilitate the delivery of coordinated documentation for publishing from the shared model files. The documentation produced will then go through the Authorisation Gateway prior to acceptance into the published section. The documentation published shall indicate the models that they have been produced from status, revision and authorisation.

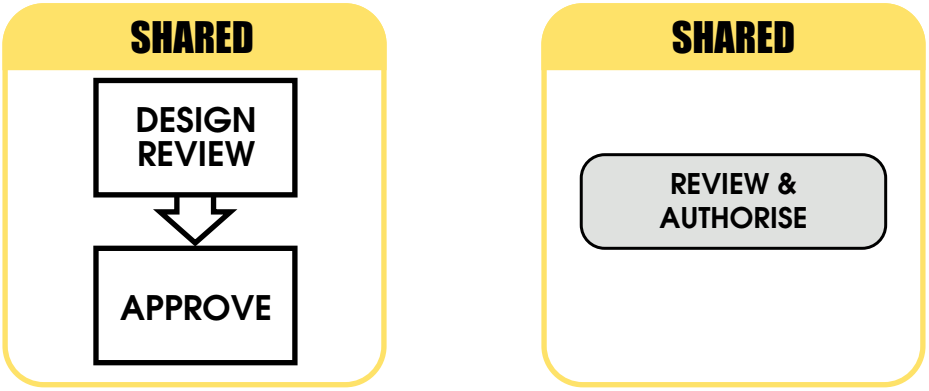


Figure 56: Shared Approved and Authorised Information. (Paul Oakley)

An example of this is Information within the Shared Area that has undertaken a design review and may also include an authorisation code to identify that this has been reviewed by the design team and approved by the lead consultant. This provides a further level of trust in the use of the models for coordination or document delivery. If CDE solutions can be configured, these processes can be automated.

To facilitate the Authorisation Gateway, the following functionality should be provided:

- Security based file access and permission control for review and authorisation
- Common file viewing, mark-up and commenting
- Application of electronic signatures
- Custom metadata field definitions
- File nomenclature verification
- Level of Information Need verification
- File status, revision, version
- Review and authorisation metadata or stamps

The Common Workflow requirements for the Authorisation Gateway environment is:

- Review of file links for naming, revisions, versions, authorisation and acceptance status
- Review against EIRs, standards, methods and procedures
- Coordination review with latest shared resources
- Authorisation or rejection decision
- Application of rejection stamp including lead consultant, authoriser name, timestamp (digital signature) or application of authorisation stamp including lead consultant, authoriser's name, timestamp (digital signature)
- Release for publish

Client's Shared Environment

Purpose of the Client's Shared Environment.

Depending upon the type of procurement contract, the client may be included or excluded from the shared environment. Where procurement adopts a design/build type approach, there is often a need to deal with design engineering, optioneering, etc. in an environment which excludes the client. It is also important to understand that a lot of the design and construction information produced is not intended for client review and acceptance. A typical example would be temporary works etc.

For the inclusion of a Common Data Environment, the clients' shared environment is created using security rights to the solution and the repository used for the shared environment.

Figure 57: Client's Shared/Review and Accept. (Paul Oakley)

The client's shared section is also used for direct communication between the lead consultant and the clients relating to contractual discussion, decision making or optioneering.

Note

Not all information released to the client's shared section is also included in the shared section.

Client's shared unauthorised information.

Clients may also require access to unauthorised information for other purposes than review and acceptance. A typical requirement may be for checking on progress linked to payments. Another use may be for client's review and comment whilst under progression or review of design options. To facilitate these capabilities, the CDE should provide:

- Security based file access and permission control for file access, viewing, linking, download, etc.
- Common file format viewing, mark-up and commenting
- Custom metadata field definitions
- Client's Shared Authorisation Gateway

The predominant use of the client's shared area is to identify information models accepted by the clients prior to the publishing of contractual documentation based upon these models. Prior to the acceptance of information, it should pass through the client's authorisation gateway. The requirements of this gateway are:

- CDE gateway requirements
- Security based file access and permission control for client review and authorisation
- Common tile viewing, mark-up and commenting
- Application of electronic signatures
- Custom metadata field definitions
- File nomenclature
- File status, revision, version authorisation and acceptance

The common workflow requirements for the client authorisation gateway environment are:

- Review of file links for naming, revisions, versions, authorisation and acceptance status
- Review against EIR, standards, methods and procedures
- Coordination review with latest shared resources
- Authorisation or rejection decision
- Application of rejection stamp including client, authoriser name, timestamp (digital signature) or application of acceptance stamp including client, acceptors name, timestamp (digital signature)
- Release for client shared.

Depending upon the contractual requirements, the client's may be required to either review and accept or reject information within a specified timeframe. Where this is the case, if the client fails to undertake the review of the information, the default authorisation is accepted after the timeframe expires. It is recommended that the CDE solution implements an acceptance stamp that differentiates between default accepted information and that reviewed and accepted.

Published

Why do we publish information?

Published information represents identified contractual deliverables to be produced at specific milestones or information against specific deliverables. Published information shall be coordinated and validated as outputs that have been reviewed and authorised by the lead appointed party, where client acceptance is not required or shall also be reviewed and accepted by the client as appropriate.

Workflow

- Workflow requirements for published area
- Custom metadata field definitions
- Ownership, roles and responsibilities linked to functions
- Gateway acceptance for contractual

Technology

Technical requirements for a published area should include:

- Process management and audit trail
- File visualisation tools for agreed project formats
- Custom metadata field definitions

Archive

The purpose of the Archive Functional Section is to capture all information releases for the purpose of professional indemnity, contractual and legal requirements (e.g., Health and Safety) that provide an auditable trail of all transactions. The concept of the Archive is that it includes the historical record of all transactions. The technical implementation of how this is achieved will be different depending upon the technology solutions and their dependencies on either a location or state-based approach. Through the Archive folder, it must be possible to retrieve the information released throughout the project life cycle whenever required, although it may not be stored in an archive location (folder).

The Archive history record for each file transaction should also include data for each of the following:

- Timestamp for every action
- Revision and version (where appropriate)
- Suitability and status code
- Checked, reviewed and approved information
- Review and authorisation (where appropriate)
- Review and acceptance (where appropriate)

The archive environment must also respect the project data access requirements, security-based approach, used throughout the other functional sections. See Figure 58 State based approach to CDE Sharing as defined in ISO 19650. As an example, a client should not have access to delivery team information not shared with the client through the archive environment. Further complexity arises where the client is also the system administrator of the technical solution used and administers those security rights.

The CDE Functional Requirements

CDE Functional Sections as Locations or States

The purpose of each functional section of the CDE is to remove any ambiguity regarding the state of information and what it may be used for. Key to this is the role-based security which controls information visibility and access rights. This enforces the workflows and therefore the associated trust within the information provided.

Different solutions deal with these technology challenges in different ways. The two main methods of identifying different environments are:

- Location based folders
- Role based security states using meta data (attributes)

The use of folders as containers to control access security was the traditional approach that represents the windows desktop workflow and traditional security-based requirements. This methodology is used to move files from folder to folder as the files progresses through the workflow. Each folder had the appropriate security controlling who had access, tasks they were entitled to undertake, etc. The solution on completion of a specific task would trigger the moving of the file to the next folder, changing the security, access and visibility.

Whilst the technology needs for this approach are less onerous, this often requires a manual process of moving files where the second revision of a file (Drawing 1 Rev P2), when released requires the first revision (Drawing 1 Rev P1) to be moved to the archive section otherwise it will be overwritten. See Figure 57. This often also required the creation of date related folders as duplicates of files were not allowed. The current version of the file will be stored in the shared section whilst historic versions will need to be moved to the archive. This often leads to duplication of files in multiple locations with a possibility of these becoming out of sync.

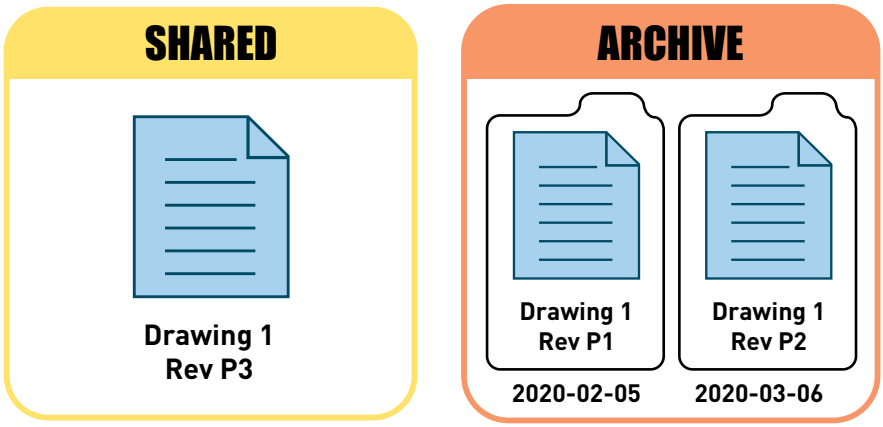


Figure 58: Folder approach to CDE Shared and Archive (Paul Oakley)

An alternative approach is to use a state approach where specific meta data (attributes), instead of locations, control how security is applied, and these identify the workflow position, controlling the access and visibility etc. This solution relies on the complexity of the software/technology utilised to resolve these security, access and visibility rights, with the removal of the files from the supporting technology is sometimes problematic. The advantage here is that all files, current and historic, exist in their original locations and therefore there is security regarding the file in addition to the reduction of duplication.

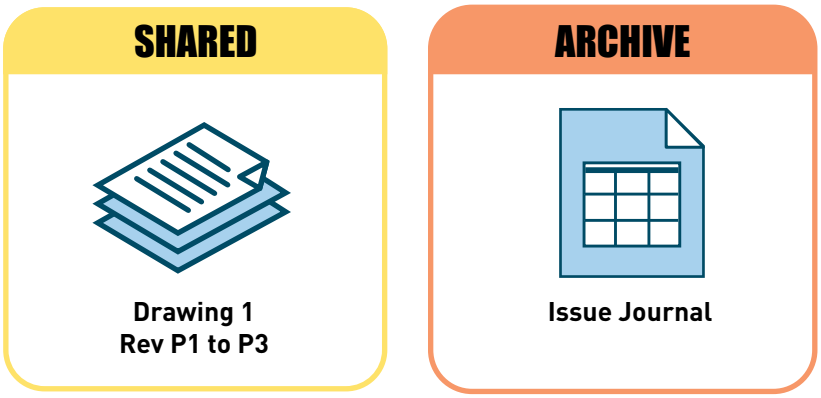


Figure 59: State based approach to CDE Shared and Archive as defined in ISO 19650. (Paul Oakley)

In the state approach, as shown in Figure 59, a new revision of the Drawing 1 file is shared into the same location as the previous revisions of Drawing 1. All reference links are automatically controlled and the archive journal is updated with the authorisations and approvals that have been undertaken. The shared section includes the current version of Drawing 1 (P3) as well as all historical versions (P1 and P2).

Figure 59 demonstrates all revisions of the drawings all three revs in the folder controlled by the platform.

The use of folders allows the CDE approach to be carried out as a manual process, but the workflows are limited to the competence and diligence of the individuals undertaking the information management functions. The state approach should ensure that information is not duplicated and allows all information to exist in a single repository.

Depending upon the approach used, the solutions would need to meet each of the specific functional requirements common to the different stage workflows.

The functional requirements of a CDE include:

1. Provide a user-customisable security access right control and management system
2. Provide a user-customisable sectional structure
3. Provide a workflow for managing information process
4. Support uploading, downloading, BIM models and documentation to facilitate retrieval of documents attributes to support the CDE processes, including as a minimum the document identifier (number), title, revision, version and status codes (suitability)
5. Support review, comment and mark-up procedures for BIM Models in the agreed proprietary and open file delivery formats and versions as documented in the Project Execution Plan
6. Support review, comment and mark-up procedures for documentation formats and versions as documented in the Project Execution Plan
7. Provide file revision/version control
8. Provide file status codes to support the suitability of use
9. Provide file authorisation codes to support workflows for
10. Check, review and approve process
11. Review and approval process
12. Review and authorisation process

13. Review and accept process
14. Allow access from portable devices and web applications
15. Contained encryption for data security
16. Provide sufficient capacity to store all files throughout the project stages and operate properly as requested by the clients
17. Installed with anti-virus software and maintained with updated security patches by the operating system or environment that the CDE resides on
18. Provide dashboards for presenting the BIM progress information to the different levels of users
19. Provide a user-customisable workflow for document submission and approval
20. Provide an issue tracking system, including the issue registration, logging, update and email notification to the selected user account
21. Provide off-site backup of all project BIM models, documents and data
22. Provide a feature of project archive that all project files and information shall be archived in clients' preferred media and transferred to the clients upon the completion of the design stage and construction stage respectively or as and when requested by the clients during the contract period
23. Allow electronic signature (e-signature)
24. Provide a full audit trail of the information stored in the CDE

Additional functional requests may include:

- Retrieving of the attributes and information from the BIM models in an open format (not limited to .IFC) on the CDE
- Provide a feature of comparing BIM models from different versions/revisions and automated identification of differences
- Provide a feature of linkage between different BIM models, 2D drawings and project documents within the CDE
- Support the use and import of information delivery manuals (IDMs) for identifying workflow requirements

4.9 Where to find the standards, policies and guides

Unlike the previous Publicly Available Specifications BIM Level 2 documents previously made freely available by the UK Government, the ISO 19650 series of standards must be paid for and are available through NSAI using the following link:

ISO 19650 Standards –

- I.S. EN ISO 19650-1:2018

https://shop.standards.ie/en-ie/standards/i-s-en-iso-19650-1-2018-1140740_saig_nsai_nsai_2701833/

- I.S. EN ISO 19650-2:2018

https://shop.standards.ie/en-ie/standards/i-s-en-iso-19650-2-2018-1140728_saig_nsai_nsai_2701796/

- I.S. EN ISO 19650-3:2020

https://shop.standards.ie/en-ie/standards/i-s-en-iso-19650-3-2020-1197556_saig_nsai_nsai_2883764/

- I.S. EN ISO 19650-4:2022

https://shop.standards.ie/en-ie/standards/i-s-en-iso-19650-4-2022-1307963_saig_nsai_nsai_3188959/

- I.S. EN ISO 19650-5:2020

https://shop.standards.ie/en-ie/standards/i-s-en-iso-19650-5-2020-1195111_saig_nsai_nsai_2872192/

- NA:2021 TO I.S. EN ISO 19650-2:2018

https://shop.standards.ie/en-ie/standards/na-2021-to-i-s-en-iso-19650-2-2018-1206951_saig_nsai_nsai_2919352/

- UK BIM Framework ISO 19650 Standard Documents

https://www.ukbimframework.org/standards/

Section 5:

Bidding For Digital Project Delivery

Section 5 Bidding For Digital Project Delivery

5.1 Introduction

Building Information Modelling (BIM) has become an industry standard on all types of construction projects. As more construction companies reap the benefits of BIM, more projects have added a modelling component. With the ISO 19650 series there has also been recognition of BIM as information management, which has led to further processes and data to support a life cycle approach. Designers and constructors are also starting to get to grips with the delivery of digital requirements as well as the construction sector.

This section is for Owner Managers, Senior Managers, Commercial Managers, Quantity Surveyors, Project Managers, Information Managers and BIM Managers in main and sub-contracting companies.

This section covers:

- Information management roles & responsibilities
- Procurement stages
- Information management requirements
- Legal documents
- Project verification requirements
- Asset information requirements
- Information management delivery planning
- Digital delivery fee checklist

When a tender package that has a digital project delivery requirement is received for pricing, it is essential that all areas are covered. To ensure that the project has been priced correctly, you must understand what you are going to receive, but most importantly what you must deliver at the end of the project to the client.

There are many factors that will alter the information within the pricing of a project such as:

- Procurement routes -design and build, traditional, 2-stage, novated designers etc.
- Programme - as the programme develops the timing of the release of information may need to be altered
- Specialist designers - what specialists are needed and when information is required.

The use of these factors is for those who undertake pre-qualification activities or provide pre-qualification services which will help to streamline tendering processes by:

- Reducing the risk of pricing without all relevant information
- Facilitating the identification of suitable projects for main/specialist sub-contractors
- Increasing consistency between various prequalification databases
- Clarifying the distinction between criteria at the prequalification and contract award stages of the procurement process.

5.2 Information management

The process of information management as identified in ISO 19650 requires the client to define their information requirements prior to the appointment of a delivery team for a design, construction or operations project.

The concept is that these Information requirements are developed and modified throughout the life cycle of the project with each project stage being used to enrich the requirements for the next project or project stage.

As well as the requirements being developed by the client, shared resources should also be identified. These can include existing information about a site or built asset and can also include models and drawings of the asset or previous project stages undertaken. Therefore, the BIM deliverables produced at the design stage are provided as shared resources within the construction stage from which the contractor can develop their construction models. The ownership of the models should be identified clearly, as passing the ownership of the design models can vary according to the procurement route.

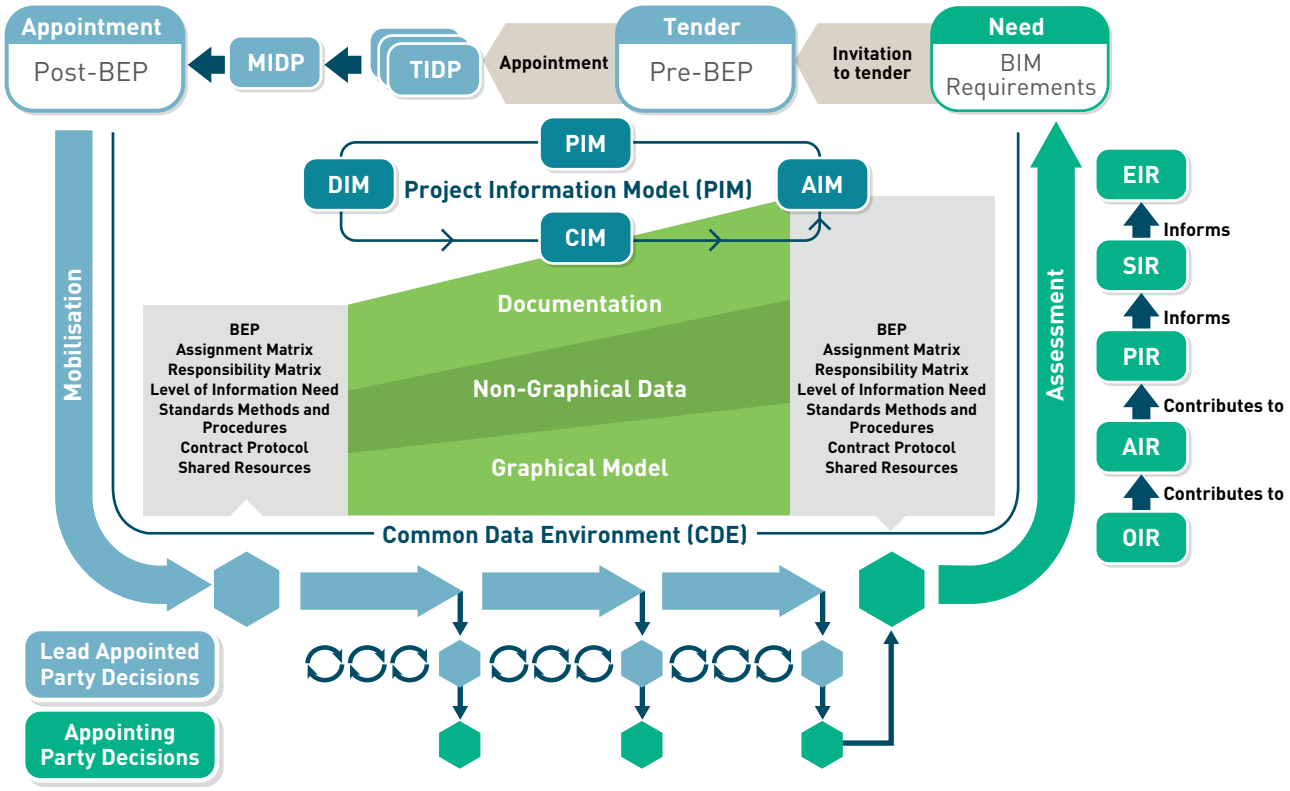


Figure 60: Project Information Cycle (DCT)

- OIR – Organisational Information Requirements
- AIR – Asset Information Requirements
- PIR – Project Information Requirements
- SIR – Security Information Requirements
- EIR – Exchange Information Requirement
- BEP – BIM Execution Plan
- MIDP – Master Information Delivery Plan
- TIDP – Task Information Delivery Plan

- PIM – Project Information Model
- DIM – Design Information Model
- CIM – Construction Information Model
- AIM – Asset Information Model

Figure 60 above consolidates the information management flow in the project cycle from PAS 1192 and ISO 19650.

