

FM-BIM Mobilisation Framework:

Critical Success
Factors to Help
Deliver Successful
BIM Projects

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Authors:



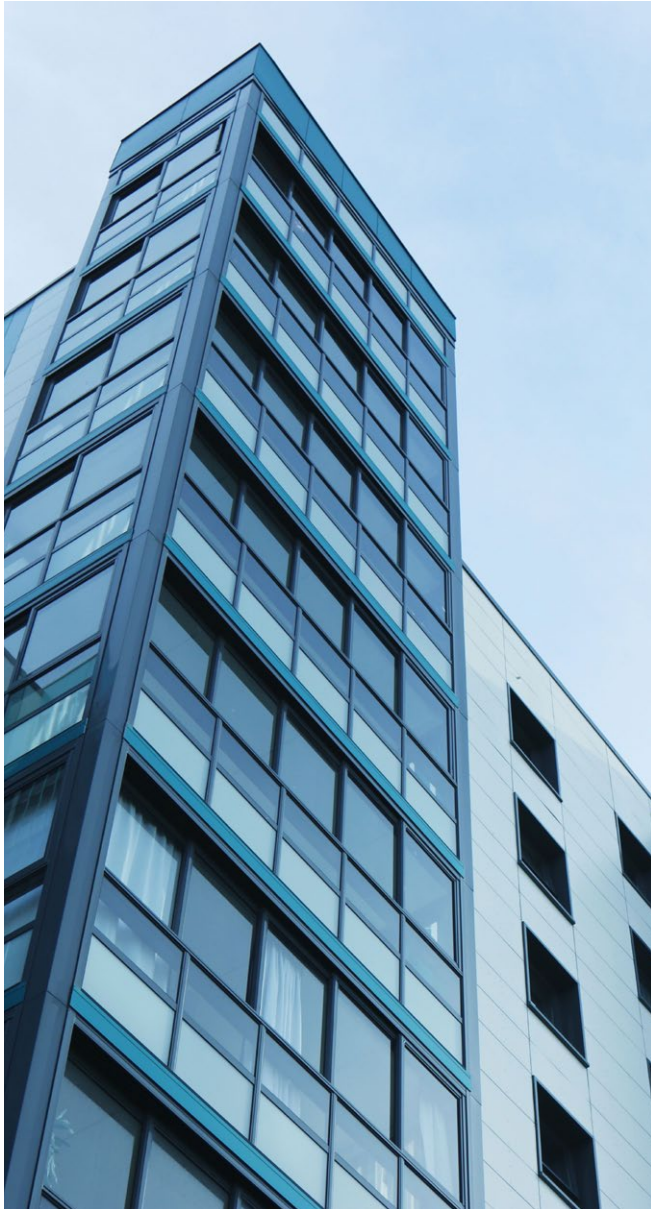
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1. Introduction

The aim of this guide is to provide a series of Critical Success Factors (CSF), which can be used by Facility Management (FM) professionals and other stakeholders to help them better engage in Building Information Modelling (BIM) projects. By doing so we will all help deliver better project outcomes and the full benefits of BIM, enabling us to optimise built assets in operation for users, organisations and wider society.

BIM has become the chosen route for procuring and delivering new built assets. In addition, the BIM process is increasingly being applied to existing built assets. Laser scanning and other data capture techniques are being used in the digitalisation of organisations' real estate portfolios.

The collection of information/data may also be used 'where appropriate' to set up retrospective BIM models. If well implemented, the BIM process has the potential to deliver significant benefits not only during the design and construction phases but also during the much longer operational phase. However, the benefits need to be clearly transparent, realistic and achievable. Working with the BIM process also presents its own challenges and concerns. If we are to deliver the full benefits of BIM across all the built asset's life cycle phases these barriers need to be addressed and overcome. This '**FM-BIM Mobilisation Framework**' presents ten CSF Main-Themes (MT) with associated Sub-Themes (ST). These can be seen as a **mobilisation checklist** of actions with supporting explanations, examples and useful links to resources for support. If acted upon, they will help people engage more successfully with

BIM projects to achieve their desired outcomes. The CSF and associated guidance are not intended to be a complete guide to BIM as there are many other resources already available which fulfil this requirement.

The '**FM-BIM Mobilisation Framework**' is based on my PhD work and associated research papers. These can be accessed on my Researchgate account. I hope this guidance is useful to readers and would welcome any feedback or suggestions for additional examples, which might improve the document over time. Where links are not working please let me know and I will update the document.

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2. Guidance for using the ‘FM-BIM Mobilisation Framework’

The main idea behind the ‘*FM-BIM Mobilisation Framework*’ is that it can be used as a reference guide to help people understand the CSF which will lead to success in the BIM process. It can also be used as a **check list** when starting to mobilise BIM projects, ensuring each of the CSF have been assessed and, where appropriate, acted upon in order to deliver a successful outcome. The **hyperlinks** and **buttons** used throughout the document allow easy navigation and access to sources of information to help the reader’s understanding of BIM.

The framework is presented to the reader in two key parts. The first part is the **Summary List of CSF** in [Section 3](#). Ten CSF are presented which address topics that research indicates are important to consider in order to deliver successful BIM projects. The summary list gives an overview of each CSF, the topics addressed and why the CSF is critical in the BIM process.

The second part presents the reader with individual **CSF Tables** in [Section 4](#). The overall **Aim** of each CSF is shown and the associated ST highlight further important issues that need to be considered. Detailed **Explanations** and **Examples** are provided for each ST. The **Mobilisation Status Check List** column allows the reader to keep track of which CSF have been reviewed and which may require further attention to improve the overall success and outcome of the BIM project.