The different colours used in the figure represent the different parties' input, with green elements depicting the Appointing Party/Client, blue the Lead Appointed Party and purple the Appointed Parties (Task Teams).

Figure 60 shows that the Appointing Party may start with input accumulated from a previous stage BIM Implementation Plan and project deliverables (point A), or with existing asset data (Point B), or the Assessment process may start without any input from these (Point C).

The BIM Implementation Plans are likely to contribute to the development of the BIM Requirements taking on board the understanding developed through the creating of the graphical models, non-graphical information, and documentation.

Why is this important?

Our aim is to create a clear line in the sand between the design and construction stage. Once the design team have confirmed they have completed their scope of work on the model if should be presented to contractors for auditing and acceptance. Figure 60 shows this.

A model handover document could be created as a record of the contractor noting issues with the model prior to acceptance, this can then be presented back to the design team for updating, if required. If nothing is noted, then it would be taken they are satisfied with the maturity and development of the model to take ownership and further develop it.

Likewise, the construction models will be filtered to identify the asset information model which will be provided as part of the shared resources to facilitate the operations stage.

Therefore, if the project is procured as a Design/Build/Operate project the BIM requirements need to ensure that they are delivered in a manner to facilitate the different needs over the project lifecycle. In general practice, each activity of design, construction and operation are dealt with as separate projects. The completed BIM deliverables and BIM implementation plan from one project stage will be used to develop the BIM requirements for the next project stage.

It should also be noted that the requirements of ISO 19650 should be applied in a way that is proportionate and appropriate to the scale and complexity of the asset or project.

Standardisation of many of the requirements, templates and tools can facilitate the ease of use and aid in making the approach appropriate whilst achieving the recognised benefits.

5.2.1 ISO 19650 Activities

The ISO 19650 series identifies eight specific activities to be undertaken in relation to a project. No information is provided with the ISO 19650 series regarding procurement solutions, the definition of a project or stages within a project, which are left to industry to interpret. Figure 61, however, provides an overview of how they correlate. The ISO 19650 activities identified and order are defined as:

1. Assessment and need
2. Invitation to tender
3. Tender response
4. Appointment
5. Mobilisation
6. Collaborative production of information
7. Information model delivery
8. Project close-out

Note

That the above are ISO 19650 activities and are not work stages from a plan of work such as the RIBA Plan of Work 2020. Therefore, all eight ISO 19650 activities could apply to the concept, design or construction stage of a project. For further details about ISO standards revert to Section 4 – Standards, Policies & Guides.

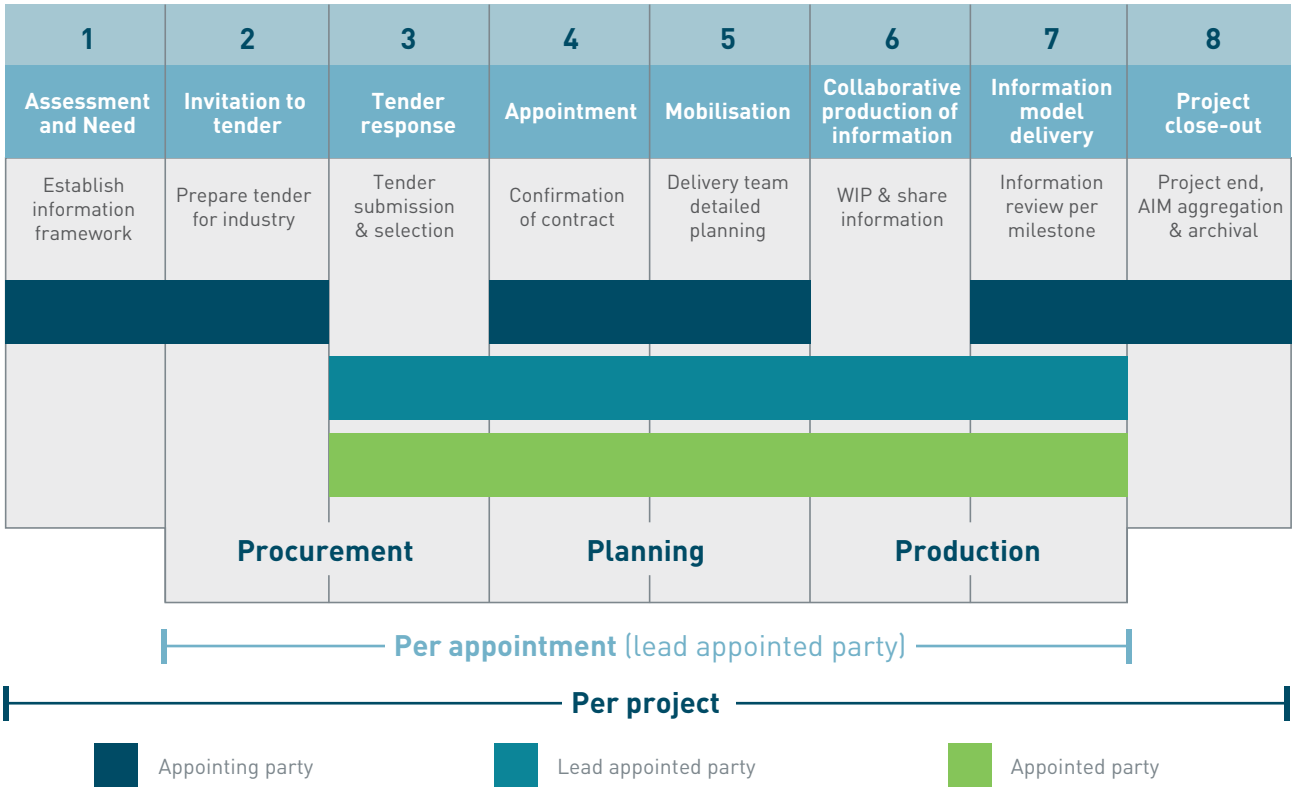


Figure 61: Overview of the structured 8-stage information management process set out by ISO 19650. (12d Synergy)

5.2.2 ISO 19650 Parties

The ISO 19650 identifies three parties involved in information management which are:

1. Appointing party (client or employer)
2. Lead appointed party (lead designer or main contractor)
3. Appointed parties (task teams).

The terms in brackets in the list above are the equivalent terms used in the superseded UK standards.

The ISO 19650 series also identifies two collections of the above parties identified as:

- The Project Team (Appointing party, lead appointed party and appointed parties)
- The Delivery Team (Lead appointed party and appointed parties)

Figure 62: ISO 19650 Party Appointment Relationship (DCT)

Figure 62 shows the relationships between the different parties.

Whilst the ISO 19650 series allows for multiple lead appointed parties and delivery teams, it does not clarify whether these are concurrent or sequential. It is recognised that concurrent lead appointed parties fail to achieve the benefits of collaboration and a single lead appointed party should be identified for each project at a designated stage. It is worth noting the project stages are likely to overlap, particularly design and construction. However, the lead appointed party for design will remain in that function for the design stage, although they may have a subservient function at the construction stage.

Note

Throughout this documentation, the traditional industry terms of client will be used to reflect the ISO 19650 term appointing party. The terms lead designer/main contractor will be used to reflect ISO 19650 lead appointed parties and task teams will be used to identify ISO 19650 appointed parties.

Document	Responsibility	Document Set	Required
Asset Information Requirements (AIR)	Client	Information delivery requirements	Per organisation
Organisational Information Requirement	Client	Information delivery requirements	Per organisation
Exchange Information Requirements (EIR)	Client	Information delivery requirements	Per project
Project information requirements	Client	Information delivery requirements	Per project
Delivery team BEP	Lead appointed/ Main contractor	BIM Execution Planning	Per project
Detailed Responsibility Matrix	Lead appointed/ Main contractor	BIM Execution Planning	Per project

Information delivery strategy	Lead appointed/ Main contractor	BIM Execution Planning	Per project
Schedule of software, hardware and IT infrastructure	Lead appointed/ Main contractor	BIM Execution Planning	Per project
Main contractor's information requirements	Lead appointed/ Main contractor	BIM Execution Planning	Per appointment
Information protocol/ standards	Client/Main contractor	BIM Execution Planning	Per appointment
Task Information Delivery Plan (TIDP)	Task teams/ Sub-contractors	BIM Execution Planning	Per task team
Master Information Delivery Plan (MIDP)	Lead appointed/ Main contractor	BIM Execution Planning	Per project
Lessons learned	Client	Asset Management Strategy	Per project

Table 23: Schedule of required resources and content under ISO 19650 (Paul Oakley)

Table 23 identifies resources and content to be produced by each party as well as the documentation set, they belong to.

No internationally agreed terms are defined for the collection of the appointing party's/client's requirements or the collection of the responses from the delivery team.

Associated with each party is the delivery of a series of resources or content, these are generally provided as documentation of the requirements or responsibilities. Within this documentation the client resources or content are grouped under the title of BIM requirements. Figure 63 shows these relationships.

For the delivery team (lead designer/lead contractor and task teams) this is identified as the BIM Project Implementation Plan (BIM IP). The BIM Project Implementation Plan (BIM IP) is initially identified as the draft BIM IP prior to appointment and then expands into the project BIM IP post appointment.

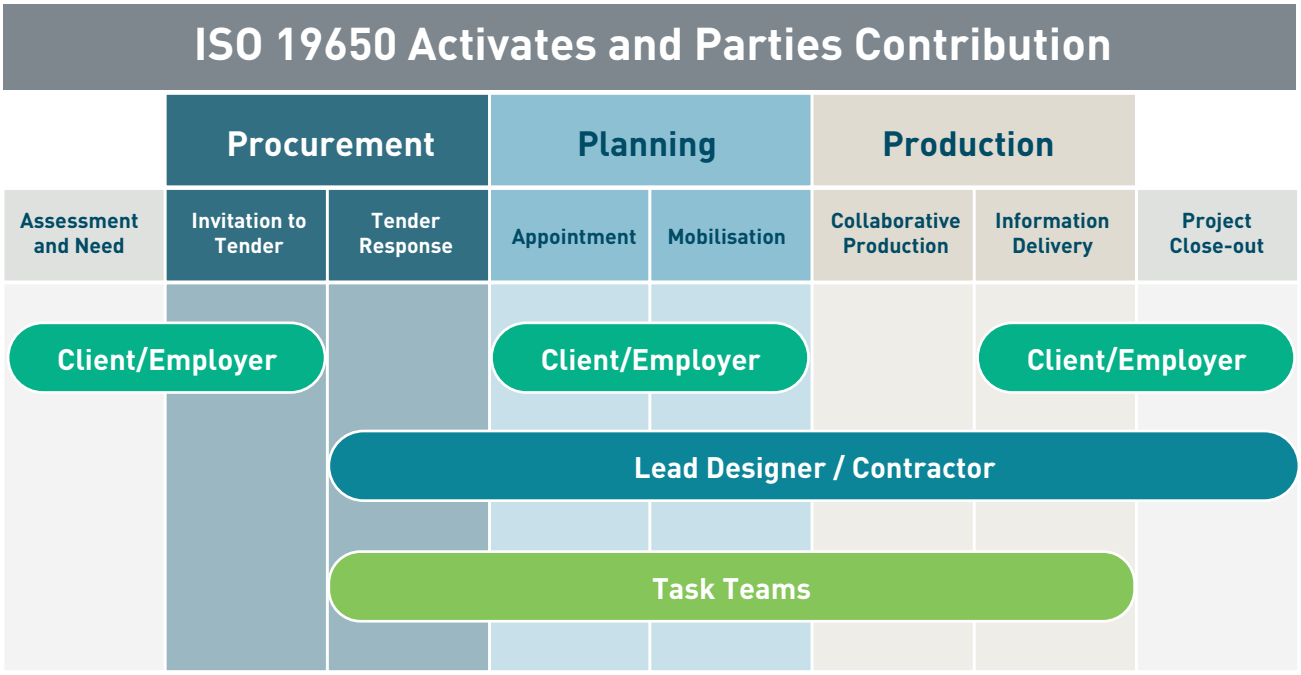


Figure 63: ISO 19650 activities against the parties' contribution (Paul Oakley)

Parties

Effective information management requires clear definitions of ownership with identified responsibility and accountability. Information management functions provide an abstract hypothesis which translates to the need to identify the appropriate parties and responsibilities associated with each of the following project functions:

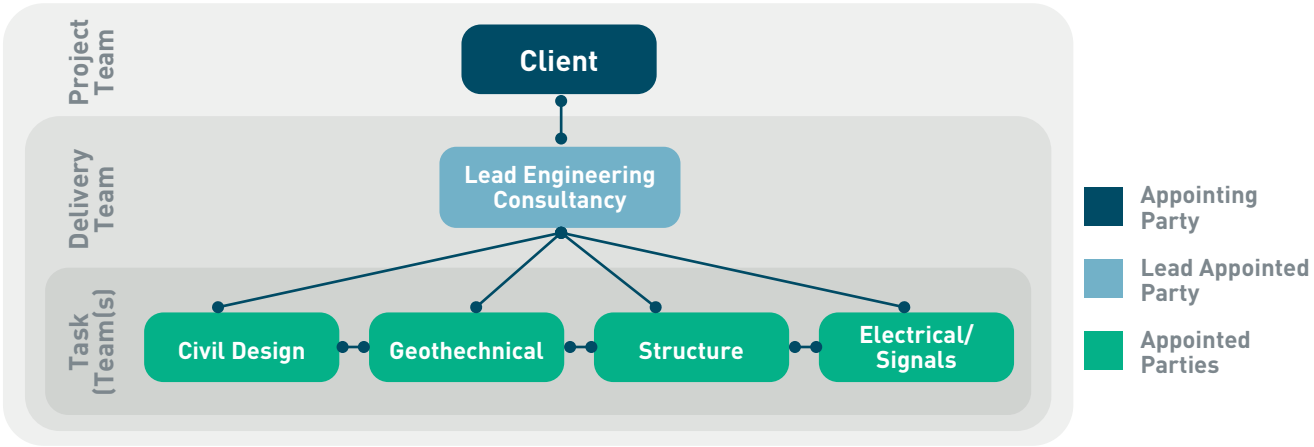


Figure 64: ISO 19650 Teams Hierarchy Diagram: Project, Delivery and Task Teams. (https://www.12dsynergy.com/)

Listed below are the owners and their identified responsibilities.

- Clients/appointing party
  - Clients' delivery management function
  - Clients' information management function
  - Asset information management function
  - Security information management functions.
- Lead designer/main contractor/appointed party
  - Project delivery management
  - Project information management.
- Sub-contractors/task team management functions
  - Task management
  - Task information management
  - Interface management
  - Information authoring.

Prior to the appointment of any parties, it is important to establish the capability and capacity of those undertaking these information management functions. Résumés, individual certification and professional memberships are acceptable methods of reviewing capability.

It should be noted that depending upon the size and complexity of a project functions can be handled differently. It should also be understood that information management responsibilities are likely to be only a part of the functional responsibilities that an individual will undertake on a project. For example, an individual may undertake the responsibilities of project information management and task team information management whilst their predominant role is the project architect, also undertaking lead designer responsibilities.

It is important to note that on a small simple project, it is likely that a single individual may take on multiple functions. On large complex projects, the opposite may apply where multiple individuals may be required to undertake a single information management function. Whichever is the case, these should be documented within the information management assignment matrix.

A clear definition of the tasks and those responsible should be identified in the information management assignment matrix provided by the client and this should then be expanded by the delivery team and managed through the project. Section 4 provides further information on information management functions.

5.3 Procurement

Digital project delivery can provide benefits to design, construction and the operations of a built asset, but digital project delivery is a multifaceted solution with both benefits and cost. The "starting with the end in mind" approach requires the client to identify what information they require throughout the life cycle, no matter what the procurement process. The information requirements produced by the client should clearly identify the deliverables based upon the defined BIM uses.

The design and construction teams can also benefit from adopting specific BIM uses to meet their identified needs. The delivery team BIM uses may aid in mitigating risk, reducing cost and provide certainty about the outcome. The lead design or main contractor therefore needs to ensure that their supply chain has the capability and capacity to deliver, as well as the putting the contractual framework in place to make it happen.

5.3.1 Build

With a traditional construction contract, where the design team is employed directly by the client/the appointing party, the contractors uses of digital project delivery will be limited to the information made available through the client, unless they remodel everything themselves. This provides an inherent risk of the design and construction models becoming out of sync.

Here the contractor must clearly identify the proposed uses and information requirements for the delivery team. There is specific risk as the information provided is unlikely to be modelled in a manner to meet the contractor's requirements.

5.3.2 Design Build

The advantage of a design build approach is that the main contractor controls the design teams and can dictate the proposed approach and methodology to be used to meet their identified BIM use requirements.

The main contractor can identify proposed approaches such as quantity extract, construction sequencing and health and safety criteria and dictate through their own requirements how they want the information broken down and delivered to meet their needs.

5.3.3 Design, Build, Operate

Where a design, build, operate contract is identified there is far more onus on the supplier to consider not just the capital construction costs but the lifecycle costs for the identified operation period. Clear definition of the asset information requirements, working with a facilities management provider should establish resourcing, maintenance and replacement costs for the operational period of the contract to inform specification and product selection choices. Also, the identified BIM uses through the maintenance and operation stages will inform the level of information needed. The benefits of identifying, delivering and structuring of the information will be to the benefit of the supplier and therefore detailed organisation information requirements will also aid informing the requirements.

5.4 Agreement on project procedures and standards

ISO 19650 series sets out the need for the definition of project information standards and project information production methods and procedures. It is expected that the client will provide these initially as part of their requirements. These may be left at high level, indicating specific ISO standards to comply with leaving the main contractor to identify how this shall be delivered in detail. Alternatively, they may take on board detailed requirements from an earlier phase or from a client's estate or management requirements. Whichever approach is taken these need to be clearly documented and approved by the client early in the process.

5.5 Identify BIM uses or purposes

As part of the requirements to identify the level of information needed, the purposes or uses that the information will be used for should be identified by the client or their agents.

Initially the client will identify their purposes and then the delivery team, designers and contractors will also identify their purposes. The proposed use will depend on multiple factors including procurement, sector and associated risk. With each proposed use are both associated costs and benefits, which should be reviewed subjectively to identify the appropriate way forward. All information should be clearly detailed in the Asset Information Requirements (AIR) and Exchange Information Requirements (EIR).

5.6 Agreement on process & standards to be used

Ensure each member of staff working on the bid is competent and has a good working knowledge of digital project delivery documents before proceeding. The development of plain language questions/Project Information Requirements (PIR) can help inform what processes and standards are needed.