Further **navigation buttons** are provided at the bottom of each page to navigate back to the summary list, appendices or other pages the reader is interested in. The following key explains each section of the Mobilisation Framework:

Key	Meaning
CSF MT	Critical Success Factor Main-Theme: addressing important topics.
CSF ST	CSF Sub-Theme: each MT has a series of Sub-Themes (ST). These provide further relevant topics under the MT which form part of the mobilisation framework.
Aim	Describes how the CSF will help deliver improved BIM project outcomes.
Explanation	Provides further clarification and detail for each CSF ST to help the reader understand what the ST relates to and why it is important.
Examples	Provide suggestions and sources where FMs can find out more information. Note: Where further information/help is required a search against the MT or ST is recommended to find advice to meet the individual’s or organisation’s needs.
Mobilisation Status	Provides a simple check system allowing the FMs to assess the status of the mobilisation CSF. <div style="display: flex; justify-content: space-around; align-items: center; margin-top: 10px;"> <div style="text-align: center;"> <div style="background-color: #555; color: white; padding: 5px; writing-mode: vertical-rl; transform: rotate(180deg);">Completed</div> <div style="color: green; font-size: 24px;">✓</div> </div> <div style="text-align: center;"> <div style="background-color: #555; color: white; padding: 5px; writing-mode: vertical-rl; transform: rotate(180deg);">Initiated</div> <div style="color: orange; font-size: 24px;">✓</div> </div> <div style="text-align: center;"> <div style="background-color: #555; color: white; padding: 5px; writing-mode: vertical-rl; transform: rotate(180deg);">To-do</div> <div style="color: red; font-size: 24px;">✓</div> </div> <div style="text-align: center;"> <div style="background-color: #555; color: white; padding: 5px; writing-mode: vertical-rl; transform: rotate(180deg);">N/A</div> <div style="color: blue; font-size: 24px;">✓</div> </div> </div>

3. Summary list of Critical Success Factors (CSF)

The table below shows the ten **CSF MT** and why they are important from an FM perspective. Each one should be reviewed and, where appropriate, actioned when mobilising BIM projects in order to deliver the required project outcomes. The **Why the CSF is important** column provides a single line summary of why each CSF is key to the success of the BIM process.

Note: The MT are not ranked in any order of importance. The reader should access them as appropriate to their needs. The hyperlinks can be used to navigate to the different MT themes.

No	CSF Main-Themes (MT)	Why CSF is important
MT1	Implementing BIM with a WLC approach to support sustainability and UK government construction strategy targets	BIM can help deliver improved WLC and sustainability, especially when considered over the typical long life of built assets.
MT2	Recognising the importance of digitalisation and technology to FM and the BIM process	To remain innovative and competitive organisations need to be aware of and prepared for the changes that digitalisation trends will bring to the FM and RE industries.
MT3	Addressing and overcoming perceived barriers and challenges to adoption and use of BIM	Overcoming barriers will avoid 'silo-mentality' working and ensure FMs can position themselves for early engagement in BIM projects.
MT4	Making the benefits of BIM to the operational phase of assets transparent, realistic and achievable	It is important to manage expectations about BIM and not over-sell its capabilities: therefore having realistic and achievable benefits will allow them to be achieved.
MT5	Planning the strategic and operational information needs for FM in the BIM process	Clearly defining the strategic information needs for the operational phase will ensure FM teams have the right information/data they need to run and optimise built assets.
MT6	Improving stakeholder collaboration and understanding of the BIM process	A project which makes the most out of the collaboration possibilities within the BIM process stands a much higher chance of delivering successful outcomes for all stakeholders.
MT7	Clarifying the role of, and tasks of FM in the BIM process	Having a clear understanding of the role of FM will ensure FMs contribute their knowledge, thus improving project outcomes and the successful delivery of BIM projects.
MT8	Acquiring essential knowledge of key BIM standards/guidance documents for practical use in a BIM project	Using BIM standards and a 'standardisation approach' with good guidance documents will ensure all stakeholders communicate in the same language and avoid confusion and costly mistakes.
MT9	Ensuring people have adequate BIM training and competency skills to successfully engage in BIM projects	FM teams must have the right digital skills to work in an increasingly digitalised environment and understand the implications and impact on how they deliver FM services.
MT10	Ensuring successful transfer/ongoing management of information/data for the operational phase of assets	Starting a BIM project by planning 'with the end in mind' will greatly improve the project outcomes and ensure the efficient, accurate and fast population of data into CAFM and FM management systems.

4. Tables:

CSF Main-Themes (MT) and Sub-Themes (ST)

The following section provides a set of tables for the CSF MT as well as a short introduction text which explains why each CSF is important. In each CSF table an overall **aim** is defined and presented in the form of a **strap line** or **action**. If adopted and acted upon the intention is that the CSF action will help FMs and the other stakeholders involved in BIM projects to deliver the successful outcomes everyone desires.

A series of numbered **CSF ST** are then presented line by line in the tables. The **Explanation** column provides further detail to clarify the focus of the CSF and to highlight important issues that need to be considered. The **Examples** column provides some useful advice and links for the reader, and the **Mobilisation Status Check List** column can then be used to make an assessment as to the status of each ST and whether it is applicable or not.

Note: Links to useful websites and resources are provided throughout the document. Where these are provided (usually bold blue text) the links are shown when hovering over the text.