Typical questions may include:

- Have the information requirements been provided within the tender documents?
- Have the standards to be used been identified? (e.g. ISO 19650 Series, BS 8541 series, COBie, LOD to US(BIMForum/ AIA) etc.)
- Has a classification system been identified? (e.g. Uniclass 2015)
- Are additional classification systems required?
- Has the proposed nomenclature been identified and documented?
- Have Asset Information Requirements (AIR) been identified?
- Have Asset Information Model (AIM) requirements been identified? (ISO 19650 -3)
- Have non-graphical data requirements been identified? (ISO 19650-4 & COBie)
- Have data security requirements been identified? (ISO 19650 -5)
- Have all verification requirements been detailed? (As built model and information)
- Have handover procedure and post occupancy evaluations requirements been identified? ("soft landings" – BS 8536)

These questions will then inform what is required within the project information standards and project information production methods and procedures.

5.7 Approach to clients wanting BIM without the requisite requirements

Many clients are asking for BIM but do not realise the initial requirements are their responsibility to produce. Where BIM is a requirement some basic questions to the client can aid in identifying their needs:

- What do you want the model for?
- Do you have an Exchange Information Requirements (EIR) or other information management requirements documentation available?
- Have you identified your BIM objectives and associated BIM uses?

- Do you have a clients' Information Manager?
- Does the Information Manager have the authority to sign off the deliverables on behalf of the client and what is the required process?

It should also be recognised that the delivery of requirements can vary dramatically depending upon the detail required. Ensure that as-built deliverables are agreed and clearly documented including the proposed delivery process. The cost between delivering an as-built model verified in the field by redline PDFs and a point cloud scan are vastly different, but both may meet the requirement, depending upon how specific it is.

5.8 Information requirements

ISO 19650 identifies the need for the client to set out their requirements as part of their assessment and need activity. The delivery team act as the information provider to meet the use purposes identified by the client, as can be seen in figure 65 below.

Figure 65: Client purpose and requirements prescribe the information deliverables. (Paul Oakley)

5.8.1 Information requirements provided by the client

As part of their assessment and need activity it is necessary for the client to produce information requirements which set out the information management delivery needs against the identified client uses. Figure 66 provides a list of the information requirements identified in ISO 19650:

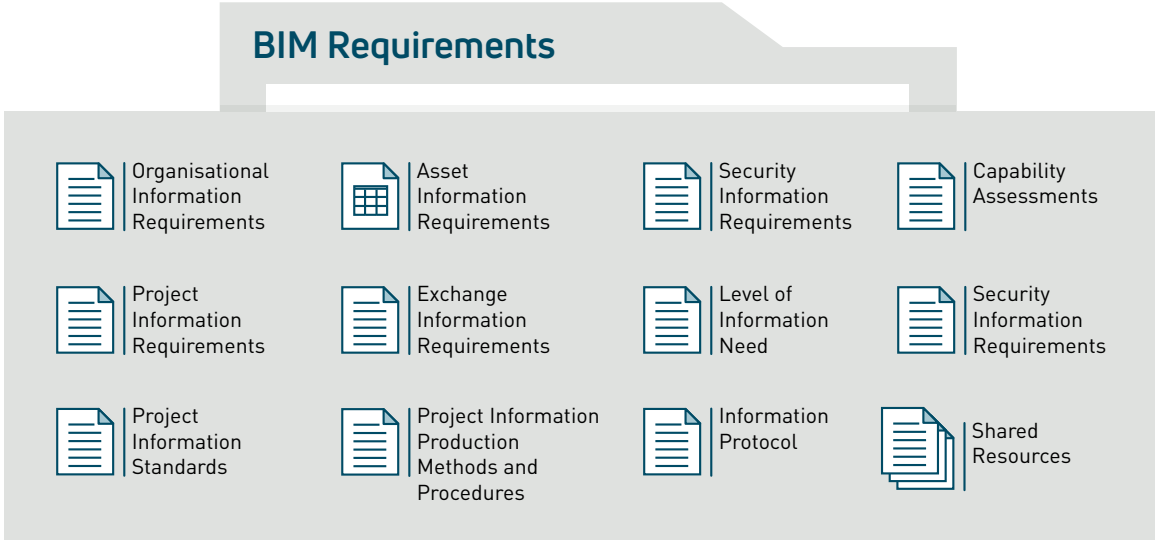


Figure 66: Information requirements required provided by the client (Paul Oakley)

- Organisational Information Requirements (OIR)
- Asset Information Requirements (AIR)
- Project Information Requirements (PIR)
- Security Information Requirements (SIR)
- Exchange Information Requirements (EIR)
- Level of Information Need
  - Level of Geometrical (LOG)
  - Level of Alphanumerical Information (LOI)
  - Level of Documentation (DOC)
- Project Information Standards
- Project Information Production Methods and Procedures
- Information Protocol
- Shared resources

The information requirements are important documents and should be reviewed by a competent staff member. They should clearly set out the requirement of the client and define what models need to be produced at each project stage.

Design Information Model (DIM)

The Design Information Model (DIM) is the end of design stage model and consists of the Project Information Model (PIM) information identified as suitable to support the strategic and day to day management processes of the design activities. The Design Information Model (DIM) requirements shall be identified by the client and may also include design requirements such as room data sheets, drawings generated from DIM and the quantities scheduled from DIM.

The client shall also establish the information delivery requirements, formats and versions necessary for acceptance of the DIM. But this is not always the case, so cannot be taken as a given.

The client decides whether the DIM is to be included as part of the tender documentation, is contractually binding or only serves as reference material for the main contractor to develop their models from.

Construction Information Model (CIM)

The information model that is developed through the construction period should be identified as the construction model and its contents should be wholly under the control of the main contractor and their supply chain.

Where a design model has been handed over by the client this may be used to form the basis for the construction model. Care needs to be taken where ongoing changes are being undertaken to the design model and appropriate robust change management procedures need to be in place to ensure that the design and construction models stay in sync where changes have been approved and verified.

Asset Information Model (AIM)

The Asset Information Model (AIM) is the operational stage model and consists of the Project Information Model (PIM) information identified as suitable to support the strategic and day to day management processes of the built asset. The AIM requirements shall be identified by the client and may also include design requirements such as room data sheets and equipment register as well as records of installation and maintenance regimes, jobs, ownership details and other details regarded as necessary. The client shall also establish the information delivery requirements, formats and versions necessary for acceptance of the AIM.

The following are examples of information requirements that should be considered for the AIM through the design and construction phases of an asset:

- Data security requirements
- Unique asset identifiers
- Unique type identifier
- Geospatial referencing of asset locations
- Spatial identification requirements of levels, areas, spaces or rooms
- Asset details including ownership, manufacturer and supplier
- Any product data sheets, warranty, guarantee information and periods including start, installation or commissioning dates
- Access statements
- Planned maintenance requirements, schedules, tasks, spares and jobs
- Health and safety considerations, including hazardous contents or waste
- Emergency planning considerations
- End of life and disposal consideration

These elements should be identified within the client's information requirements as well as identifying data requirements, nomenclature and delivery formats of these elements to support the client's application.

Depending upon the size and complexity of the client organisation they may already have in place existing enterprise solutions relating to functionality such as:

- Computer Aided Facilities Management (CAFM)
- Electronic Document Management Systems (EDMS)
- Integrated Workplace Management Systems (IWMS)
- Property management systems
- Enterprise Resource Management (ERP)
- Accounting and financial systems
- Purchasing and supplier relationships

Again, the requirements for integration of information into these systems from the design and constructions team's information need to be clearly identified within the BIM requirements highlighting the need for "starting with the end in mind."

ISO 19650-3 explains the procedures for how this then expands into the operational stage of the asset.

5.8.2 Delivery team information requirements

Whilst the client will have identified uses for the information to be delivered, the main contractor may also have specific information delivery requirements against identified BIM modelling and information uses which may extend above and beyond those required by the client.

A typical construction requirement for digital project delivery may be the use of the BIM model for construction sequencing. For this to be undertaken the models produced by designers and specialist sub-contractors would need to be broken down to facilitate this use. For example, a wall may be traditionally modelled by designers from Ground floor level to roof. To incorporate sequencing the wall would need to be broken down into different lifts. Non design items such as scaffolding and temporary works may also need to be considered and modelled. The cost and benefit of this and to what level it should be provided needs to be considered.

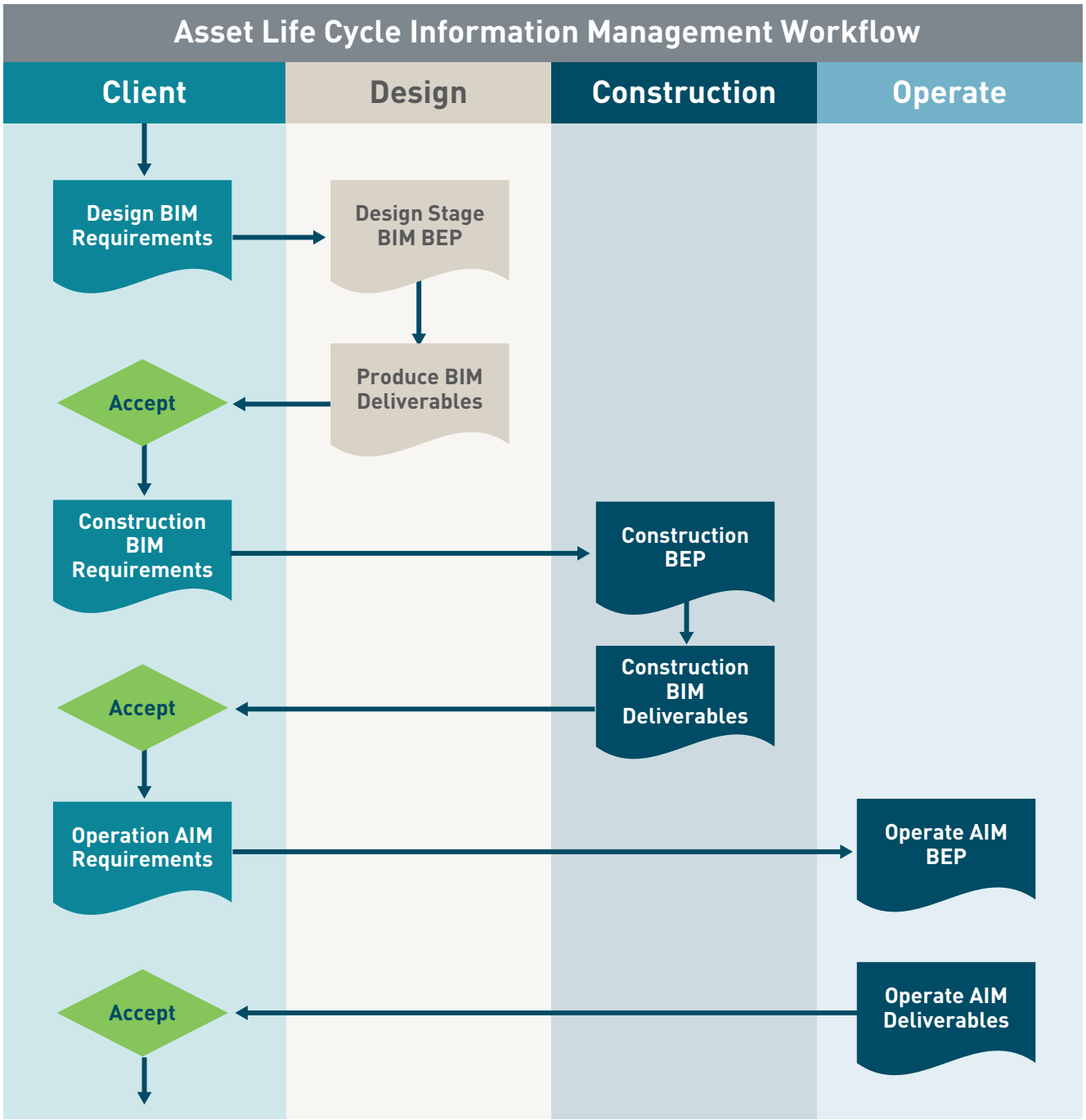


Figure 67: Life cycle BIM model requirements and BIM Execution Planning based upon client's assessment and need (Paul Oakley)

Figure 67 details the different BIM requirements depending on the stage of the project. The process would detail the standard design and build process with the design team producing their BIM Execution Plans (BEP) meeting their BIM deliverables and issuing back to the client for approval.

Once approved it is then issued to those responsible for the construction and operating stages of a project, who in turn produce the construction BEP and then issue their BIM outputs to then be accepted by the client.

5.9 Information management responsibilities

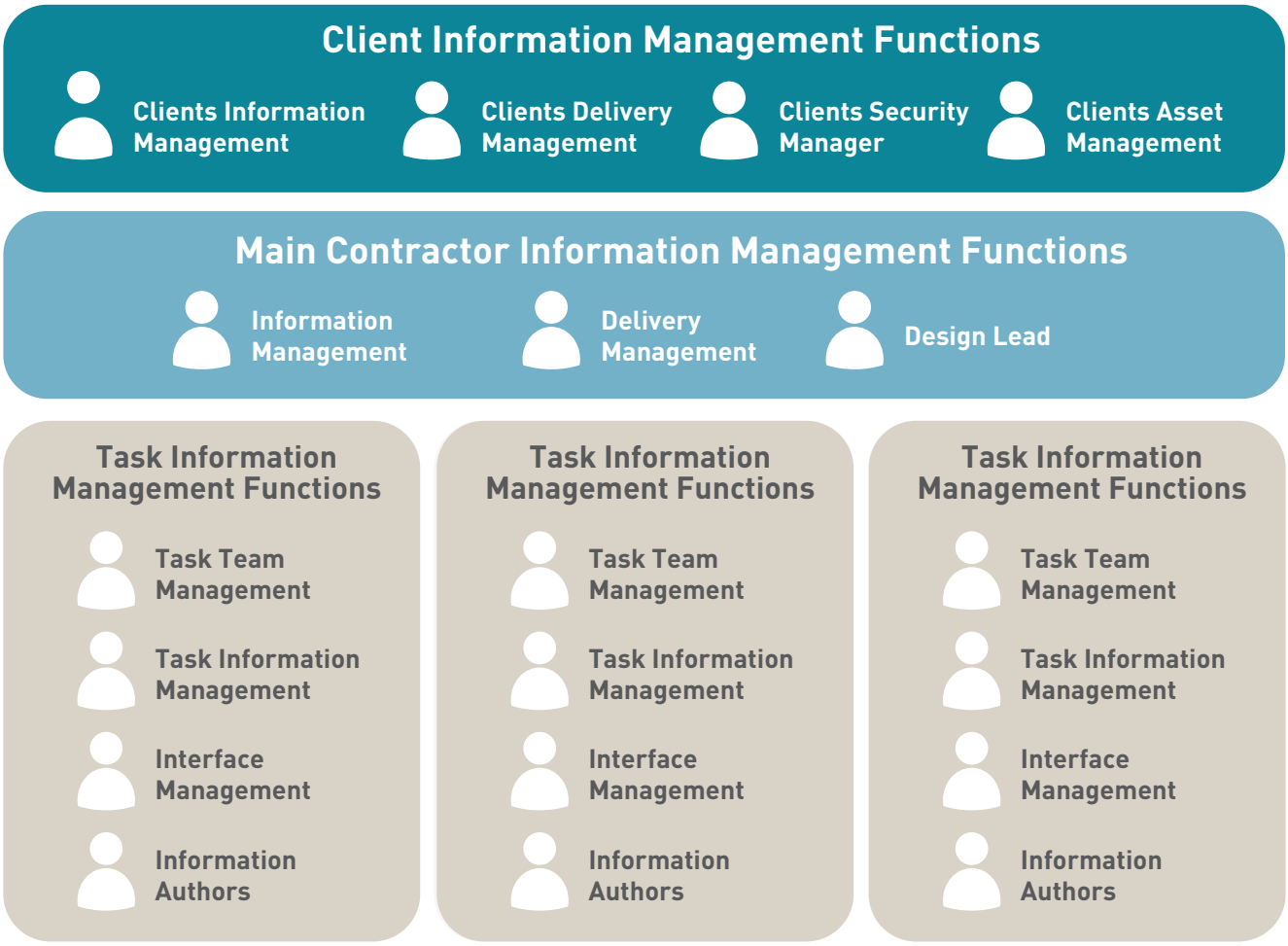


Figure 68: Information Management Functions (Paul Oakley)

A key aspect of the ISO 19650 approach to information management is the assignment of information management function to the identified parties. These can be seen in Figure 68. The initial burden lies with the client who is required to assign their information management functions to ensure the BIM requirements are defined and delivered. The client information management functions at the project level will break down into specific sets of functional criteria and these are:

- Client delivery management function
- Client information management function
- Asset information management function
- Security information management function.

The project information management functions for a construction project should be assigned to the main contractor as the lead appointed party. The main contractor is expected to provide the following functions:

- Project information delivery functions
- Project information management functions.

The project information delivery function deals with the project management tasks of ensuring that the right teams produce the correct information at the right time to meet the design and/or construction management requirements. It is important to recognise that information management is not a silo and needs to take on board design management and/or construction management needs depending upon the project stages being undertaken.

Each task team will also need to identify their own information management functions. Using the responsibilities initially identified within ISO 19650 documents the identified task information management responsibilities are:

- Task team management
- Task information management
- Interface management
- Information authors

5.9.1 Client's information management

It is important to understand that the initial burden of information management lies with the client to facilitate the process by defining their needs as the BIM requirements. It is recognised that few clients have the appropriate knowledge or skill base to undertake this work. The client is legally obliged to have an Information Manager on every project in accordance with the Information Protocol. This position was created for several reasons, i.e. to interrogate the model, protect the client, provide guidance, but additionally to ensure that the client understands what they are to receive at the end of a project. This ensures that non-realistic expectations are not put on the project stakeholders.

Where the client will outsource this work, they should identify a clear scope of services for the function to be undertaken.

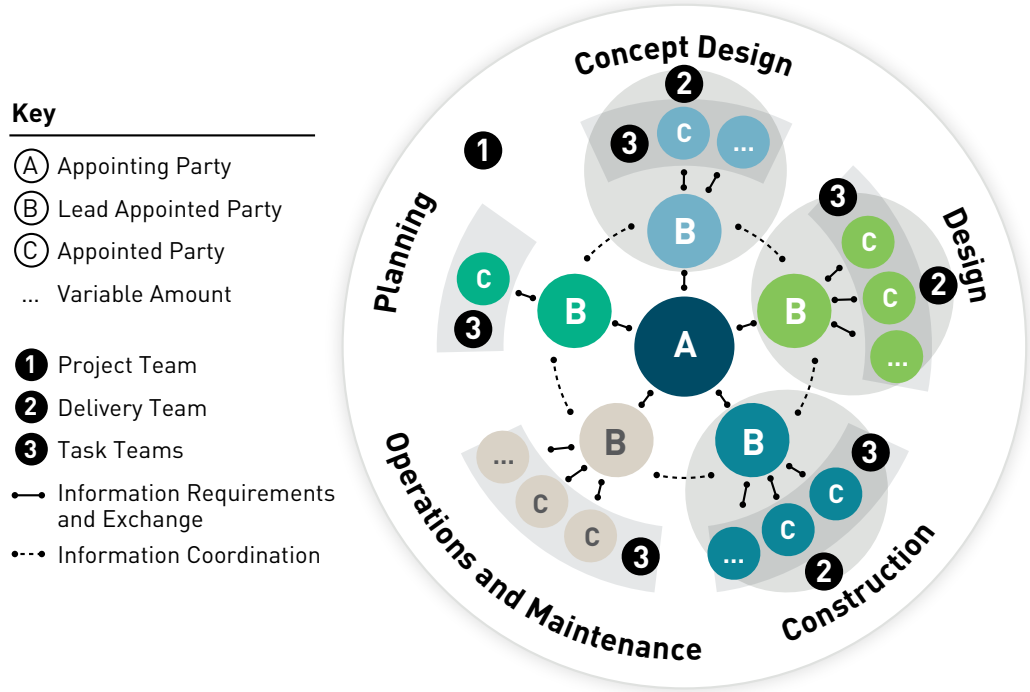


Figure 69: Relationship of parties (Paul Oakley)

Client's delivery management responsibilities

The client has a requirement to define their information management requirements, ensure that information is delivered in accordance with the information management requirements and meet project milestones. There is also the obligation to accept information on behalf of the client. These are identified as tasks to be assigned to a delivery management function.

This delivery management function is likely to be undertaken by those with job titles such as project manager, client's agent, client's BIM manager or their representative.

Client's information management responsibilities

The client also needs to identify an information management function which will ensure that the information requirements are clearly defined and documented, plus supporting the delivery function. They will also ensure access to the client's shared resources, information formats and that deliverables are all identified. Ongoing reviews are also part of the tasks likely to be assigned to this those undertaking this function. Verification of information against the requirements is also an appropriate task.

This function is likely to be undertaken by those with job titles such as client's BIM manager, information manager, document controller or client representative.

Client's' asset management responsibilities

The client has a requirement to define their asset information requirements and ensure delivery against this. This will identify an asset management function who will also identify what information is required from the project information model to populate the asset information model.

This function is likely to be undertaken by those with job titles such as operations manager or facilities manager.

Client's security management responsibilities

It is important to understand that the initial burden of information security lies with the client. It is their responsibility to undertake the security triage process and then if a risk is assessed appoint somebody to undertake the security functions on their behalf.

This function is likely to be undertaken by those with job titles such as quality manager or security officer.

5.9.2 Construction lead responsibilities

The main contractor. undertaking the function of the ISO lead appointed party, will have specific duties to undertake and are responsible for:

- Task team(s) appointment(s) and defining the information production responsibilities of each team
- Defining the volume strategy and assigning the appropriate level of definition (volume module)
- Developing and gaining consensus of the project standards, methods and procedures
- Responding to the client's information requirements within the BIM implementation plan
- Documenting and validating the information requirements within the lead designer/constructors Exchange Information Requirement/s (EIR/s)
- Reviewing the project information model against the client's information requirements and authorizing its contractual delivery on behalf of the delivery team.

This function is likely to be undertaken by those with job titles such as design manager, lead architect or lead engineer.

Project Information delivery management responsibilities

Within the lead designer/constructor, there are specific delivery management tasks associated with information management as well as the traditional design and construction management tasks. The information delivery duties to be undertaken may include:

- Compiling and managing the Master Information Delivery Plan (MIDP) from the task team's Task Information Delivery Plan (TIDP)
- Assessing the task team's capacity to deliver information in accordance with the MIDP
- Assuring the project information model is delivered in accordance with the MIDP
- Managing risks associated with the delivery of the project information model
- Ensuring effective communication between the client, lead consultant/lead constructor and each of the task teams.

This function is likely to be undertaken by those with job titles such as project manager or delivery manager.

Project information management responsibilities

Within the main contractor, there are specific information management tasks as well as the information delivery tasks. The information management duties to be undertaken may include:

- Assessing the task team's capability to produce information in accordance with the standards, methods and procedures
- Ensuring the availability of the Common Data Environment to all task teams
- Assuring the project information model produced is in accordance with the project standards, methods and procedures
- Managing risks associated with the production of the project information model
- Reviewing and authorizing the project information model on behalf of the lead designer/constructor.

This function is likely to be undertaken by those with job titles such as BIM manager or design manager.

5.9.3 Task Information management responsibilities

Task teams are responsible for ensuring that information is delivered accurately and on time to meet project programmes and requirements. The information management function breakdown for each task team can be generally described as:

- Team management
- Information management
- Interface management
- Information authoring

Task team management

The task team management function is responsible for the task team delivery and there are specific management tasks that need to be assigned or to be undertaken including:

- Appointing the task information management functions
- Developing the Task Information Delivery Plan (TIDP)
- Ensuring the availability and capacity of competent resources to execute it
- Approving the information produced by the task team against the task brief prior to sharing or publishing
- Assigning the appropriate status (suitability) of the information shared by the task team
- Identifying and escalating risks associated with the delivery of the project Information model

This function is likely to be undertaken by those with job titles such as project architect or project engineer.

Task information management

Associated with each task team is the delivery of information to meet project needs. Each task team will require information management functions which may include:

- Ensuring the task team is producing information in accordance with the project standards, methods and procedures
- Assuring (pass/fail) that the information produced by the task team is compliant with the project standards, methods and procedures (before being shared)
- Ensure the latest shared information is being referenced
- Reviewing the information produced by the task team prior to sharing or publishing to ensure the correct file identifiers, revisions and status codes are used
- Providing education and support to information authors with respect to the project standards, methods and procedures
- Identifying and escalating risks associated with the production of the project information model

This function is likely to be undertaken by those with job titles such as technician, BIM coordinator or document controller.

Interface management

Associated with each task team is the spatial coordination of information with other task teams. Each task team will require interface management functions which may include:

- Resolving spatial coordination issues with other task team interface functions
- Escalating unresolved coordination issues to the design/construction lead
- Keeping the task team updated with agreed resolutions and progress of ongoing resolutions

This function is likely to be undertaken by those with job titles such as BIM coordinator, technician, architect or engineer.

Information authoring

The key function of each task team is the production of information. The main information management functions are the responsibility of those authoring information whose information managements functions may include:

- Creating files and ensuring the appropriate file attributes are captured correctly
- Producing and/or amending information in accordance with the BIM requirements
- Producing and/or amending information in accordance with the Project Implementation Plan
- Ensuring the graphical models (they produce) are spatially coordinated (clash avoidance) and escalating any interface issues to the Interface Manager
- Ensuring all elements of the information model are fully coordinated with each other (graphical, non-graphical and documentation), escalating to the interface manager where clashes are identified
- Checking submitted information prior to review and approval in accordance with the TIDP

This function is likely to be undertaken by all those authoring information.

5.9.4 Information management assignment matrix

An information management assignment matrix identifies each of the information management functions associated with each party. For every project, each party is required to identify within an information management assignment matrix who will undertake the function on behalf of that party. This provides clear ownership and responsibility against each function.

ID	Task R = Responsible for undertaking activity A = Accountable for activity completion C = Consulted during activity I = Informed following activity completion	Appointing Party's / Client's Delivery Manager	Appointing Party's / Client's BIM Manager	Asset/ Security Officer
1	Appoint individuals to undertake the Appointing Party / Client information management function	R	A	C
2	Establish the project's information requirements	A	R	C
3	Establish the project milestones	R	A	C
4	Establish the Project Information Standards	A	R	C
5	Consider the exchange of information	A	R	C
6	Consider the means of structuring and classifying information	A	R	C
7	Consider the use of information during the operational phase of the asset	A	C	R
8	Establish the project's information product methods and procedures	A	R	C
9	Consider the capture of existing asset information	A	C	R
10	Consider the security of distribution of information	A	C	R

Table 24: Indicative appointing party/client information management assignment matrix using RACI. (Paul Oakley)

Table 24 gives an example of an appointing party/client information management responsibility matrix using a RACI approach and identifies ownership and responsibility for each task.

5.10 Legal documents

In terms of digital project delivery, legal documents are important for a number of reasons and these reasons are outlined in Table 25.

Protects all parties involved	Set clear expectations and responsibilities for all parties involved in a construction project. This helps to ensure that everyone is on the same page and reduces the likelihood of misunderstandings or disputes.
Defines project scope	Help to define the scope of the project, including the design, construction and operation of the building. This helps to ensure that everyone involved in the project understands what is expected of them and what the final outcome should be.
Establishes standards	Establish standards for the use of BIM on a construction project. This helps to ensure that the BIM model is accurate, consistent and meets the needs of all parties involved in the project.
Supports dispute resolution	In the event of a dispute, BIM legal documents provide evidence of the design and construction process. This can help to resolve disputes quickly and fairly by providing clear and accurate information about the building and its components.
Increases efficiency	Help to increase efficiency by establishing clear expectations and reducing misunderstandings. This can help to avoid delays, rework and additional costs.

Table 25: Legal documents importance

Overall, BIM legal documents play a critical role in ensuring the success of a construction project by protecting all parties involved, establishing standards and supporting dispute resolution.

Resource - Overcoming the legal and contractual barriers of BIM.
https://wearenima.im/winfield-rock-report/

5.10.1 Professional Indemnity Insurance

Professional Indemnity Insurance (PII) is a type of insurance that provides coverage for professionals in the event of negligence, errors or omissions that lead to financial losses for their clients. In the case of BIM (Building Information Modelling) projects, PII is particularly important for several reasons, including those listed in Table 26.

Legal protection	PII provides legal protection to professionals in the event of a claim made against them. BIM projects involve complex processes and any error or omission can result in financial loss for clients. PII coverage protects professionals against such claims and offers legal assistance in the event of a dispute.
Risk mitigation	PII also serves as a risk mitigation tool. BIM projects involve multiple parties and stakeholders and the risk of disputes and claims is high. PII coverage helps mitigate this risk by providing financial protection against any potential claims.
Compliance	Many clients require professionals to have PII coverage to comply with project requirements. Having PII coverage not only helps professionals comply with client requirements but also helps them demonstrate their commitment to quality and professionalism.
Reputation	PII coverage also helps professionals protect their reputation. Claims of negligence or errors can damage a professional's reputation and PII coverage provides a safety net in the event of such claims.

Table 26: Professional Indemnity Insurance importance

In summary, PII is crucial for professionals working on BIM projects, as it provides legal protection, risk mitigation, compliance and reputation protection. Professionals should ensure that they have adequate PII coverage in place to protect themselves and their clients.

Digital Delivery Professional Indemnity

It is advisable to ensure that Digital Delivery Professional Indemnity is in place and covers all elements relating to Building Information Modelling. The CIC Best Practice Guide for Professional Indemnity Insurance, 2013, summarises the key areas of risk which Professional Indemnity ('PI') insurers associate with the delivery of the project to the ISO 19650 standard and what you can do about those risks as a prudent insured. The guide indicates what you might be required to do in order to ensure that your PI insurance arrangements are in order. The link to the guide is below.

Resource

http://cic.org.uk/download.php?f=best-practice-guide-for-professional-indemnity-insurance-when-using-bim.pdf

Information protocol

In the UK, BS EN ISO 19650-2:2018 requires an information protocol to be produced and included in appointments.

This information protocol template provides an example of what could be included in an information protocol to be used when conforming to BS EN ISO 19650-2:2018 for projects and their appointments to which English law applies. It is not prescriptive, but it provides a useful starting point for an information protocol and is presently, to the authors' knowledge, the only template or standard form information protocol that is designed to be used when conforming to BS EN ISO 19650-2:2018.

This information protocol template further develops the requirements of the CIC BIM Protocol, Second Edition 2018 to reflect BS EN ISO 19650-1:2018 and BS EN ISO 19650-2:2018 and acknowledges the contribution made by the CIC BIM protocol to information management using building information modelling.

Figure 70: Information Protocol Guide (UK BIM Framework)

The information protocol guidance document and template can be found here:

Resource

https://ukbimframeworkguidance.notion.site/Information-protocols-supporting-the-delivery-phase-BS-EN-ISO-19650-2-and-the-operational-phase-B-c45b3a15baa846779d3ac563a21f9ffb

The information protocol template can be found here:

Resource

https://ukbimframeworkguidance.notion.site/UK-BIM-Framework-Guidance-20a045d01cfb42fea2fef35a7b988dbc#665f0516978c472bac72a71341829893

5.11 Digital delivery capability assessment

The need to establish the approach, capability and capacity of the delivery teams is a key requirement. To facilitate this, all parties shall complete a BIM capability assessment as part of the appointment process.

5.11.1 BIM capability assessment

Recognizing the BIM capability and capacity of the delivery team to meet Exchange Information Requirement (EIR) is crucial. This is to ensure the understanding and application of appropriate national and international standards related to information management and BIM.

Pre-Qualified on BIM Capability (PAS 91 Table 8 Questions) with supporting documents

PAS 91 is a Publicly Available Specification (PAS) and is the standard capability form when tendering for a BIM project. The document is used to streamline and reduce the cost of prequalification. To be eligible, it is necessary that suppliers demonstrate that they possess or have access to the governance, qualifications and references, expertise, competence, health, and safety/ environmental/financial and other essential capabilities to the extent necessary for them to be considered appropriate to undertake work and deliver services for potential buyers.

Figure 71: Construction prequalification questionnaires (BSI)

5.11.2 Supply chain assessment forms

Supplier BIM resource assessment forms are completed by each individual supplier in the project, demonstrating their BIM modelling and information management competence, experience and their willingness and capability to exchange data. In addition to submitting the form, a supplier can provide additional evidence to further demonstrate their understanding and competence in BIM.

5.11.3 Third party certification scheme

Gaining ISO 19650 accreditation demonstrates that your company works to an international standard for information management; it also enables your teams to work more effectively and efficiently.

Prior to the appointment of any parties, it is important to establish the capability and capacity of those undertaking these information management functions. Résumés, individual certification and professional memberships are acceptable methods of reviewing capability.

5.11.4 Supply chain capability summary

IS EN ISO 19650 requires the lead appointed party to assess the capability and capacity of each task team to deliver information in accordance with the appointing party's exchange information requirements and the delivery team's proposed (pre-appointment) BIM Execution Plan.

Supply Chain Capability Summary (SCCS) indicates the BIM competence of all firms on the supply chain of principal suppliers and contractors. Supply chain capability can be verified through inspecting the following assessment forms:

- CPix Summary form
- CPix BIM Assessment form
- CPix IT Assessment form
- CPix Resource Assessment form

The BIM assessment form provides a meaningful method of assessing a project member's BIM competence and maturity. It comprises four sections:

- Gateway questions: A set of key questions about willingness to exchange data and quality of that data. If the answer to any of these questions is 'No' then contact the project BIM enabling team.
- 12 Areas of BIM: An opportunity to introduce the 12 Areas of BIM from which the project will benefit and an opportunity for the company being assessed to demonstrate understanding of each of the areas and which areas they could support the project with.
- BIM Project Experience: An opportunity to highlight up to three projects where the benefits of BIM have been realised.
- BIM Capability Questionnaire: The BIM capability questions, in this section are a discussion starter and are intended to help the project BIM enabling team identify training, coaching and support required.

Link to the assessment forms:

Resource
https://bimuk.co.uk/wp-content/uploads/2021/04/cpix_-_bim_assessment_form_ver_1.0.pdf

This capability and capacity assessment method should also be used to assess critical members of the supply chain upon whom the delivery team may rely for crucial information. The prospective lead appointed party shall establish the delivery team's capability by aggregating the assessments undertaken by each task team to produce a summary of the delivery team's ability to manage and deliver information and its capacity for timely delivery of the information.

5.12 BIM Execution Plan (BEP)

This BIM Execution Plan (BEP) focuses specifically on project information delivery, where the graphical data, non-graphical data and documents, known collectively as the Project Information Model (PIM), are accumulated from design to construction activities and then on to the operation of the building.

For a main contractor, having a good knowledge of the client's requirements set out within their Exchange Information Requirements (EIR) will be essential when completing an adequate BEP. As a subcontractor, it is necessary to understand your requirements set out within the BEP, i.e. what you need to deliver and what will be provided in terms of the standard of the model received from the design team, or lack of model detail, being delivered.

Important note

Ensure to check the design model when received to ensure it meets the deliverables for a given project stage prior to acceptance of the model. All parties must commit to the BEP.

The BIM Execution Plan is developed in two stages. The initial stage is the pre appointment BIM Execution Plan which provides a response to the client's information requirements. This is used to assess the ability of the tendering party to meet the client's requirements and should indicate the proposed capability, capacity, approach and methodology.

Figure 72 details the BIM delivery process for the contractor from the tender issue from the client to the tender return, appointment, to the final BIM model produced and accepted in simple terms.

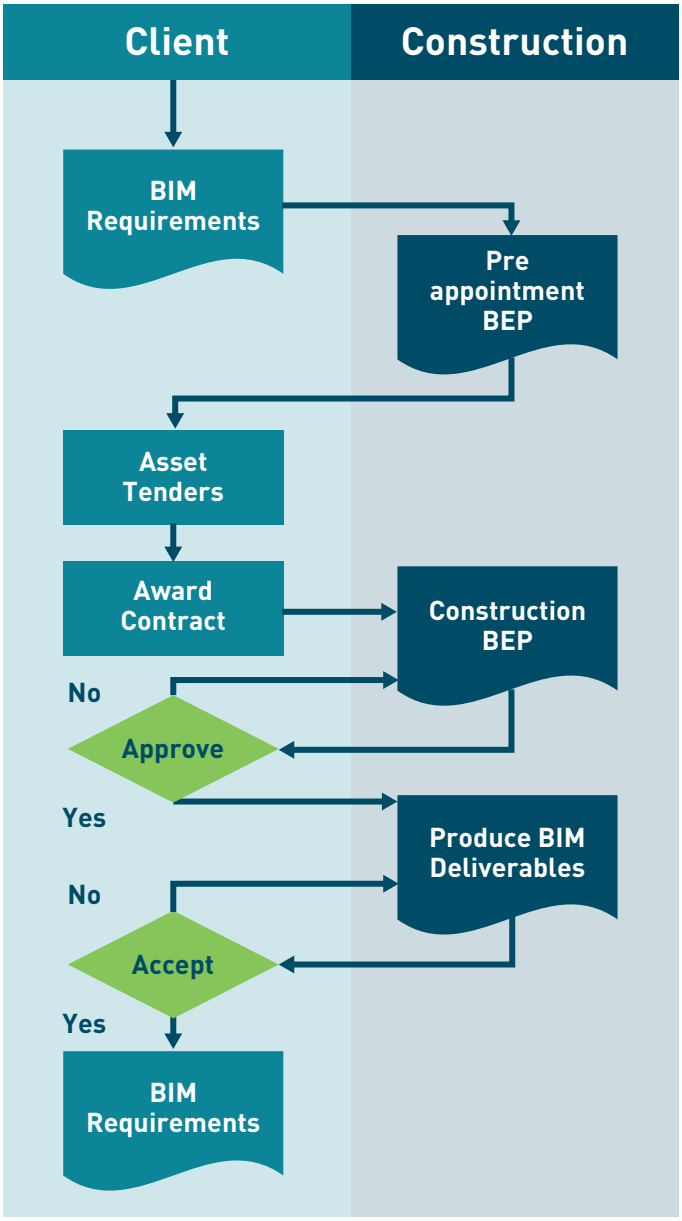


Figure 72: BIM Delivery Process (Paul Oakley)

Mobilistation Plan

The mobilisation plan identifies how identified risks can be mitigated prior to the delivery of information activity commencing.

After tender acceptance the focus then changes to the development of the post appointment BIM Execution Plan. This will act as the proposed methodology against which all information will be developed.

The mobilisation activity should test and verify the proposed approach and establish that the documents methods and processes work prior to seeking approval and moving to delivery.

5.12.1 Pre-appointment (pre-contract) BIM Execution Plan (BEP)

The pre-appointment BEP is the document identified with ISO 19650 that provides the client with the proposed approach and capability of the delivery team. ISO 19650 does not distinguish between the procurement of design or construction. Each of the elements of the BIM requirements provided will need to be taken on board and the contents of the pre appointment BEP and should include responses as shown in the Figure 73 Pre-appointment framework resource and content mapping table between parties.