CSF MT and ST

MT1: Implementing BIM with a WLC approach to support sustainability and UK government construction strategy targets

- ST 1.1** Using BIM to maximise the long-term value and ROI of built assets
- ST 1.2** Using BIM to reduce operational costs, improve sustainability and help meet government 2025 targets
- ST 1.3** FM readiness to engage in BIM projects
- ST 1.4** Making the benefits of BIM to the operational phase of assets transparent, realistic and achievable
- ST 1.5** Planning the strategic and operational information needs for FM in the BIM process
- ST 1.6** Improving stakeholder collaboration and understanding of the BIM process
- ST 1.7** Clarifying the role of, and tasks of FMs in the BIM process

MT2: Recognising the importance of digitalisation and technology to FM and the BIM process

- ST 2.1** Awareness of digital trends and their potential impact on FM
- ST 2.2** Using technology/software tools to help improve collaboration and sharing of data
- ST 2.3** Linking BIM models to external databases
- ST 2.4** Set up of the CDE and ensuring security of BIM data
- ST 2.5** Ensuring data is correctly structured for efficient information exchange
- ST 2.6** Using BIM viewing tools/mobile technology to help improve FM services and access to information
- ST 2.7** Using social media for knowledge sharing and networking
- ST 2.8** Maintaining BIM models to ensure they remain up to date

MT3: Addressing and overcoming perceived barriers and challenges to the adoption and use of BIM

- ST 3.1** Upskilling FM teams to empower them for successful engagement in BIM projects
- ST 3.2** Preparing people and organisations for full engagement in BIM projects
- ST 3.3** Addressing concerns about costs associated with BIM and ROI
- ST 3.4** Clearly articulating the value and benefit of BIM to FM and the operational phase of assets
- ST 3.5** Setting realistic expectations of what BIM can deliver
- ST 3.6** Addressing pessimism about BIM
- ST 3.7** Understanding the need to focus on the quality of data rather than quantity
- ST 3.8** Addressing concerns about the complexity of BIM
- ST 3.9** Advising clients about BIM and how it might benefit them
- ST 3.10** Deciding on the appropriate IT tools and whether to adopt an open or closed BIM approach
- ST 3.11** Using case studies to document the benefits of BIM to FM
- ST 3.12** Reviewing CAPEX/OPEX budgets to ensure a sustainable WLC approach
- ST 3.13** Understanding legal implications for BIM projects
- ST 3.14** Avoiding silo-working mentality and encouraging early FM engagement
- ST 3.15** Assessing security and risks associated with BIM information
- ST 3.16** Understanding and use of BIM acronyms
- ST 3.17** Use of BIM/other standards with a KISS to ensure people can engage with BIM
- ST 3.18** Using BIM for existing built assets and capturing 'as-built' records during construction
- ST 3.19** Understanding the link between BIM, CAFM and FM management systems

- ST 3.20** Ensuring standard classification systems are used to improve access and transfer of data /information
- ST 3.21** Ensuring FM is fully and positively engaged with other stakeholders
- ST 3.22** Understanding the possible impact of short-term FM contracts and data ownership in a BIM project
- ST 3.23** Understanding the limitations of bi-directional transfer of data between BIM and FM systems
- ST 3.24** Working with BIM processes and preparing good quality OIR, AIR and EIR documents
- ST 3.25** Understanding the use of IFC/COBie for transfer of data into CAFM/ other FM management systems

MT4: Making the benefits of BIM to FM transparent, realistic and achievable

- ST 4.1** Using case studies as reference material to help provide evidence of the benefits of BIM to FM
- ST 4.2** Making the benefits of BIM clear and transparent
- ST 4.3** Ensuring a WLC perspective is taken to realise the full potential of BIM to FM
- ST 4.4** Measuring the benefits of BIM
- ST 4.5** Planning realistic timelines for the realisation of benefits
- ST 4.6** Ensuring access of good quality data from one place
- ST 4.7** Increasing operational efficiency
- ST 4.8** Improving strategic management of assets
- ST 4.9** Using the visualisation power of BIM models to help improve FM planning and safety
- ST 4.10** Improving the prediction of maintenance costs and ROI
- ST 4.11** Improving sustainability and the transparency of WLC
- ST 4.12** Helping collaboration with the design and construction teams

- ST 4.13** Improving health, safety and risk management
- ST 4.14** Supporting innovation, commercial models and use of visualisation technologies (AR, VR and MR) and AI
- ST 4.15** Using BIM to improve procurement, tendering and for insurance
- ST 4.16** Improving the handover from construction to operation
- ST 4.17** Reducing the cost of transferring data from construction into FM management systems
- ST 4.18** Avoiding abortive, disruptive or wasteful work
- ST 4.19** Using BIM for benchmarking RE
- ST 4.20** Providing added value by integrating BIM with other technology
- ST 4.21** Using Retro-BIM techniques to provide additional information about existing assets
- ST 4.22** Improving the handover process of quality information from construction to operation
- ST 4.23** Using BIM to improve the advertising and management of space

MT5: Planning the strategic and operational information needs for FM in the BIM process

- ST 5.1** Using BIM to support an organisation's AM strategy
- ST 5.2** Defining what FM information is needed from the CAPEX phase for the OPEX phase
- ST 5.3** Ensuring a good EIR is in place which addresses client and FM needs
- ST 5.4** Ensuring BIM models and quality information are updated and maintained after handover

MT6: Improving stakeholder collaboration and understanding of the BIM process

- ST 6.1** Improving the perception of FM in BIM projects
- ST 6.2** Using BIM to improve collaboration between stakeholder groups

ST 6.3 Ensuring FM readiness for early engagement in the BIM process

ST 6.4 Using BIM to meet government targets for improving assets and adding value to wider society

ST 6.5 Motivating and supporting people in the BIM process

ST 6.6 Preparing for the impact of BIM on the FM and AEC industries

ST 6.7 Using BIM to gain a competitive advantage

ST 6.8 Using BIM and other technologies to support FM delivery for existing buildings

ST 6.9 Using BIM to help improve data transfer

MT7: Clarifying the role of and tasks of FMs in the BIM process

ST 7.1 Supporting and advising clients in BIM projects

ST 7.2 Defining the EIR, OIR, AIR and FM information requirements to support the AM strategy

ST 7.3 Defining the data structure for BIM projects

ST 7.4 Considering the long-term OPEX budget in BIM projects

ST 7.5 Writing key BIM documents and providing guidance for clients

ST 7.6 Helping design teams understand the information needs of FM

ST 7.7 Giving feedback to D&C teams to improve operational and WLC decisions

ST 7.8 Using BIM to improve the handover process from construction to operation

ST 7.9 Identifying client needs and using FM know-how to help improve BIM project outcomes