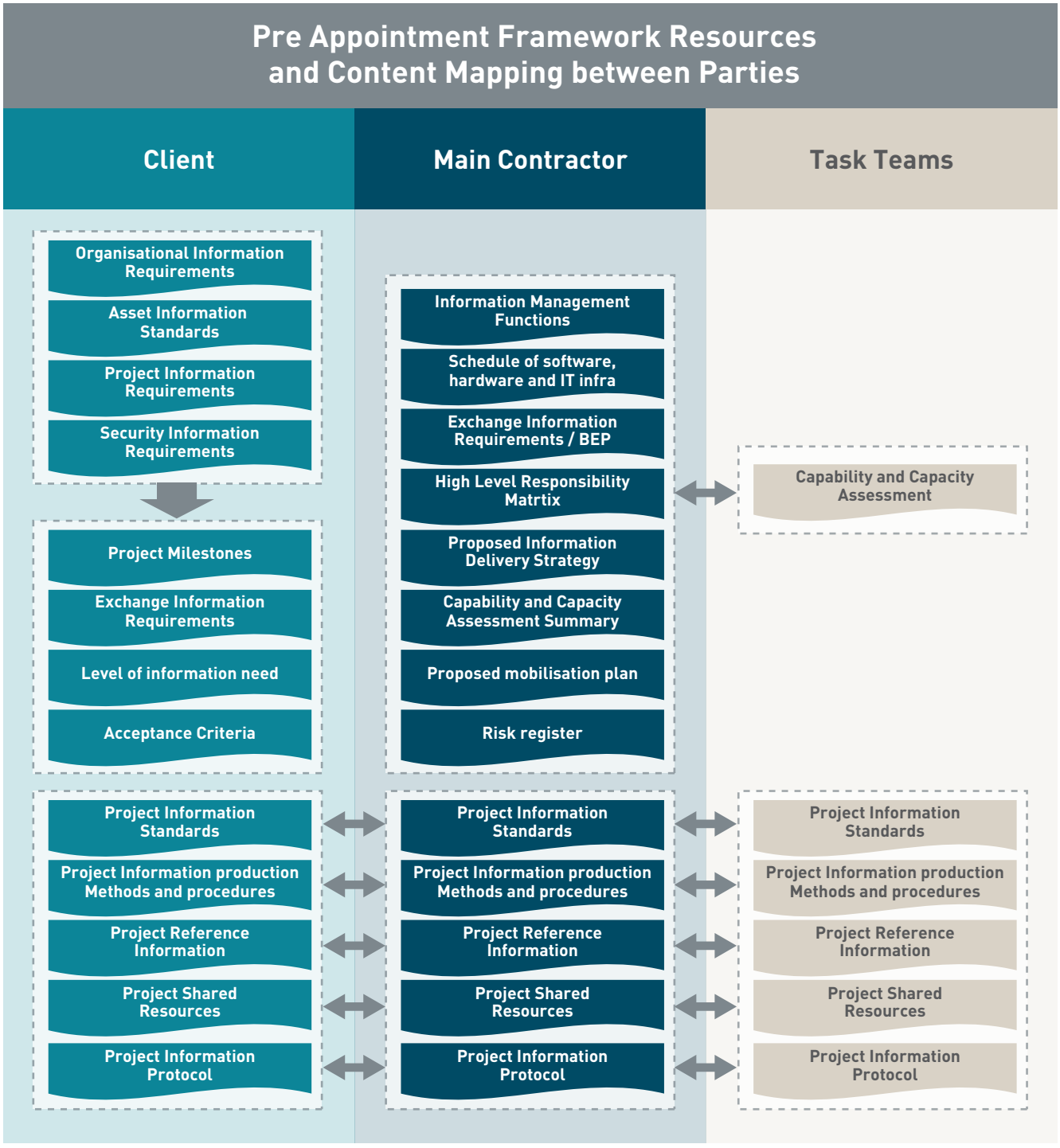


Figure 73: Pre-appointment framework resource and content mapping table between parties (Paul Oakley)

The pre-appointment BEP contents shall include the following content:

- Information management functions (roles)
- Proposed names and resumes of individuals to undertake information management functions
- Capability and capacity assessment
- Delivery strategy
- Approach to Exchange Information Requirements (EIR)
- Goals for collaborative production
- Overview or organisation structure
- Delivery team composition
- Federation strategy
- Responsibility matrix
- Project information production methods and procedures
- Project information standards
- Delivery team risk register
- Mobilisation plan

and

- Proposed schedule of software (including versions), hardware and IT infrastructure.

The digital project delivery requirements and draft BIM Implementation Plan responses will then form the basis for the appointment or contract between the parties. A contract or appointment could be for design, construction or operation stages of the project life cycle requiring both the BIM modelling and information management requirements.

5.12.2 BIM Execution Plan (BEP)

After the appointment, the content and resources of the pre-appointment BEP need to be tested during the mobilisation stages to mitigate any of the risks defined and associated within the risk register. This will include, but will not limited be to, interoperability between software versions and file format requirements, as well as access to IT/CDE solutions, etc. They are then incorporated into the Post-Appointment (Post-Contract) BIM Execution Plan (BEP). This is referred to as the BEP.

It should be noted that the BEP will be continually changing and updating throughout the project delivery stage and traditional change management requirements will need to be incorporated, specifically where elements have been defined as contract documents. It is therefore recommended that the BIM requirements, pre-appointment BEP and BEP are made available to all project team members through the Common Data Environment (CDE).

Once an appointment is confirmed, the BEP shall then be expanded to include:

1. Project information
2. Information management functions (roles)
3. Information management functions and responsibility matrix
4. Information delivery strategy
5. Approach to fulfilling the Exchange Information Requirements (EIR)
6. Project Information Requirements (PIR)
7. Level of information need

8. Acceptance criteria
9. Project information production methods and procedures
10. Project information standards
11. Security strategy to fulfilling the Security Information Requirements (SIR)
12. High and detail level responsibility matrix
13. Delivery team risk register
14. Mobilisation plan
15. Task Information Delivery Plans (TIDP)
16. Master Information Delivery Plan (MIDP);
17. Schedule of software (including versions), hardware and IT Infrastructure
18. Federation strategy
19. Organisational responsibility and agreement.

The main contractor may provide recommendations for additional resources and services which they consider may also be needed by the client. They may also have specific requirements for their own BIM uses which they will define within their BIM requirements.

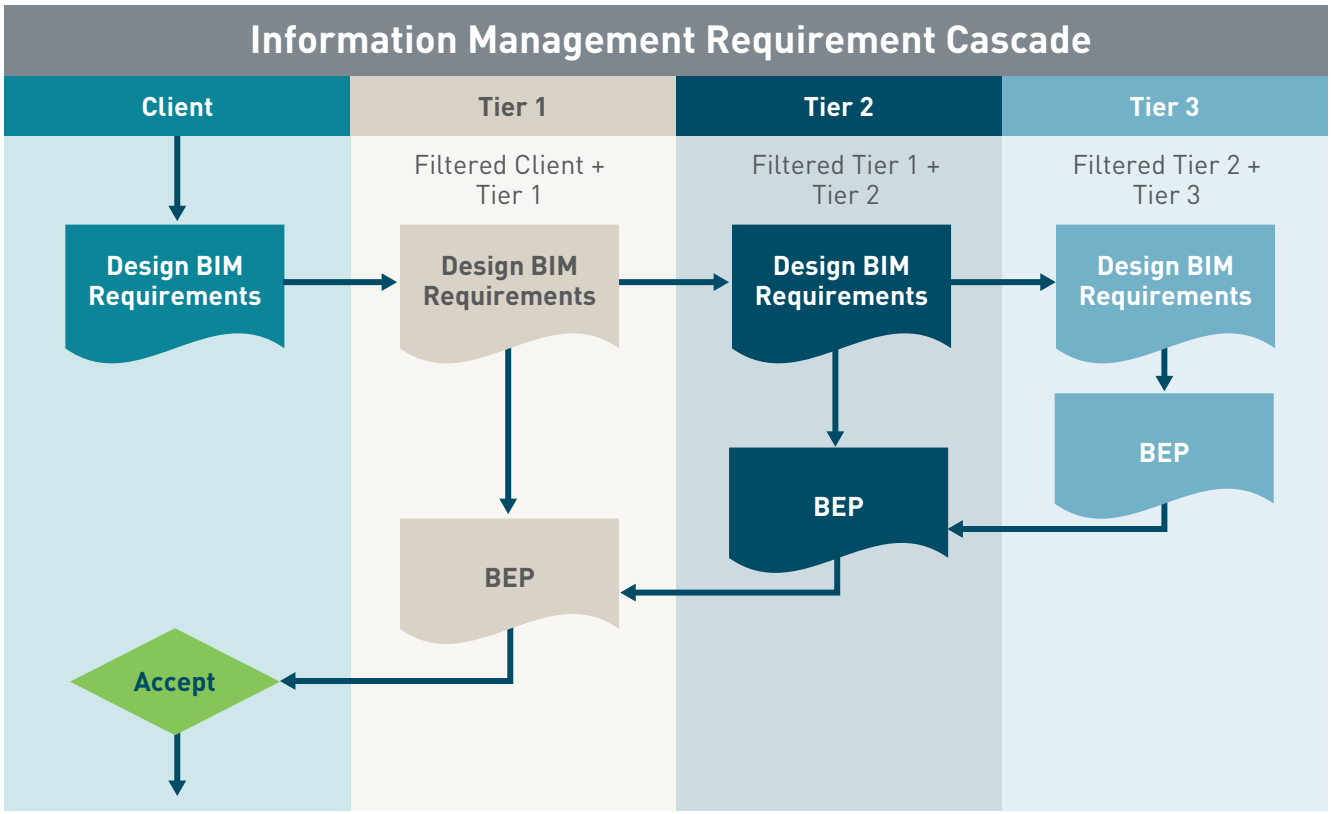


Figure 74: Cascading of BIM information requirements to construction tiers (Paul Oakley)

The main contractor shall cascade their requirements to each appropriate tier and shall confirm that all the delivery team have agreed and committed to the draft BEP. The client will assess and approve the draft BIM Execution Plan (BEP) prior to the production of deliverables which will also be required to be accepted by the client. These will form the basis for the asset information model and any future BIM project requirements for the asset. Figure 74 demonstrates the cascading effect of information requirements filtered down the supply chain from the client to the main contractor and then on to the sub-contractors.

After the BEP has been developed, assessed through discussions with the delivery team and clients and tested through the mobilisation phase, the BEP should then be approved by the client or their representative.

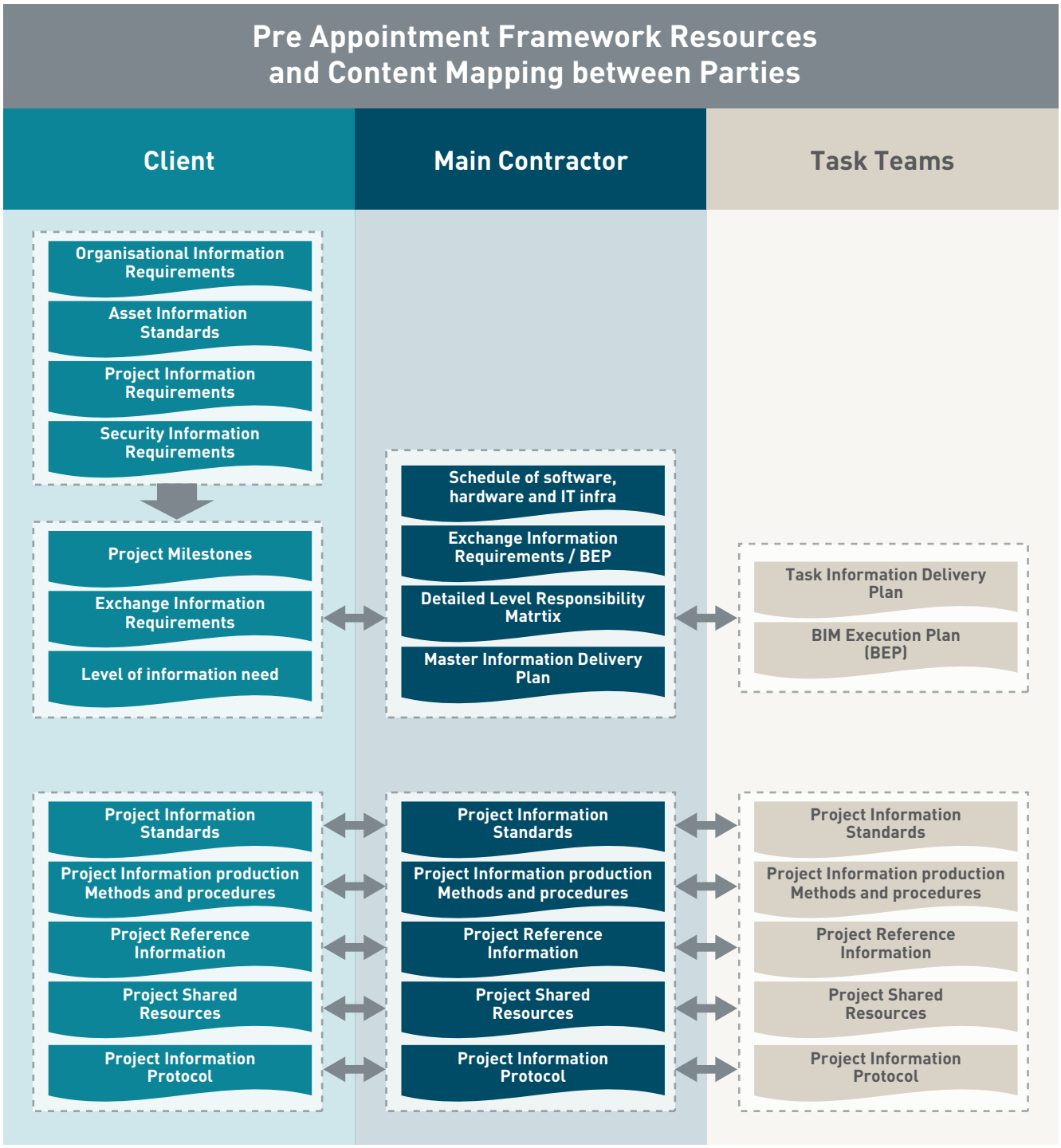


Figure 75: Post appointment framework resource and content mapping table between parties (Paul Oakley)

During the mobilisation phase, the proposed content and resources will be tried and tested taking any amendments needed on board. This will include, but is not limited to, interoperability between software versions and file format requirements, as well as access to IT/CDE solutions, etc. for the main contractor (lead appointed) and the subcontractors (task teams), as per Figure 75.

5.13 Project technology requirements

The digital delivery for every project shall be driven by the requirements of the client. When commencing a project, it is essential to ensure that, if additional hardware or software purchases are required to meet the needs of the client, they have been set out within the project requirement documents and that an allowance is made with the tender return.

Here are some items that should be factored into be factored into the project price:

Software licenses	BIM software often requires licenses, which can be costly. The number of licenses needed will depend on the size of the project, the number of users and the specific software used.
Hardware requirements	BIM software can be resource-intensive and may require powerful hardware, such as high-end computers, graphics cards and memory.
Specific site set up	On certain projects the client may request a high specification meeting room or BIM site boxes onsite to allow the teams to view the models.
Training and support	BIM software requires a high level of expertise to use effectively. The cost of training and ongoing support should be considered.
Customization and integration	BIM software may need to be customised or integrated with other applications.
Maintenance and upgrades	BIM software requires regular maintenance and upgrades to ensure that it continues to function properly. The cost of these activities should be factored into the project's price.
Data storage and security	BIM software generates a large amount of data that must be stored securely. The cost of data storage and security measures should be included in the project's price.
Project complexity	The complexity of the project and the amount of data to be processed will affect the software's performance, which may require additional resources.

Table 27: Project technology price factors

Overall, pricing for BIM modelling and information management projects that involves software requires careful consideration of all the factors mentioned above. It is essential to accurately assess the project's requirements and work with a vendor that can provide a comprehensive pricing model that covers all aspects of the project.

5.14 Project verification and validation requirements

As part of a project deliverables a client may require that the project must be verified and validated. The main contractor or sub-contractor for a new build or retro fit project must demonstrate that information has been validated.

Verification refers to the manual process of checking deliverables (output) against requirements (input); while validation refers to the automated process of checking a digital deliverable (e.g. BIM model) or physical outcome (e.g. a product or a whole building) for consistency/errors or against information requirements.

If it has been remitted by the client that a project must be verified and validated, it is essential that an allowance is made to facility the following;

- Validation of information
- Verification of the graphical level of detail
- Verification of the accuracy of the as built model versus the onsite installation.

5.14.1 Validation of information

The Level of Information Need (LOIN) should be specified clearly and unambiguously to allow both manual and machine-readable verification and validation processes.

Figure 76 presents the relation diagram from IS EN 17412-1:2020. This standard identifies the concepts and principles to establish a methodology for specifying the Level of Information Need and information deliveries in a structured way when using Building Information Modelling (BIM).

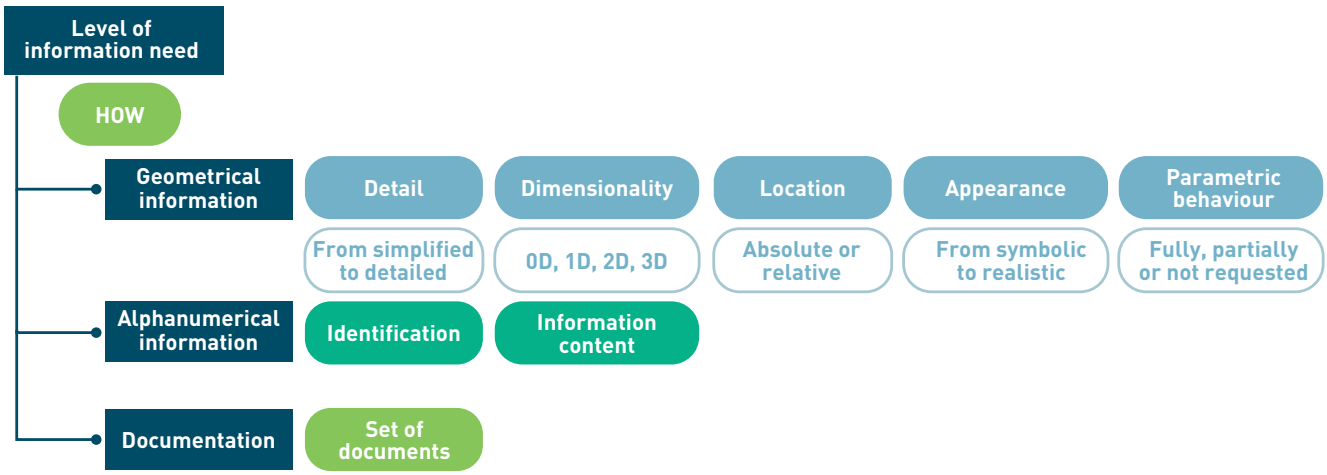


Figure 76: Relationship diagram on level of information need (IS EN 17412-1:2020)

An appointing party should specify their information requirements using the level of information need framework defining:

- The purpose why information is needed And then, if the aspect is applicable:
- The geometrical information to fulfil the purpose
- The alphanumerical information to fulfil the purpose
- The documentation to fulfil the purpose

To facilitate such verification, digital information requirements need to be developed. The ability to compare object requirements against delivered data using Project Data Templates (PDT) and Product Data Sheets (PDS) as identified in ISO 23386 and ISO 23387 facilitates object verification and, eventually, validation.

Note

Ensure the Level of Information Need (LOIN) is clearly detailed by the appointing party and a clear detailed deliverable is presented with any specific requirements.