ST 7.10 Validating data in BIM projects and keeping the BIM models up to date

MT8: Acquiring essential knowledge of key BIM standards/guidance documents for practical use in a BIM project

ST 8.1 Using BIM standards and guidance in projects to achieve better outcomes for all stakeholders

ST 8.2 Other useful BIM guidance documents

MT9: Ensuring people have adequate BIM training and competency skills for successful engagement in BIM projects

ST 9.1 Acquiring essential knowledge about BIM standards and guidance documents

ST 9.2 Using key BIM standards/guidance in practice

ST 9.3 Sources for EIR guidance, BIM books and BIM training courses

ST 9.4 Ensuring FM have the right guidance for engaging in BIM projects

ST 9.5 Bridging the digital knowledge gap between construction and operation

ST 9.6 BIM training for FM staff to ensure they have the necessary BIM and digital skills competencies

ST 9.7 Using the IWFM BIM guides to help improve FM engagement in BIM projects

ST 9.8 Essential tips for developing BIM guidance

MT10: Ensuring the 'successful transfer and ongoing management' of '3D models, alphanumeric data and documents' for CAFM/FM systems

ST 10.1 Planning the data transfer and quality checking process for BIM projects

ST 10.2 Planning what data to collect and how to transfer it into FM management systems

ST 10.3 Using standards and a specific classification system to ensure data is well-structured to enable easy transfer from BIM models using COBie/IFC

ST 10.4 Bi-directional data transfer and improving data handover processes and future possibilities

CSF 1:

Implementing BIM with a WLC approach to support sustainability and UK government construction strategy targets

Built assets are often procured with a **lowest price wins** approach. However, research and many industry *best practice reports* such as the CLC *'Procuring for Value'* (2018, p13) suggest that this is not the best approach to achieve long term value. The report recommends that in order to deliver sustainable built assets for society, the procurement should be carried by "exploiting new technologies and encouraging a focus on delivering the greatest value throughout the life of the project". BIM offers an excellent opportunity to do this and at the same time consider the procurement process from an OPEX perspective. This will help reduce costs over the whole-life of the asset rather than just looking for the cheapest short-term CAPEX solution. The importance of early engagement to influence costs was highlighted by *Patrick MacLeamy* (2004) in his work with HOK and later buildingSMART. This work is based on earlier work, shown in Figure 1 by *Paulson (1976, p 588)* his findings illustrated how the early stages of a project are where **high influence** over changes and project costs can be achieved at **low expenditure**.

Such an approach to procuring our built assets will help reduce waste and contribute to a better *circular economy*. People wishing to find out more can look at the ARUP *Circular Economy in the Built Environment* web page.

The BIM approach also helps support key targets (Figure 2) outlined in the Government's *'Construction 2025'* industry strategy (HM Government, 2013, p5).

Achieving the targets will only be possible if all stakeholders in the BIM process take ownership and consider ways to improve how we currently deliver, maintain and run built assets over their whole-life. From an FM perspective this starts with early engagement in the BIM process by contributing FM knowledge and helping design teams choose quality products, systems and materials. This will help optimise the long-term running costs of the assets. FMs should also help review proposed designs from an operational perspective to avoid issues which might incur additional operational costs over the WLC (e.g. lights at height that require expensive access equipment to change bulbs). Through collaborative discussion such issues can be designed out or a better solution found by the team. The paper by Meslec et al (2018) *'Integrating Life Cycle Sustainability Analysis with BIM'* provides some useful insights as to how BIM can be used to help improve sustainability in the design process, and the paper by Ashworth and Druhmman (2016) also provides some insights on how *'Rating Systems in Conjunction with BIM Deliver Outstanding Possibilities for Sustainable Construction'*.

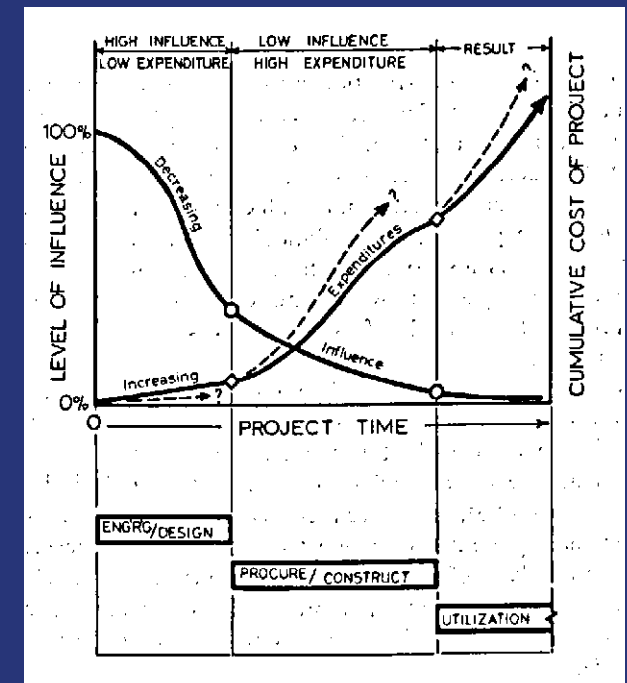


Figure 1

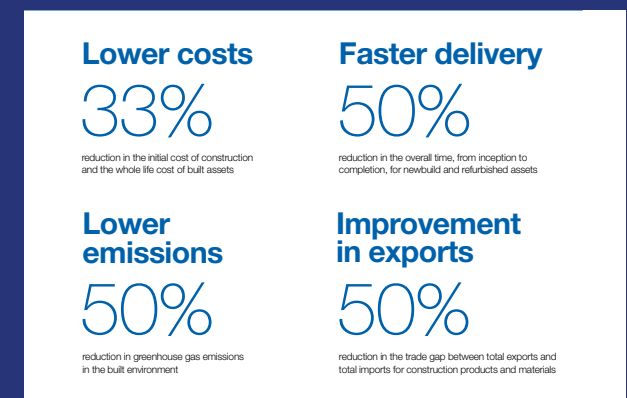






























Figure 2

CSF							
MT1: Implementing BIM with a WLC approach to support sustainability and UK government construction strategy targets							
Aim: Adopting a WLC approach to BIM will help deliver more sustainable built assets for people, organisations and society							MOBILISATION STATUS CHECK LIST
ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
1.1	Using BIM to maximise the long-term value and ROI of built assets	Adopting a WLC cradle-to-cradle approach to BIM, rather than short-term capital expenditure (CAPEX) focus, will help maximise best value over the long-term and ROI for built assets. Feedback loops with design teams should review designs, energy systems and quality/longevity of products/systems to reduce frequency of asset replacement (thus waste) and ensure sustainable WLC options are chosen. CAPEX and (operational) OPEX budgets should be balanced to see where more spend upfront will save over the long term. Value engineering should not result in increased long term OPEX cost just to get the cheapest CAPEX cost. BIM can help improve procurement and also achieve sustainable outcomes. 'Soft Landings' and 'BS 8536' should be adopted. FMs should also consider setting up performance targets to measure the success of a BIM project.	Adopting a WLC cradle-to-cradle approach will make the procurement of built assets more sustainable. The report 'Constructing a better future: achieving quality and best value in the built environment' is a good reference to understanding how we should all work towards achieving best value . This requires considering CAPEX and OPEX costs, rather than focusing just on the initial CAPEX cost of building an asset (e.g by considering equipment/material quality and life expectancy, and focusing on value engineering in favour of the operational phase). Research shows it is often worth paying more upfront for quality products that will reduce long-term operational costs. Project teams should also consider assessing life cycle costs of built assets. The 'Soft Landings' approach should be adopted which takes into account CAPEX and OPEX costs . The 'BS 8536' guidance standard should also be used to ensure FMs can give input at the appropriate time to achieve a sustainable outcome.				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
1.2	Using BIM to reduce operational costs, improve sustainability and help meet government 2025 targets	BIM enables FMs to contribute towards the Government construction strategy targets (research shows 66.1% of FMs believe BIM will help achieve the first target of a “ 33% reduction in the initial cost of construction and the WLC of built assets ”). More FM-BIM leadership is needed to reduce operational costs through WLC decisions and help clients drive change in their organisations. The FM incentivisation is realising the correct information needed to run and manage assets. In a wider context the digitalisation of Britain’s assets will help improve carbon sustainability and improve the circular economy as well as empowering the creation of smart cities. By supporting a more digitalised industry FM can also help attract young people into our industry.	The Government construction targets can be reviewed in the ‘ Construction 2025 ’ and ‘ Construction strategy ’ documents. the IWFM guide ‘ The role of FM in BIM projects ’ outlines how FMs should actively engage and work with design teams using their know-how to review the ‘ Digital Twin ’ (BIM model) and assess how the design will impact FM service delivery. Designs requiring expensive access equipment, or additional FM staff should be reviewed and a way found together with the design team to eliminate any unnecessary costs, e.g. by making access for maintenance easier, reducing the number of operational staff needed, etc.				
1.3	FM readiness to engage in BIM projects	Educating the FM industry with regards to BIM is critical if FMs are to be ready to contribute towards the success of BIM projects. Organisations like IWFM, IFMA, RICS, etc. are now providing guidance for people engaging in BIM projects in order to improve the overall outcome. People need to understand BIM is not just about software , but more about the overall process. FMs need to lead and engage clients and provide evidence of the benefits of BIM to convince their clients that there is a good business case to engage in BIM.	The IWFM have produced a range of FM specific BIM guidance. Several useful books have been produced including ‘ BIM for Facility Managers ’ which is available from the IFMA or online book retailers. RICS have produced an ‘ International BIM Implementation Guide ’. Some other useful texts include the ‘ BIM Handbook: A Guide to Building Information Modelling for Owners, Managers, Designers, Engineers and Contractors ’ available online at many retailers; and ‘ BIM for Construction clients ’.				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
1.4	Understanding the UK Government BIM Level 2 mandate	FMs need to be aware of the UK Government mandate to adopt and use BIM Level 2 on government procurement projects, which came into effect in April 2016. The requirements include the need for project and asset information, and for documentation and data to be electronic. This is important as the research indicates only 53.5% of people surveyed were aware of the mandate.	Specific guidance as to what is required from a government BIM Level 2 project is available from the UK BIM Framework and also SFT websites.				
1.5	Awareness of BIM 'maturity levels' and 'dimensions of BIM'	FMs should be aware of the difference between the ' maturity levels of BIM ' (the graduated increase of complexity) and the ' dimensions of BIM ' (referring to stepped addition of dimensions including time, cost, FM data etc). Having a clear understanding of the terminology will help better communication with other stakeholders in BIM projects.	Specific guidance about BIM maturity levels are available in a video from the B1M websites. Further guidance is also available from the UK BIM Framework and SFT website. An explanation relating to BIM dimensions can be found on the NBS website.				
1.6	Awareness of Britain's plans for a more 'Digital Built Britain'	FMs should be aware of the Government's ' Digital Built Britain Strategy ' and the cdbb , which has been set up as a central focus to understand how industry sectors can use a digital approach to better design, build, operate, and integrate the built environment. The research indicated 48% of people were not aware of the Government strategic approach. FMs can use the cdbb website to access publications, research and news pertaining to Britain's plans for future digital developments of infrastructure and built assets.	FMs can review a range of publications on the cdbb website. The publications help outline Britain's plans to create a digital built Britain.				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
1.7	Awareness of key BIM websites where FMs can access guidance and information	FMs should be aware of key websites where they can access guidance, standards and information relating to BIM. The research indicated 52% of people were unaware of such useful websites and their valuable resources.	A wide range of websites are available for BIM advice e.g. UK BIM Framework , cddb , IWFM , Scottish Futures Trust , EUBIM , BSi , NBS , buildingSMART , BIM excellence , BIM dictionary , BIM+ , TheBIMhub , designbuildings .				