Resource

ISO/DIS 22014 — Library objects for architecture, engineering and construction. https://www.iso.org/standard/84473.html

ISO 12006-3:2022 Building construction — Organisation of information about construction works — Part 3: Framework for object-oriented information. https://www.iso.org/standard/74932.html

ISO 23386:2020 BIM and other digital processes used in construction — Methodology to describe, author and maintain properties in interconnected data dictionaries. https://www.iso.org/standard/75401.html

ISO 23387:2020 BIM — Data templates for construction objects used in the life cycle of built assets — concepts and principles. https://www.iso.org/standard/75403.html

5.14.2 Verification of the graphical level of detail

NBS

LOD bandings					
	Code	Description/ requirement	Purpose	Fabric example	Services example
2	**Concept design** **What is typical for concept stage?**	Visual information to provide general principles of the design. Showing arrangement of system with their relationship to internal and external context, and key project criteria to suit client brief. General descriptions would be expected to communicate principles of materiality, scope, colour and context. Expect strategic coordination with other professions to show general principles of the design.	To provide a visual indication of proposals at a concept stage and support general spatial coordination, identifying key requirements such as access and maintenance zones for primary systems.		
3	**Spatial coordination** **What is typical as the design develops?**	Visual information to provide developed principles of the design to a greater level of detail. Developed coordination between all professions. Visual development showing coordination for general size and primary relationships between different elements of the construction. Can form a brief for a specialist subcontractor or fabricator to progress with their technical design, fabrication and installation. This would be expected to include critical dimensional coordination, performance requirements and qualities of finish.	To provide a visual representation of proposals at a Design Development stage and to allow greater spatial coordination, confirming brief for Technical Design stage.		
4	**Technical design** **What is required for technical design?**	Visual information to provide fixed principles of the design supporting procurement. Developed coordination between all professions. Visual representations showing coordination for general size and relationships between different elements of the construction. Dimensionally accurate graphical representation of system, indicating primary performance characteristics. Graphical information represented may alter, dependent on visual information to be produced, e.g. scope of work drawings, setting out, floor loading, etc. Typical installation details separately produced, linked to model element and adjacent constructions.	To provide a visual representation of proposals at a Technical Design stage supporting full spatial coordination.		
5	**Construction** **What has been constructed?**	Visual information to provide full information to support construction/ installation. Developed coordination between all professions. Visual representations showing final coordination for size and relationships between different elements of the construction. Dimensionally accurate graphical representation of system, indicating primary performance characteristics and sufficient information to support installation. Typical installation details separately produced, linked to model element and adjacent constructions.	To provide sufficient information for construction/ installation of the required products. To be updated during the construction process to reflect final decisions.		
6	**Record** **A record of the final constructed built asset for FM/ owners**	Visual information (such as record drawings) showing an as-built record of the final systems and products installed in the built asset, and any relevant references to associated information. Visual and geometric data may be acquired through surveys (e.g. laser scanning) of the final built asset.	Visual data that reflects final selections, including any changes made during construction. To provide future reference during the operation stage of a building's life cycle to aid with maintenance, product replacement and disassembly. This will include any verification that demonstrates final results, e.g. final survey results.		

Figure 77: NBS Banding project stage dependant. (NBS)

Level of Information Need (LOIN) should be specified clearly and unambiguously by the client. As noted in Figure 77 it covers geometrical information (graphical), alphanumerical information (non-graphical) and documentation (documents)

The verification of the graphical level of detail in terms of Building Information Modelling (BIM) refers to the process of assessing and ensuring that the level of detail and accuracy of the graphical representation of a building model in BIM is consistent with the intended purpose and use of the model.

Verification of Level of Information Need (LOIN) is essential to ensure that the BIM model is reliable, accurate and fit for purpose. It involves checking that the model geometry, attributes and information are correctly represented and that the model meets the required level of detail for the intended use. This verification process may involve reviewing the BIM model against project specifications and standards, conducting clash detection tests and coordinating with other project stakeholders to ensure consistency and accuracy.

Note

Ensure the Level of Information Need (LOIN) is detailed by the client and covers the purpose, object, why, when, who and what.

5.14.3 Verification of the accuracy of the as built model vs the onsite installation

Field verification of the model elements is important for most projects to enable contractors to produce their as built drawings or record drawings and as built model.

In most local and international BIM standards, "field verified" is the key interpretation for the definition of As-built LOD 500 (US BIMForum), Stage 6 (RIBA work stage) or Level of Detail (LOD) Stage 6 UK and stage 8 project close out (ISO 19650).

In practice, it may not be possible to field verify all model elements in the project and the methodology and grading of field verification may vary subject to the appointing party's/client's considerations and requirements. Different methods of field verification should be stated in the BEP, e.g. by visual inspection, measured survey, 360° panorama images, photogrammetry, laser scanning or any other measures agreed by the project appointing party/client.

In order to develop the Project Information Model (PIM) to a field verified as built Asset Information Model (AIM) prior to handover to the client, a main contractor will scan and verify the installed works on the project, if required.

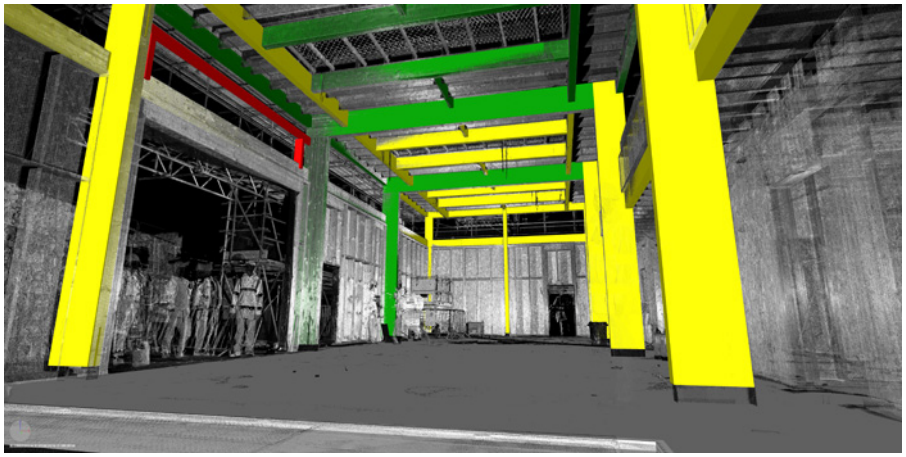


Figure 78: Verity software compares the point cloud against the BIM Model. (verity)

It is essential that the physically built asset matches the virtually built asset or BIM model that is provided at the handover stage of a project. But if we review this in more detail, what does this entail?

Figure 78 shows the Verity software which compares the 3D laser-scanned point cloud of as-built work onsite with the corresponding as-built model (in yellow), in order to produce clear visual outputs that illustrate deviations of elements.

The Level of Accuracy (LOA) of the deliverable should be clearly detailed by the client with strict tolerances of what is required. Spatial accuracy relates to the dimensional characteristics of information. The Level of Accuracy (LOA) shall be higher or lower depending on the requirement of the project, but it is important to note that the higher the accuracy the more expensive it is to deliver.

For example, we could break it down into the following;

LOA/Tolerance/Activity/Sector		
LOA - Tolerance +/- 200mm	**LOA – Tolerance +/- 25mm**	**LOA – Tolerance +/- 5mm**
Visual walkdown with redline mark ups from the field. Residential sector	Laser scanned and BIM model aligned to the scan. Commercial sector	Laser scanned, verified with Verity software, BIM model deviations updated, models re-verified. Semi-conductor sector

Each and every project shall have its own deliverable in terms of the required level of accuracy and tolerances to ensure it meets the client's needs on a project.

5.14.4 Verification & validation deliverable considerations

Below is a check list of items that should be considered when managing an allowance for the verification and validation requirements on a project.

Checklist 6 Verification & validation

Deliverables

- ☐ The deliverable would usually contain a completed data set that has been acquired through 3D laser scanning equipment. It includes the point cloud data, which is a 3D representation of the scanned area, as well as any textured mesh models, surface models and other information that has been picked up by the scan.
- ☐ The deliverable should ultimately follow the project specifications and should include all the data requested by the client. It is of the utmost importance to agree the deliverable with the client before any work commences.

Upskilling

- ☐ Are the staff within your company competent to deliver the required outputs or will they require upskilling? Will this need to be outsourced?
- ☐ Does your company need to introduce new processes and procedures to meet this client need?

Software

- ☐ Does the project require any specific type of software that this is highlighted and allocated against the project? (This is in relation to viewing the point cloud scans for example).
- ☐ Are the type of files to be received from or provided to the client clearly detailed? (The format needs to be detailed along with the purpose of the file type.)

Hardware

- ☐ Does your company have the required hardware?
- ☐ Does the required hardware need to be purchased?
- ☐ Does the required hardware need to be leased? (For example, surveying equipment, laser scanners, 360 cameras.)
- ☐ Do you have the appropriate desktops or laptops to process the information?
- ☐ Due to the size of point clouds and sharing point cloud data sometimes the easiest way to share information is via encrypted external hard drives. Will your project require hard drives to ensure information is shared in a timely manner?

Surveys

- ☐ Do you need to conduct a survey of the current underground services?
- ☐ Are you required to conduct a survey of the landscaping or surrounding buildings?

Level of Information Need (LOIN) (Geometrical/Information/Documentation) –

- ☐ Has the client provided the graphical LOIN for the project?
- ☐ Has the client provided the information LOIN for the project?
- ☐ Has the client provided the detailed LOIN?

Level of Accuracy

- ☐ Has the Level of Accuracy (LOA) been detail in the tender pack?
- ☐ Have you assessed the experience or capability of the delivery team to meet this requirement?

Packages/Elements to be verified

- ☐ Have all the packages been detailed that have to be delivered in the building as part of the tender pack?
- ☐ Are all items detailed in the Responsibility Matrix?

Verification Methodology

- ☐ Has the client detailed how they would like the information to be verified or validated?
- ☐ Have you allocated the required resources to manage your supply to deliver on this requirement?

Establish the acceptance criteria

- ☐ What are you required to deliver at the end of the project?
- ☐ What is the tolerance that is required by the client to meet their acceptance criteria?

Handover Process

- ☐ At the end of the project, if not provided, query how point cloud data is to be forwarded to the client? For example, on an encrypted hard drive. Point cloud data are large files.
- ☐ Is all information required to be transferred to an asset management or Computer Aided Facilities Management (CAFM) system?

5.15 Asset Information Requirements (AIR)

Asset Information Requirements (AIR) should be provided by the client prior to commencement on a project. It should clearly define the information required by their organisation to support an asset operation activity.

The AIR should be reviewed in conjunction with the Exchange Information Requirements (EIR) for the given project because the delivery of the AIR against each project milestone should be established within the level of information need.

I.S. EN ISO 19650-3:2020 and the ISO 55000 and ISO 55001 series of standards provide further details and guidance on asset management.

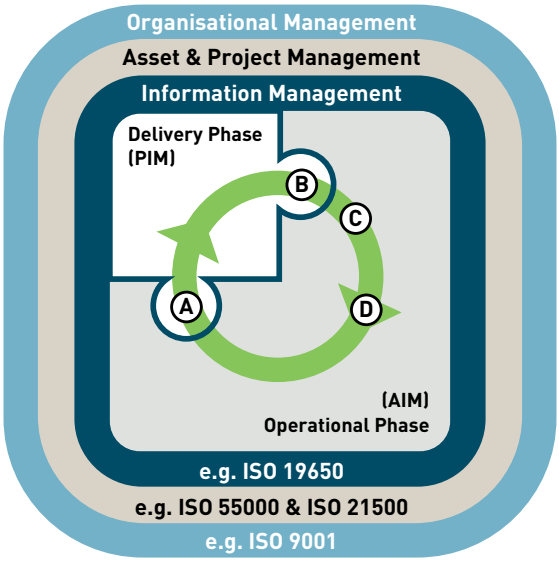


Figure 79: Information management during the life cycle of an asset [ISO 19650-3 Figure 1]

Key

- AIM - Asset Information Model
- PIM - Project Information Model
- A - Start of delivery phase - transfer of relevant information from AIM to PIM
- B -Start of operational phase - transfer of relevant information from PIM to AIM
- C - Post-occupancy/implementation evaluation or performance review
- D - Trigger events during the operational phase

Note

Information can be transferred between PIM and AIM during the delivery phase as well as at points A and B.

ISO 19650-3 is designed to be a companion to ISO 19650-2. As a member of the ISO 19650 series, Part 3 uses the same terminology as Part 2, and many of the detailed clauses are recognizably similar. This is intended to make it as easy as possible for both standards to be used together, as they should be, over the whole life cycle of an asset as shown in Figure 79.

Figure 79 also demonstrates how the organisational management standard (ISO9001) is key to the asset and project management standard (ISO 55000 & ISO 21500) and finally the information management (19650 Series) over the whole life cycle of an asset.

5.15.1 Client requirements

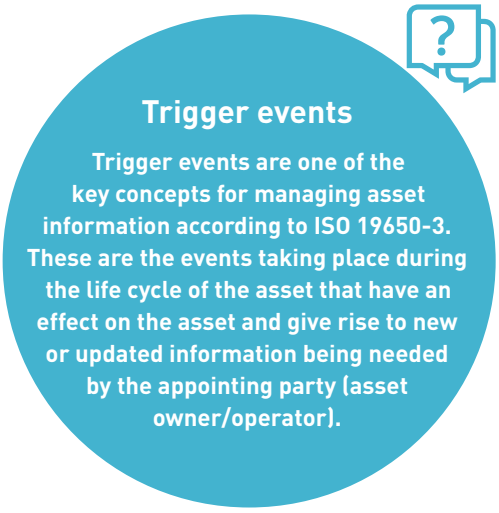
The Asset Information Requirements should explicitly provide the detailed specification for the delivery of the Asset Information Model (AIM) and the formats of its delivery should be clearly defined in the Exchange Information Requirements (EIR).

Within the AIR a list of the maintainable assets should be created, then the associated attributes should be detailed and included in the project information standard for each of the assets.

The client should provide the following:

- Provide an Organisational Information Requirement document (OIR)
- Provide an Asset Information Requirement document (AIR)
  - Information required. This shall include the following:
    - List of all maintainable equipment
    - Regulatory requirements
    - Health and safety information
    - Security
    - Operations and maintenance (O&M) aspects
    - A unique identifier for each asset type
    - Classifications system
    - Schema associated with assets will facilitate the cascading of requirements
    - URL linkage
    - QR Codes/Bar codes/RFID Tags
- List of how it is delivered/exchanged (exchange information requirements)
- The ability to procure a more accurate and comparable tender cost returns from the prospective contractors
- Detail trigger events (ISO 19650 -3 Details this information)
- Requirements to link data to an enterprise system – Facilities Management (FM) or Computer Aided Facilities Management (CAFM) system
- Details if soft landing is required

Figure 79 shows sample trigger events, which can be grouped largely under four main headings. The lists of specific trigger events are not exhaustive and are included to indicate the range of possible trigger events that might need to be considered.

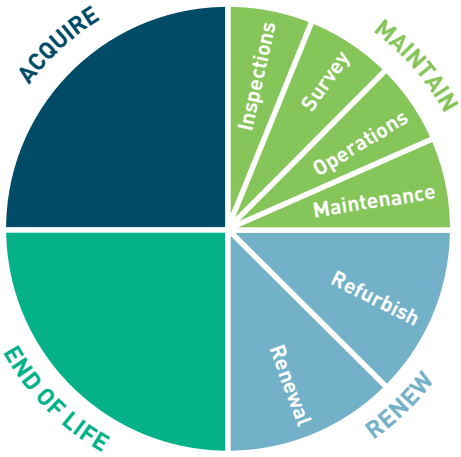


ACQUIRE

- Acquisition of an asset
- Transfer of asset from construct phase to in-use phase
- Onboarding: Asset enhanced handover & commissioning
- Post occupancy evaluation Initial aftercare period
- Transfer of ownership

END OF LIFE

- Disposal
- Decommissioning
- Decontamination
- Deconstruction
- Demolition
- Transfer of ownership



MAINTAIN

- **Inspections**
  - H&S inspection
  - Fire safety
  - Energy performance
  - Defects/warranty inspections
- **Survey**
  - Measured survey
  - Laser scan
  - Building services survey
  - Stock condition surveys
  - H&S survey, asbestos
  - Topography
  - Utilities survey
  - FM validation survey
  - Space utilisation
- **Operations**
  - Cleaning
  - Utilities
  - Waste management
  - Catering
  - Hospitality
  - Helpdesk
  - Post room
  - Security
- **Maintenance (Annualised maintenance)**
  - Planned: scheduled tasks
  - Reactive - unscheduled tasks
  - Proactive - inspect/ monitor/condition based maintenance regimes

RENEW

- **Renewal (Forward Maintenance)**
  - Major repairs and replacements
  - Improvements/ upgrades (e.g. energy refuctions)
  - Redecoration
- **Refurbishment and adaption**
  - Major refurbishment
  - Change of use
  - Alterations or churns

Figure 80: Example trigger events grouped by theme. (UK BIM Framework)

https://ukbimframeworkguidance.notion.site/ISO-19650-Guidance-3-Operational-phase-5c1d1f1ea41a4c428a0cd3777ba01b6d#b7632667593849138f534a1ad43957bf

5.15.2 Attribute requirements

Building Information Modelling (BIM) attributes are the characteristics or properties of the building components that are added to the BIM model. These attributes can include a wide range of information related to the component, such as its size, shape, material, manufacturer, cost, installation date, maintenance requirements and more.

Attributes can be assigned to any BIM model element, including walls, doors, windows, roofs, pipes, electrical components, etc.. By assigning attributes to each component, the BIM model can serve as a comprehensive database of information for the entire building project.

Attributes are used to create a data-rich model that can be used throughout the lifecycle of the building project. For example, during the design phase, the attributes can be used to analyse and optimize the building design. During the construction phase, the attributes can be used for scheduling, quantity take-offs and estimating. And during the operations and maintenance phase, the attributes can be used for asset management, maintenance planning and cost control.

In summary, attributes are essential to the effective use of BIM technology. They allow for the creation of a comprehensive model that can be used throughout the entire building project, from design through to operations and maintenance.

Depending on the quantities of the maintainable assets, classification system and the attributes remitted by the client, it is important to allocate time against the updating of the BIM Models with this asset data in a tender return.

Classification Systems

We shall investigate the different classification systems that may be added to the BIM model depending on the requirements of the client.

Uniclass 2015

Uniclass 2015 is a classification system for the construction industry in the United Kingdom. It is used to classify information and data related to construction projects, such as building components, materials and activities.

Uniclass 2015 was developed by the Construction Project Information Committee (CPIC), which is a committee of industry experts representing various professional bodies in the UK construction industry. It is designed to replace earlier versions of Uniclass and other classification systems and to provide a more comprehensive and flexible approach to classification.

Uniclass 2015 is organised into a series of tables, each of which corresponds to a specific aspect of construction. The tables cover areas such as elements, systems, products, spaces and activities. Within each table, items are further classified using a system of codes and sub-codes.

By using Uniclass 2015, construction professionals can ensure that information is classified consistently and accurately across different projects and disciplines. This can help to improve communication, reduce errors and misunderstandings, and make it easier to share information between different stakeholders in the construction process.

What are the Uniclass tables?

The Uniclass tables are a set of classifications grouped into logical arrangements, organised to provide increasingly detailed descriptions and to support specific aspects of asset management, construction projects and data processes.