CSF 2:

Recognising the importance of digitalisation and technology to FM and the BIM process

Digitalisation is having a significant impact across all sectors of industry including the FM and the AEC industries. If FM's are to remain innovative they need to be aware of developing trends and prepared to use these to their advantage. The book *'Facility Management as a digital change agent'*, (DFM, 2019), illustrates the wide range of technology used in the FM and RE industries (Figure 3).

The figure shows groups of technologies (columns) used in FM and RE ranked according to information level.

Note: the most information-generating technologies are placed at the top. (DFM, 2019)

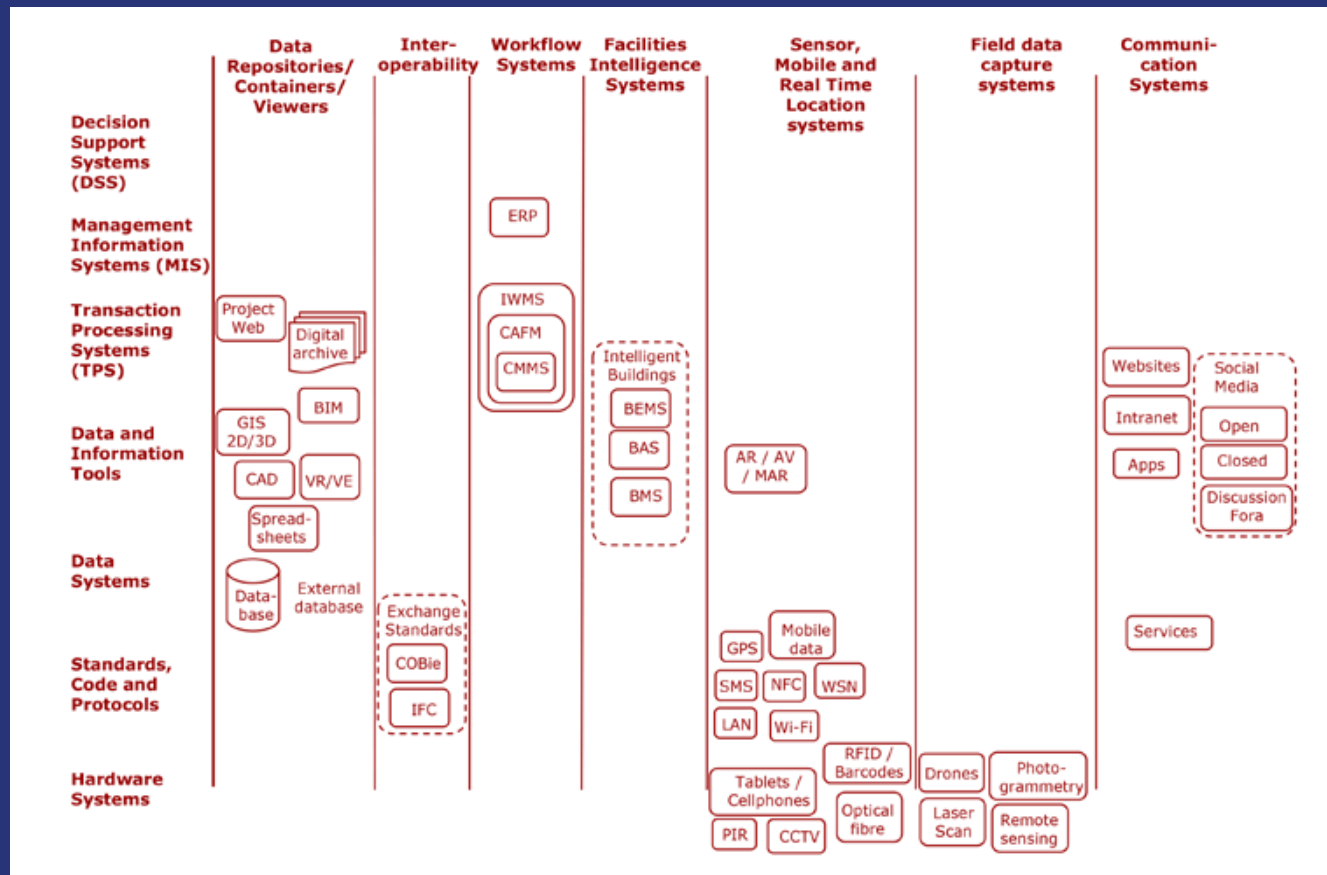


Figure 3

The annual Gartner *'Hype Cycle'* is one way of assessing the status of digital trends. These include Smart Workspace, AI, IoT, etc., some of which are already starting to impact on FM. BIM, also sometimes referred to in the context of a *Digital Twin* Deloitte explores this in the report *'Industry 4.0 and the digital twin'*. The concept is important as in 2018 the digital twin was at the 'Peak of Inflated Expectations'. The cycle shows the trend has already peaked and is now on the way towards the **Plateau of Productivity** which is estimated in the next 5-10 years (Figure 4). The FM industry needs to engage with BIM now, so it is well positioned to deal with the significant increase in information/data that will come from the many BIM projects (for both new and existing buildings) that will be handed over to FM in the coming years.

CSF 2:

Recognising the importance of digitalisation and technology to FM and the BIM process

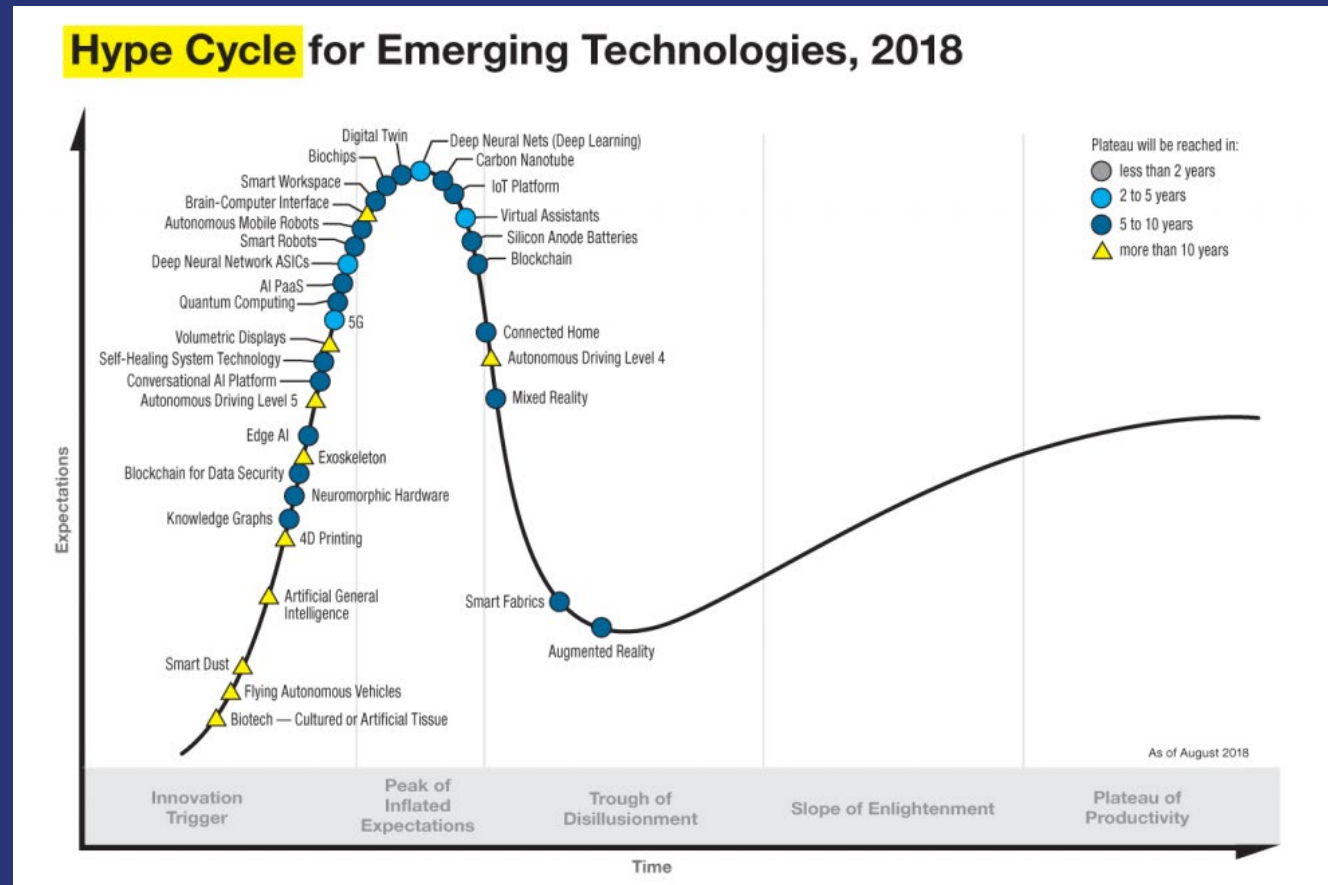


























Figure 4









The *cdbb* publications section outlines a series of reports on digitalisation including *'The Gemini Principles'* which "sets out proposed principles to guide the national digital twin and the information management framework that will enable it" (cdbb, 2019). They also have developed an interactive *'Roadmap for delivering the information management framework for the built environment'* (cdbb, 2019).

The report *'FM Awareness of BIM'* (Ashworth and Tucker, 2017) specifically highlights the importance of BIM as a trend, which will have a significant impact on FM especially with respect to the handover of **as-built information** about assets from construction to operation. Traditionally FMs have often been handed large numbers of files (hard and soft copies) consisting of drawings, specifications, operation and maintenance manuals, product data sheets etc. These are essential to the ongoing ability of operational teams to successfully manage systems, equipment and assets over their whole life. These are needed to run systems and equipment in the building. Increasingly this information will be delivered in digital formats. As one interviewee stated "unless FMs know how to receive, store, use and manage this digital information there is the potential for a data cemetery".

MT2: Recognising the importance of digitalisation and technology to FM and the BIM process								
CSF		Aim: Having the right digital knowledge and skill set will empower people to collaborate and deliver the benefits that digitalisation promises			MOBILISATION STATUS CHECK LIST			
ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A	
2.1	Awareness of digital trends and their potential impact on FM	It is important that FMs understand the impact of digital trends (BIM, IoT, big data, sensors etc.) on the FM industry. FMs need to be aware of how smart buildings are becoming more common and to think of BIM as an ecosystem and its link to trends like PropTech . This is leading to more automated ways of planning and carrying out maintenance to check equipment in response to a generated signal rather than just as a routine check.	The Gartner group produce a series of ' Top 10 Strategic Technology Trends ' which are updated every year. 'Digital Twins' were high on the list in 2019. The Danish FM network has also produced a useful book about the impact of digitalisation on FM called ' FM as a digital change agent '. The CBRE also predicted 10 FM trends for 2019, three of which focus on digitising FM . FMs should be aware of Smart buildings and how they are evolving, which is key to the FM industry. FMs can refer to the book chapter ' BIM Ecosystem: The evolution of products, processes, and people ' (Gu et al, 2014). People wishing to know more about PropTech can visit theBIMhub . Companies like Deloitte are looking at important issues such as ' Digital future readiness '.					
2.2	Using technology/software tools to help improve collaboration and sharing of data	Usability and operability are key issues that should be taken into consideration in BIM projects. Key to digital communication are online collaboration tools that can be used by project teams. The technology needs to be easy to use and require minimal training. How FMs access data in BIM projects should also be clear. This might involve the use of BIM viewer and other tools such as dRofus may be used to help plan room data sheets.	Usability and operability in the context of BIM are discussed in several papers e.g. (Mayouf, 2016), (Yousefzadeh, et al, 2105). There are many online collaboration tools that can be considered for projects. Some Blogs and papers address usability issues in BIM software . Software tools like dRofus might also be considered for early FM planning.					