As can be seen in Figure 81, the Uniclass tables classify:

- Activities (Ac)
- Complexes (Co)
- Entities (En)
- Spaces/locations (SL)
- Elements/functions (EF)
- Systems (Ss)
- Products (Pr)
- Tools and equipment (TE)
- Project Management (PM)
- Form of information (FI)
- Roles (Ro)
- Materials (Ma)
- Properties and Characteristics (PC)
- CAD and modelling content (Zz)

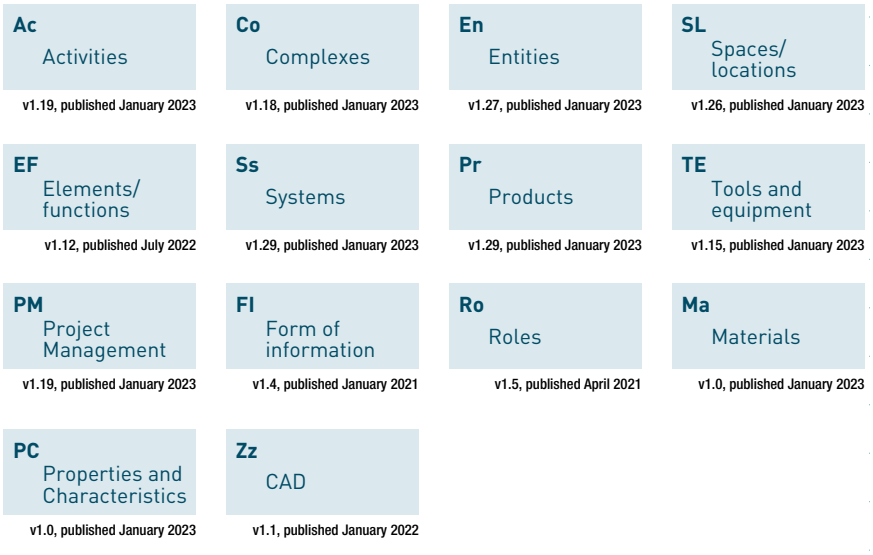


Figure 81: List of Uniclass tables (NBS)

As of January 2023, Uniclass tables have been updated with two new tables the 'Properties and characteristics' and 'Materials' tables. These tables are as described in ISO 12006-2 and provide new codes to help with heritage objects and with embodied carbon data.

New Rules of Measurement (NRM) – Royal Institute of Chartered Surveyors (RICS)

The New Rules of Measurement (NRM) is a set of rules and guidelines for the measurement and quantification of construction works, published by the Royal Institution of Chartered Surveyors (RICS).

NRM was first introduced in 2009 and was developed as a replacement for the Standard Method of Measurement (SMM). The purpose of NRM is to provide a modern and comprehensive method of measurement that reflects the changing nature of the construction industry and considers new technologies, materials and construction techniques.

NRM is divided into three volumes, each of which provides detailed guidance on a specific aspect of construction measurement:

- NRM 1: Order of cost estimating and cost planning for capital building works.
- NRM 2: Detailed measurement for building works.
- NRM 3: Order of cost estimating and cost planning for building maintenance works.

NRM is intended to be used by quantity surveyors, cost consultants, contractors, architects, engineers and other professionals involved in the construction industry. It provides a standard approach to measurement and cost planning that can help to improve accuracy, reduce disputes and ensure consistency across different projects.

The new editions of NRM were effective from 1 December 2021.

The primary development in recent years has been the publication of the International Cost Management Standard (ICMS) (formerly known as International Construction Measurement Standards). Together with the recent publication of the cost prediction professional statement, there now exists a hierarchy of cost management standards and tools from the high-level and global ICMS, through the more detailed principles of all aspects of cost prediction in the professional statement, to the detailed rules and guidance in the NRM suite.

Further information can be found below.

Resource - overcoming the legal and contractual barriers of BIM.

https://www.rics.org/profession-standards/rics-standards-and-guidance/sector-standards/construction-standards/nrm

ARM 4 - SCSI

ARM, or "Analysis of Rates and Measurement", is a standard method of measurement used in the construction industry in Ireland. It is published by the Society of Chartered Surveyors Ireland (SCSI) and provides a uniform basis for measuring building work.

The purpose of ARM is to provide a consistent and transparent way of measuring construction work, so that everyone involved in a project, from architects to contractors to clients, can have a clear understanding of what is included in the scope of work and how much it will cost.

ARM includes detailed guidance on how to measure and price various types of construction work, including materials, labour and equipment. It also provides a set of standard units of measurement, such as square meters and cubic meters, to ensure that all parties are using the same terminology and calculations.

By using a standardised method of measurement like ARM, the construction industry can improve accuracy, reduce misunderstandings and disputes and ultimately deliver better value for money to clients.

Note

The ARM Joint Committee, following receipt of submissions from the SCSI, CIF and GCCC, are currently engaged in drafting what will become ARM 5.

SFG20 Building Maintenance Specification

SFG20 is a set of industry standard specifications for building maintenance that is widely used in the United Kingdom. The acronym "SFG" stands for "Service and Facilities Guidance".

The SFG20 specification includes detailed guidance and schedules for Planned Preventive Maintenance (PPM) of building services, including heating, ventilation, air conditioning, electrical systems, etc.. The schedules are based on best practices and industry standards and are regularly updated to reflect changes in technology and regulations.

By following the SFG20 specification, building owners and managers can ensure that their building services are properly maintained and kept in good condition, which can help to prevent breakdowns, reduce energy consumption and extend the life of the equipment. The specification can also help to ensure compliance with relevant health and safety regulations, as well as any requirements of insurance providers.

Material passport & circular economy

When creating a BIM (Building Information Modelling) model for the circular economy, it is important to request attributes that support the principles of circularity. Here are some key attributes that should be requested for a BIM model that supports the circular economy:

Material data	The types of materials used in the building, including their composition and origin. This information is important for evaluating the potential for recycling, reuse and repurposing of materials.
Product lifespan data	The expected lifespan of building components and systems, including equipment and assets. This information is important for planning and budgeting for maintenance and replacement, as well as for evaluating the potential for repair and repurposing.
Deconstruction and disassembly data	The ease of deconstructing and disassembling building components and systems, including their separability and accessibility. This information is important for evaluating the potential for recycling and reuse of materials.
End-of-life data	The potential for recycling and repurposing building materials and products at the end of their useful life. This information is important for evaluating the circularity of the building and for designing for circularity.
Energy data	The energy consumption of the building, including heating, cooling, lighting, and other systems. This information is important for evaluating the potential for energy efficiency and renewable energy generation.
Water data	The water consumption and treatment systems in the building. This information is important for evaluating the potential for water conservation and reuse.
Indoor air quality data	The quality of the indoor air, including ventilation systems and air filtration. This information is important for evaluating the potential for improving indoor air quality and reducing harmful emissions.

Table 28: BIM key attributes

In summary, if the client is requesting an asset information model for the circular economy, it is important to request attributes that support the principles of circularity. These include material data, product lifespan data, deconstruction and disassembly data, end-of-life data, energy data, water data and indoor air quality data to be clearly defined.

This information is essential for designing and operating buildings that support the circular economy and promote sustainability.

5.15.3 Asset Information Requirement fee considerations

Handover deliverables to meet the clients Asset Information Requirements may include models, documents and specific data. It important to ensure that all information is reviewed that has been present when preparing a tender return to ensure that all requests from the client has an allocation against it.

Due to lack of awareness, the time required to meet the client's Asset Information Requirement (AIR) can be overlooked and will cost the company later in the project.

Here are some key items of asset data that should be received from the client to ensure that all areas of the proposal are covered and do not place the company at risk:

Equipment and asset lists	A comprehensive list of equipment and assets, along with their specifications and other relevant data. This can include everything from HVAC systems to lighting fixtures, plumbing fixtures and other equipment.
Manufacturer data	Data from manufacturers, such as specifications, installation manuals and maintenance instructions. This information is important for ensuring that the equipment and assets are installed and maintained correctly.
Maintenance schedules and procedures	The maintenance schedules and procedures for all equipment and assets. This is important for ensuring that the building is well-maintained and that equipment and assets perform effectively.
Warranty information	The warranties for equipment and assets, including the duration of the warranty and the type of coverage provided. This information is important for managing warranty claims and ensuring that equipment and assets are covered under warranty.
Lifecycle information	The expected lifecycle of equipment and assets, including the estimated replacement or maintenance schedule. This information is important for planning and budgeting for equipment and asset replacement.
Cost data	The cost of equipment and assets, as well as the cost of maintenance and replacement. This information is important for budgeting and cost management.
Spatial data	The location of equipment and assets within the building. This information is important for maintenance and repair, as well as for planning and design purposes.

Table 29: Asset data key items

In summary, when tendering for a project it is important to ensure what the client has requested for their operating period that the above is clarified. This may include asset data that includes equipment and asset lists, manufacturer data, maintenance schedules and procedures, warranty information, lifecycle information, cost data and spatial data.

5.16 Information Delivery Planning

The ISO 19650 process requires a delivery team to plan, monitor and deliver information in accordance with a documented programme. This programme is identified as a Master Information Delivery Programme (MIDP). To facilitate its production each task team is required to identify all of their information deliverables as tasks along with the resources, timescales, prerequisites, etc. within their own Task Information Delivery Plan (TIDP).

5.16.1 Master Information Delivery Plan (MIDP)

The Master Information Delivery Plan (MIDP) is a primary plan which is used to manage the delivery of information during the project lifecycle. The MIDP is best developed and documented using critical path analysis software, such as MS Project, Primavera or equivalent. The purpose is to manage the delivery of information in a changing design, production information environment or construction where the impact from the lack of one delivery can escalate into significant project delays.

The MIDP will be developed by the lead designer/main contractor and collates each task team TIDP taking on board construction and project milestones, information dependencies and quality procedures identified. The provision of standard TIDP templates can facilitate the population of the MIDP fields relating to each deliverable.

The purpose of the MIDP is to manage information delivery change as and when it happens and therefore needs input from all parties. Information deliverables which may be listed in the MIDP include (but are not limited to):

- Models
- Drawings or renditions
- Specifications
- Schedules
- Room data sheets
- Reports
- Prototyping/samples

The MIDP should identify

- Milestones against which information must be delivered
- Each delivery as a task, delivery date and resource
- Predecessor or dependencies
- Design/construction authorisation requirements

and

- Client acceptance requirements.

Any changes in the MIDP should be replicated in each task team's TIDP. The main contractor should establish the baseline deliverables and dates to meet the milestones within the MIDP and inform all parties of any changes required. Risks or issues associated with resourcing should be managed using the MIDP after consultation with the project team.

5.16.2 Task Information Delivery Plan (TIDP)

Each task team should develop and maintain a task information delivery plan which identifies the deliverables and associated content and resources to be produced.

The TIDP should document for each deliverable at least the following information:

- A unique Identifier
- Title/Name
- Description
- Time estimates for production
- Proposed resource to be allocated
- Any predecessors or dependencies
- Delivery milestones
- Level of Information Need (Level of Geometrical (LOG) and Level of Information (LOI) and Documentation (DOC))

It can also be useful to identify:

- Document scale
- File format
- Delivery scale
- Paper size
- Template to be used

The task team should also consider:

- Project delivery milestones
- Detailed responsibility matrix
- Exchange Information Requirements
- Availability of shared resources
- Authorisation and acceptance process and criteria

ID	FileIdentifier								Model / Document Title	Details		Resource		Dependents		Milestone 1		
Reference	Project No.	Originator	Volume/System	Level \ Location	Discipline	Sub-Discipline	Type	Number	Description	Scale	Format	Author	Duration	Lead \ Lag	Prerequisites	LOD-G	LOD-I	Required Date
A1	STP171_C	OCS	XX	XX	A	GA	M3	001	Site Model	1:1	.RVT	PAO	5	0		200	200	01/01/2014
A2	STP171_C	OCS	XX	XX	A	SP	DR	001	Site Plan	1:500	.RVT	HEO	1		A1	200	200	01/01/2014
A3	STP171_C	OCS	XX	XX	A	GE	DR	002	Site Elevations	1:500	.RVT	HEO	1		A1,A5,A9,A14,A18	200	200	01/01/2014
A4	STP171_C	OCS	XX	XX	A	GS	DR	003	Site Sections	1:500	.RVT	HEO	1		A1,A5,A9,A14,A18	200	200	01/01/2014
A5	STP171_C	OCS	NS	XX	A	GA	M3	001	North Stand GA Model	1:1	.RVT	SJO	10			200	200	01/01/2014
A6	STP171_C	OCS	NS	00	A	GA	DR	001	North Stand Ground Floor Plan	1:100	.RVT	SJO	1	1	A5	200	200	01/01/2014
A7	STP171_C	OCS	NS	01	A	GA	DR	002	North Stand First Floor Plan	1:100	.RVT	SJO	1	2	A5	200	200	01/01/2014
A8	STP171_C	OCS	NS	0R	A	GA	DR	003	North Stand Roof Plan	1:1	.RVT	SJO	15	3	A5	200	200	01/01/2014
A9	STP171_C	OCS	ES	XX	A	GA	M3	001	East Stand GA Model	1:1	.RVT	PAO	15			200	200	01/01/2014
A10	STP171_C	OCS	ES	00	A	GA	DR	001	East Stand Ground Floor Plan	1:100	.RVT	PAO	1		A9	200	200	01/01/2014
A11	STP171_C	OCS	ES	01	A	GA	DR	002	East Stand First Floor Plan	1:100	.RVT	PAO	1	1	A9	200	200	01/01/2014
A12	STP171_C	OCS	ES	02	A	GA	DR	003	East Stand Second Floor Plan	1:100	.RVT	PAO	1	2	A9	200	200	01/01/2014
A13	STP171_C	OCS	ES	0R	A	GA	DR	004	East Stand Roof Plan	1:100	.RVT	PAO	1	3	A9	200	200	01/01/2014
A14	STP171_C	OCS	SS	XX	A	GA	M3	001	South Stand GA Model	1:1	.RVT	FAO	10			200	200	01/01/2014
A15	STP171_C	OCS	SS	00	A	GA	DR	001	South Stand Ground Floor Plan	1:100	.RVT	FAO	1	1	A14	200	200	01/01/2014
A16	STP171_C	OCS	SS	01	A	GA	DR	002	South Stand First Floor Plan	1:100	.RVT	FAO	1	2	A14	200	200	01/01/2014
A17	STP171_C	OCS	SS	02	A	GA	DR	003	South Stand Roof Plan	1:100	.RVT	FAO	1	3	A14	200	200	01/01/2014

Figure 82: Example Task Information Delivery Plan (Paul Oakley)

5.16.3 Construction programme

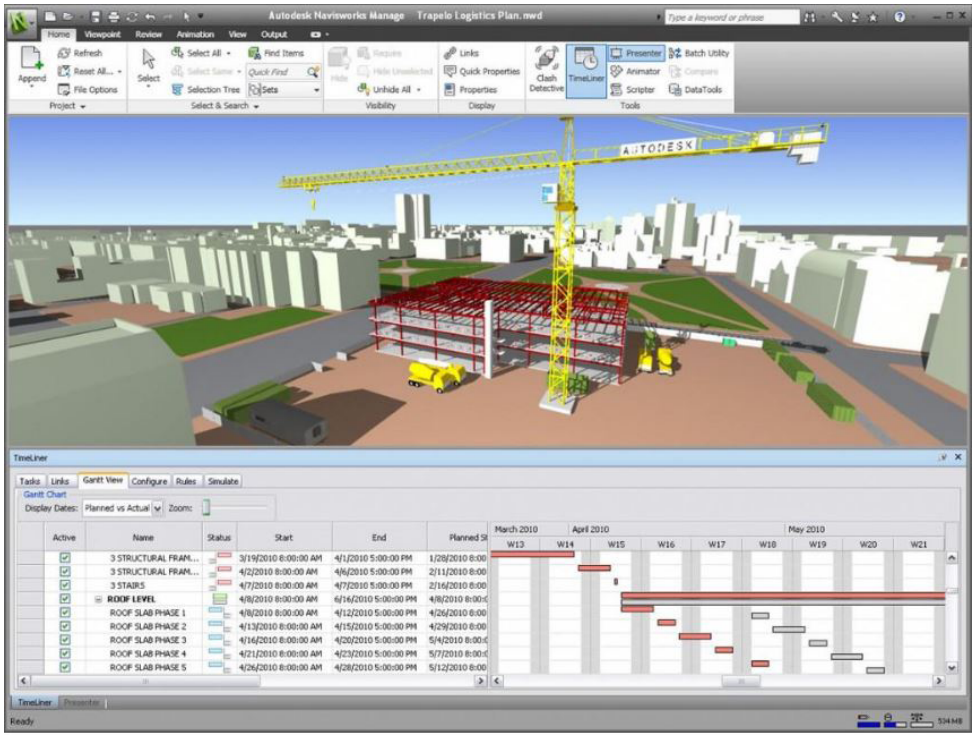


Figure 83: Example of a construction programme. (Autodesk)

A construction programme is a detailed plan that outlines the specific tasks, timelines, and resources required to complete a construction project. It typically includes information such as the project start and end dates, the sequence of work activities, the expected duration of each activity, and the resources required for each task. The construction programme serves as a guide for the project team, providing a clear understanding of the project goals, timelines and expectations. It can be created using specialised software and is often updated throughout the course of the project to reflect changes in the project scope or schedule.

It is important to align a virtual BIM (Building Information Modelling) programme to a physical construction programme because it helps ensure that the project is delivered on time, within budget and to the required quality standards. By aligning the BIM programme to the construction programme, the project team can ensure that the virtual model accurately reflects the physical construction sequence, and that any changes or delays to the construction schedule are reflected in the virtual model.

Aligning the virtual build of a Building Information Modelling (BIM) model to the physical construction of the building is crucial for several reasons:

Accurate Visualization	BIM software allows architects and engineers to create 3D models of buildings. When the virtual model aligns with the physical construction, it allows project stakeholders to accurately visualize the final product, which is essential for design coordination, construction planning and communication with clients.
Clash Detection	By aligning the virtual model with the physical construction, construction professionals can perform clash detection, which identifies potential issues and conflicts between different building systems, such as electrical, plumbing and structural. This can help mitigate errors, reduce rework and save time and money during the construction process.
Improved Coordination	When the virtual build of the BIM model is accurately aligned with the physical construction, it enables project stakeholders to work collaboratively and coordinate efforts effectively. This can lead to improved communication, fewer errors and a smoother construction process.
Project Management	Aligning the virtual build of the BIM model to the physical construction is essential for project management. Project managers can use the model to track progress, identify delays and ensure that the construction process stays on schedule.

Table 30: BIM virtual build alignment

Overall, aligning the virtual build of a BIM model to the physical construction of the building is critical to ensure accuracy, improve coordination, reduce errors and rework and streamline the construction process.

5.17 Digital delivery fee checklist

The ISO 19650 process requires a delivery team to plan, monitor and deliver information in accordance with a documented programme.

As part of the checklist, we will cover the following items:

- Specific project requirements
- Project documentation
- Project information management
- BIM model production
- Asset Information Requirements
- Project verification
- Soft landing requirements

Checklist 7 Specific project requirements

Prior to project commencement it is essential to ensure that you have a full understanding of your scope of works on the project if you are the main contractor or sub-contractor. The following is a list of useful questions to help you understand the scope of works:

- ☐ Is the scope, the delivery and responsibilities clearly detailed for construction?
- ☐ Is Building Information Modelling (BIM) in accordance with ISO 19650 a requirement?
- ☐ Will the appointing party/client provide a Common Data Environment?
- ☐ If not, then does your company utilise a Common Data Environment platform to meet the needs of the project?
- ☐ Has the client specified a specific type of digital set up on site for running meetings and/or viewing the model onsite?
- ☐ Is the project security sensitive do you have any specific requirements?
- ☐ Do you have any specific health & safety requirements to be delivered?
- ☐ Is a requirement for the utilisation of 4D project logistics or virtual project management required on the project?
- ☐ Are you required to set up a digital project hub onsite to facilitate the viewing of the model on a weekly basis?
- ☐ Are you required to place a BIM station onsite as part of the tender requirements?

Checklist 8 Project documents

During the tender stage make sure that the required documents have been forwarded so that a full scope of works can be built by the tender team. The following is a list of the required documents:

From the client:

- ☐ Has the Information protocol been provided?
- ☐ Has the Organisational Information Requirements (OIR) been provided?
- ☐ Has the Asset Information Requirements (AIR) been provided?
- ☐ Has the client Exchange Information Requirements (EIR) been provided?
- ☐ Have the project information delivery milestones been provided?
- ☐ Has the tender response requirements and evaluations criteria?
- ☐ Has a pre-appointment BIM Execution Plan (BEP) been created?

For your company:

- ☐ Have the capability forms been issued to your supply chain?
- ☐ Have you completed a risk register for the project?
- ☐ Do you have the required project delivery document? (BEP, etc,)

Checklist 9 Project information management

The main contractor takes the role of information manager on the project and as such it is imperative that the physical programme to be in sync with the virtual programme. For this to be the case the following questions need to be answered positively:

- ☐ Has a construction programme been created for the tender proposal?
- ☐ Has a master information delivery plan been created?
- ☐ Has a mobilization plan been created?

Checklist 10 BIM model production

For each and every project it is necessary to ensure that you have clear understanding on your deliverable in terms of your BIM modelling scope of work .i.e. what is included and what is excluded from your package.

Have you detailed out all the packages on the project to ensure they have all be assigned to a specific project stakeholder and if not, how shall it be completed, for e.g. the rainwater system, on a project?

For this to be the case the following questions need to be answered positively:

- ☐ Has a Responsibility Matrix table been created?
- ☐ Have you confirmed all elements within your scope of works?
- ☐ Have all elements within the building been assigned to the given task teams?
- ☐ Has the level of detail of the project been provided?
- ☐ Has the level of information need been provided?
- ☐ Does the project require any additional modelling, builder works openings, supports to be modelled?

Checklist 11 Asset information deliverable

For each project it is also necessary to ensure that you have clear understanding on your deliverable in terms of the asset information model that must be delivered at the end of work and how a fee should be allocated with your scope of works. i.e. what is included and excluded from your package?

For this to be the case the following questions need to be answered positively:

- ☐ Have the Asset Information Requirements been defined (AIR)?
- ☐ Has all information been detailed as per Section 5?
- ☐ Are the required assets clearly listed and detailed?
- ☐ Have the project attributions clearly been defined?
- ☐ Have the classification requirements been clearly defined?
- ☐ Will the client require information transferred to another database on project completion?

Checklist 12 Project verification & validation

For each project it is necessary to ensure that you have clear understanding on your deliverable in terms of the asset information model that must be delivered at the end of work and how a fee should be allocated with your scope of works, i.e. what is included and excluded from your package.

For this to be the case the following questions need to be answered positively:

- ☐ Has the client specified a verification requirement on the project?
- ☐ Has a detailed verification programme been provided by the client?
- ☐ Have they stated any specific software or platform to be utilised?
- ☐ What is the level of accuracy that the installation must be verified?
- ☐ Has it been detailed how this must be broken across the whole project into zones?
- ☐ Have you checked your supply chain is capable of completing the verification process?
- ☐ How are the files to be delivered at the end of the project and stored by the client?

Checklist 13 Soft landing requirement

Once a project has been handed over and the project delivered, in some instances the appointing party/client may request that a soft-landing period is allowed within the fee as part of your tender return.

In addition to this a period of time may be added to the contract documents for the maintenance of the asset information models. The following needs to be considered.

- ☐ Has the client noted a soft-landing period once all data has been handed over?
- ☐ Has it been noted that the model data or models must be kept up to date for a fixed period after the building has been handed over?

5.18 Available resources

Below is a list of additional available resources available to support you when tendering for a project.

5.18.1 UK BIM Framework

BSI and nima are developing resources in the form of standards, guidance, an information protocol, checklists and FAQs to support individuals and organisations in the UK to understand the fundamental principles of information management using building information modelling.

https://ukbimframeworkguidance.notion.site/UK-BIM-Framework-Guidance-20a045d01cfb42fea2fef35a7b988dbc

5.18.2 Information Protocol

This guidance information should be read in conjunction with the UK BIM Framework Information Protocol Template and 19650 Guidance Part 1 Concepts, Section 3 and Annex C.

https://ukbimframeworkguidance.notion.site/PDF-versions-of-the-UK-BIM-Framework-Guidance-88209c67fea342b69c80188dae8745a9

5.18.3 EU BIM Task Group - BIM cost benefit in public tenders

The EU BIM Task group developed a methodology for a cost benefit analysis for the use of BIM in public procurement and is one of the first deliverables of the Renovation Wave for the construction ecosystem. It aims to build the case for the introduction of BIM in public procurement for individual public projects, by demonstrating costs and benefits from the perspective of public clients.

http://www.eubim.eu/cost-benefits/

5.18.4 Cost Benefit Analysis Handbook

http://www.eubim.eu/wp-content/uploads/2021/10/Handbook-BIM_WEB_oct21_compressed.pdf

5.18.5 Cost Benefit Analysis Tool

http://www.eubim.eu/wp-content/uploads/2021/05/Cost-Benefit-Analysis-model-for-the-use-of-BIM.zip

5.18.6 BIMForum - level of development (lod) specification part i & commentary

The Level of Development (LOD) Specification is a reference tool intended to improve the quality of communication among users of Building Information Models (BIMs) about the characteristics of elements in models.

https://bimforum.org/resource/level-of-development-specification/

5.18.7 BIMForum - Estimating & Scheduling with BIM Guide

The purpose of this guide is to introduce BIM estimating and scheduling concepts to teams on small to midsized projects that may have some team members who have never previously used BIM.

https://ascendbkf.org/resources/Documents/BIMForum_2020_Estimating-Scheduling_Public-DRAFT.pdf

5.18.8 SCSI – ARM 4

https://scsi.ie/wp-content/uploads/woocommerce_uploads/2020/07/ARM-Supplement1-Final-y4qgpw.pdf

https://arrow.tudublin.ie/cgi/viewcontent.cgi?article=1039&context=beschreoth

5.18.9 RICS – NRM 1, 2 & 3

https://www.rics.org/profession-standards/rics-standards-and-guidance/sector-standards/construction-standards/nrm

5.18.10 PAS91

PAS 91 on construction prequalification questionnaires (PQQ) provides a standard list of the questions that are typically asked of suppliers at the prequalification stage of construction tendering.

https://knowledge.bsigroup.com/products/construction-prequalification-questionnaires/standard

5.18.11 U.S. Institute of Building Documentation - Guide for USIBD Document C220TM: Level of Accuracy (LOA) Specification for Building Documentation

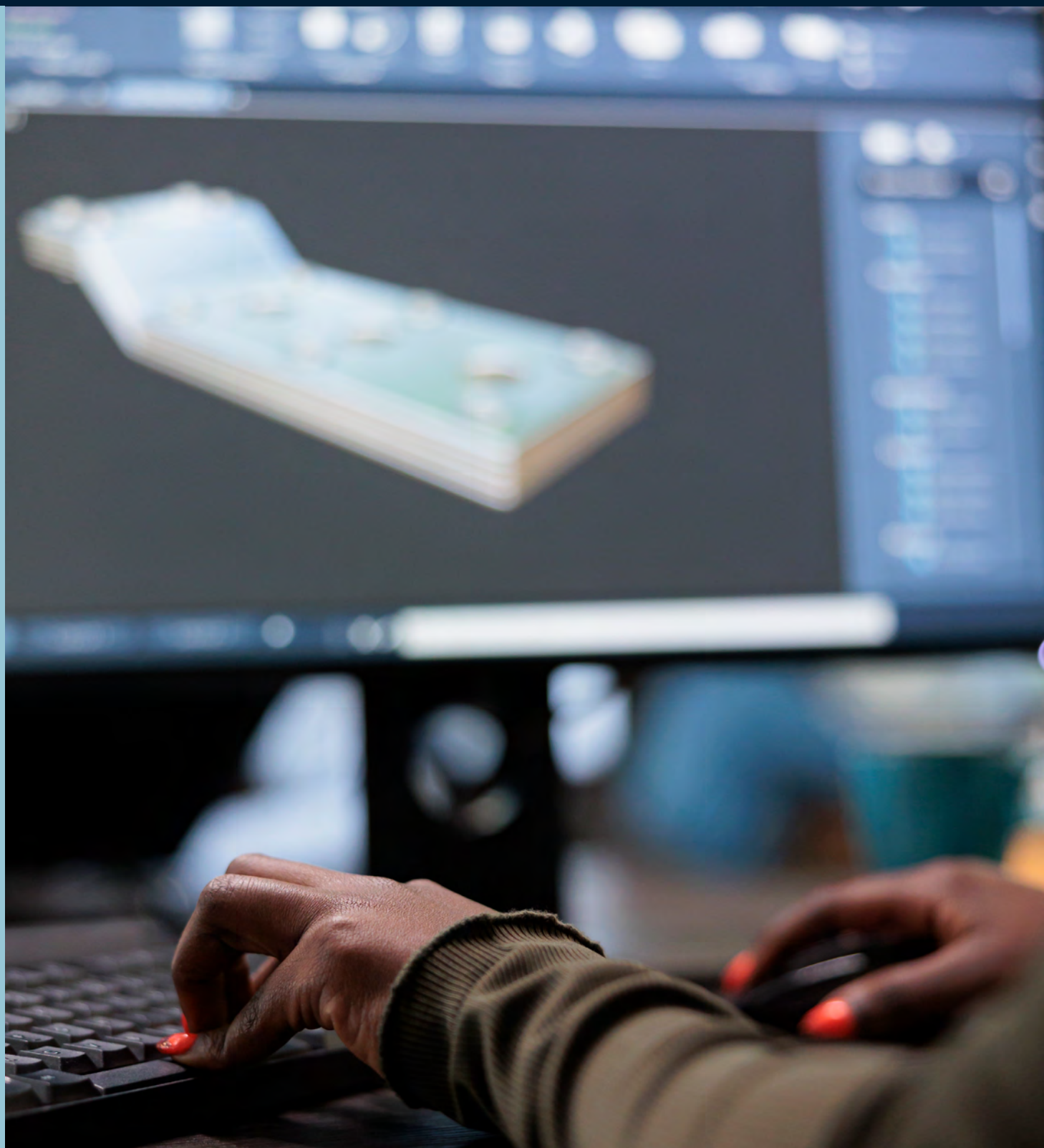
https://cdn.ymaws.com/www.nysapls.org/resource/resmgr/2019_conference/handouts/hale-g_bim_loa_guide_c120_v2.pdf

5.18.12 BIM Forum - Level of Acceptance (LoA) Specification Reality Capture and Simulation Taskforce

https://bimforum.org/wp-content/uploads/2022/06/BIMForum_2019_Recap-Sim-Spec_r19122012848.pdf

Section 6:

Appendices



Section 6 Appendices

6.1 Abbreviations

2D	Two-dimensional
3D	Three-dimensional
AIM	Asset Information Model
AIR	Asset Information Requirements
AEC	Architecture, Engineering and Construction
API	Application Programming Interface
AR	Augmented Reality
BS	British Standards
BCF	BIM Collaboration Format
BEP	BIM Execution Plan
BIM	Building Information Modelling
BIM IP	BIM Implementation Plan
AIR	Asset Information Requirements
API	Application Programming Interface
AR	Augmented Reality
BCF	BIM Collaboration Format
BEP	BIM Execution Plan
bSDD	buildingSMART Data Dictionary
BSI	British Standards Institution
BSRIA	The Building Services Research & Information Association
BIACE	Building in a Climate Emergency
CAD	Computer Aided Drafting
CAFM	Computer Aided Facilities Management
CBWD	Combined Builder's Works Drawings
CE	Carbon Emissions
CEN	European Committee for Standardization
CEN/TC	European Committee for Standardization/Technical Committees
CDE	Common Data Environment
CFD	Computational Fluid Dynamic
CIC	Construction Industry Council
CIF	Construction Industry Federation

CIM	Construction Information Model
CITA	Construction IT Alliance
CNC	Computer Numeric Control
COBie	Construction Operations Building Information Exchange
CPD	Continuing Professional Development
CR	Construction Record
CQMS	Construction Quality Management System
CSG	Construction Sector Group
CSI	Construction Specifications Institute
DfMA	Design for Manufacture and Assembly
DIM	Design Information Model
DOC	Level of Documentation
DPER	Department of Public Expenditure and Reform
DWSS	Digital Work Supervision System
EDMS	Electronic Document Management Systems
EE	Embodied Energy
EIR	Exchange Information Requirements
EN	European Standards
FM	Facility Management
GB	Gigabits
GCCC	Government Contracts Committee for Construction
GHG	Greenhouse Gas (GHG or GhG)
GSL	Government Soft Landings
GUID	Globally Unique Identifier
GIS	Graphical Information System
HVAC	Heating, Ventilation and Air Conditioning
ICT	Information and Communication Technologies
ID	Information Identification/Information Container Identifier
IDM	Information Delivery Manual
IDSxml	Information Delivery Specification/Extensible Markup Language
IFC	Industry Foundation Classes
IFD	International Framework for Dictionaries
IP	Ingress Protection
IPD	Integrated Project Delivery
I.S.	Irish Standards
ISO	International Organization for Standardization

IWMS	Integrated Workplace Management Systems
JSON	JavaScript Object Notation
LOA	Level of Accuracy
LOG	Level of Geometrical
LOI	Level of Information
LOIN	Level of Information Need
MEP	Mechanical, Electrical and Plumbing
MiC	Modular Integrated Construction
MIDP	Master Information Delivery Plan
MMC	Modern Methods of Construction
MR	Mixed Reality
MVD	Model View Definition
NA	National Annex
NBC	National BIM Council
NEC	New Engineering Contracts
NFC	Near Field Communication
NSAI	National Standards Authority of Ireland
NZEB	Net Zero Emissions Building
OC	Operational Energy
ODS	Open Data Standards
OE	Operational Carbon
OS	Operating System
OIR	Organisational Information Requirements
PAS	Publicly Available Specifications
PDT	Product Data Template
PDS	Product Data Sheet
PIM	Project Information Model
PIR	Project Information Requirements
POE	Post Occupancy Evaluation
QR Code	Quick Response Code
QTO	Quantity Take-off
RFI	Request For Information
RFID	Radio Frequency Identification
RIAI	Royal Institute of Architects Ireland
RIBA	Royal Institute of British Architects
RICS	Royal Institution of Chartered Surveyors

ROI	Return on Investment
SIR	Security Information Requirements
SME	Small and Medium-sized Enterprise
SMP	Standards, Methods and Procedures
SSD	Solid State Drive
TIDP	Task Information Delivery Plan
UAV	Unmanned Aerial Vehicle
UK	United Kingdom
UKAS	United Kingdom Accreditation Service
VDC	Virtual Design and Construction
VR	Virtual Reality
WRAP	Waste Reduction Action Program
WIP	Work in Progress
XML	Extensible Markup Language

About the Authors

Joseph Mady, DCT CEO

Joseph is the CEO of DCT. He is a member of the National Standards Authority of Ireland (NSAI) Technical Committee on BIM and a member of the Construction Industry Federation (CIF) 4.0 Committee. He is a qualified Electrician, Electrical Engineer, attaining BEng Tech and BSc degrees in Electrical Engineering Services Design, MSc in Applied Building Information Modelling and Management and is currently concluding a MSc in Business Leadership and Management Practice. Joseph is also part-time lecturer at Technological University Dublin (TUD), where he teaches courses on continuous professional development on digital delivery for site teams and construction site management course.

Paul Oakley, DCT Business Development Director

Paul previously worked for BRE (Building Research Establishment), where he headed up the BIM Division and was identified as a "World leading expert in BIM" by the organisation. Paul also worked internationally in the Czech Republic, Chile, Brazil, New Zealand, China, UAE and Hong Kong, providing consultancy services, support to Government and Industry in writing standards, implementation guidance, training and auditing in relation to BIM implementation. He also supported the UK BIM Level 2 and ISO 19650 implementation. Throughout Paul's career he has also supported both UK Universities and many overseas in developing their courses and still lectures in the UK. Part of this work was also writing the learning outcomes framework for BuildingSMART International.

More recently, Paul has provided support in authoring and updating the Hong Kong CIC BIM Standards, where he wrote the Local Annex, Standards and ISO 19650 implementation guidance and he continues to be involved in ISO development specifically relating to Construction Documentation.

DCT

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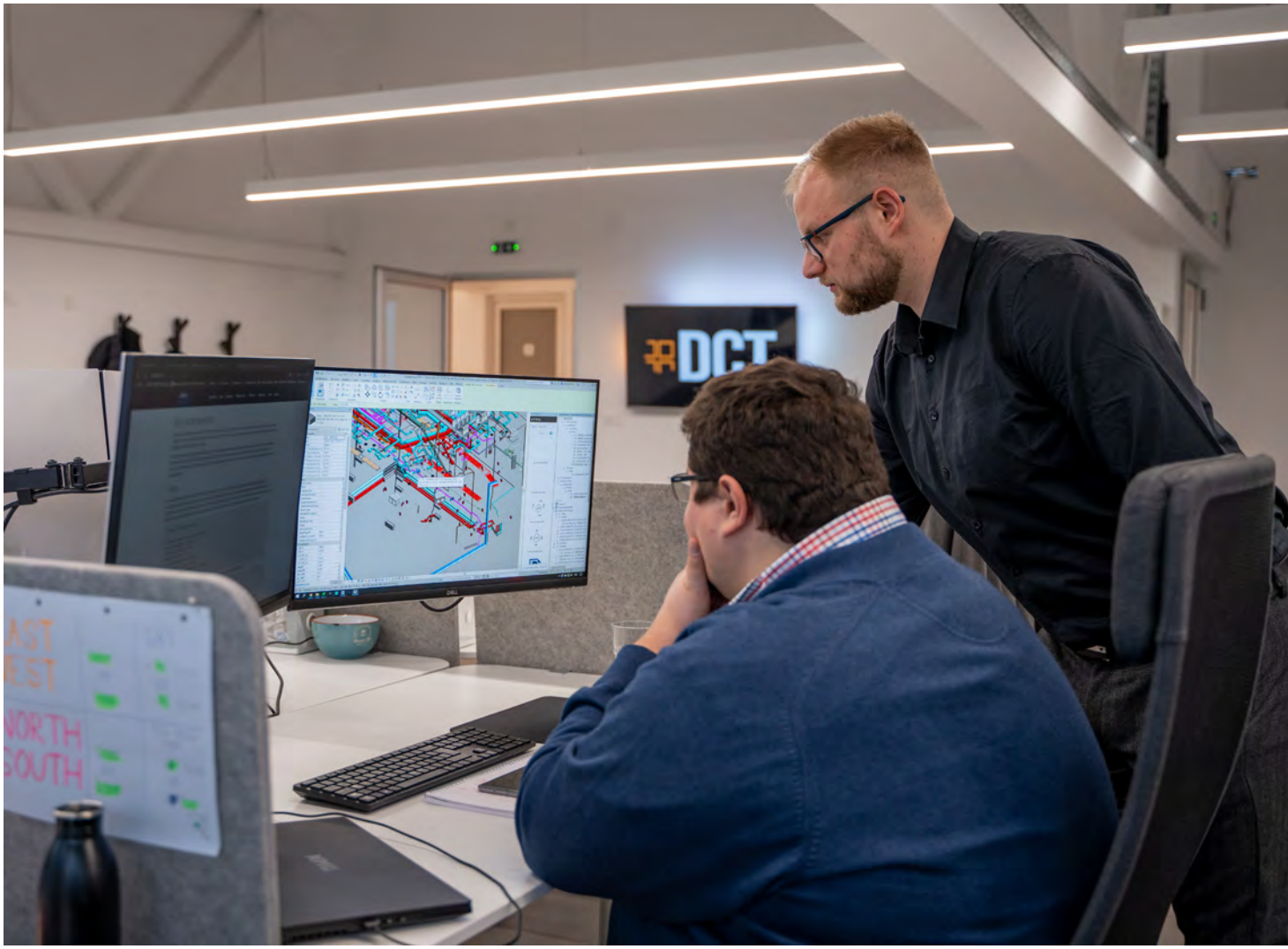

Notes

Construction Professionals Skillnet

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