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
2.3	Linking BIM models to external databases	<p>Linking databases with BIM models requires careful thought. It should be clear what data is in the BIM model and what might reside in other external databases. It needs to be clear which FM systems should be linked to BIM models (CAFM, BMS etc.). CAFM suppliers should advise FMs as necessary and clarify whether data can flow bi-directionally (BIM-CAFM-BIM), as often this is not the case. IFC and BIM Servers are also being used in countries like Norway as a future orientated approach.</p>	<p>The IWFM has produced a guide 'Essential BIM data preparation for FM systems' which can be used to help with many of these issues. Some examples of projects using IFC and BIM Servers are available here.</p>				
2.4	Set up of the CDE and ensuring security of BIM data	<p>Careful thought needs to be given to BIM/IT security risks and BIM data. It is recommended that FMs follow the advice and guidance provided in 'PAS 1192-5'. The CDE which is used to manage and control models, documents, data etc. during a BIM project should be carefully set up with BIM processes to control content.</p>	<p>The B1M explains 'What is a CDE?' in a short video. Further advice about CDEs can be found on the NBS website. Advice relating to security minded BIM is available in 'PAS 1192-5'. Additional information about security minded BIM can also be found on the NBS website.</p>				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
2.5	Ensuring data is correctly structured for efficient information exchange	It should be clear which data classification system is adopted by all stakeholders in a project. Teams need to decide if they are going to adopt openBIM , as opposed to closed BIM . Data needs to be structured so that it is easy to share between all stakeholders and therefore data exchange formats should be agreed early on in the project. This may include IFC and COBie. Data mapping may also be important when moving data from BIM into CAFM or other FM systems. PDT are also something which FMs should be aware of for capturing manufacturers' data.	Guidance about classification is available on the BIM Level 2 and the NBS websites. Information relating to different classification systems can be found online. The UK government has selected Uniclass as the default classification system for UK government projects. A video by BIM Connect explains the concept of openBIM . The BIM Journal offers further advice about open and closed BIM. FMs should be aware of IFC and COBie . Advice about BIM-CAFM data mapping can be found on the IWFM website. The NBS also have information about using PDT .				
2.6	Using BIM viewing tools/mobile technology to help improve FM services and access to information	As most FMs will not work with native software programs like ArchiCAD or Revit they will probably need a BIM viewer tool to access and look at BIM models. The FM team should establish how they will access and view BIM models and associated data (note: this may require some basic training). With proper planning and training FM staff can access BIM models on mobile devices in the field without having to go back to their desks, thus saving time and costs. The research also indicates that practitioners believe BIM can help improve the marketing of buildings .	There are a wide range of free BIM viewer tools available. Freeware IFC tools are also available for visualising, checking and translating IFC files. The SFT website also offers some advice about BIM viewing tools . A wide range of mobile apps for BIM are available to help improve workflow. Some suggestions for BIM marketing suggestions can help organisations sell buildings and promote their BIM competencies for project work. Some reports like ' Turning point for the construction industry ' (Berger, 2017) show how BIM is having a disruptive effect on the AEC industry in many ways.				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
2.7	Using social media for knowledge sharing and networking	There are many BIM communities online which can be used as valuable resources for networking and becoming better informed about BIM. It is suggested that people search LinkedIn and Twitter for groups that align with their interest. The UK BIM Alliance also has information about BIM Regions and BIM4 Groups.	FMs can check out BIM communities on Twitter or LinkedIn . The UK BIM Alliance also has information about BIM Regions where communities are established. The BIM Journal has produced a dedicated journal edition ' BIM for FM, clients, owners and operators '.				
2.8	Maintaining BIM models to ensure they remain up to date	A process should be implemented to keep BIM model(s) and their associated data up to date in a similar way to that of 2D drawings and associated data. It should be clearly agreed how this process will be implemented, when updates are needed and who will implement the updates. This will probably require the services of a professional architect service.	The role responsible for ensuring the correct handover and quality of information in the BIM process (this may be the Information Manager) should check that a process is put in place to determine when updates to the BIM models should be implemented. The NBS and the RICS give some advice on updating BIM objects on their website. Books such as ' Building Information for Dummies ', ' BIM and Construction Management ' and ' BIM for Facility Managers ' give some limited guidance on updating BIM models. However clients should review and decide how best to update their own models, being conscious of model and data ownership as well as the professional skills needed for such updates.				

CSF 3:

Addressing and overcoming perceived barriers and challenges to the adoption and use of BIM

Kelly et al (2013, p191) highlighted in their paper *'BIM for facility management: a review and case study investigating the values and challenges'* that "BIM for FM is an emerging area and there is still limited knowledge available on the subject". They identified four main challenges (2013, p197) for FM:

- "The lack of tangible benefits of BIM in FM despite agreement about the potential of BIM in FM"
- "The interoperability between BIM and FM technologies"
- "The lack of clear requirements for the implementation of BIM in FM"
- "The lack of clear roles, responsibilities, contract and liability framework"

Carbonari et al (2015, p60) in their paper *'How Facility Management can use Building Information Modelling (BIM) to improve the decision-making process'* noted a need for "evidence to convince facility managers to fully embrace this new technology". Ashworth and Tucker's (2017, p2) article *'Building a bridge to BIM'* suggested there was still "more work to be done" before the FM industry is in a position to be able to reap the full benefits of BIM.

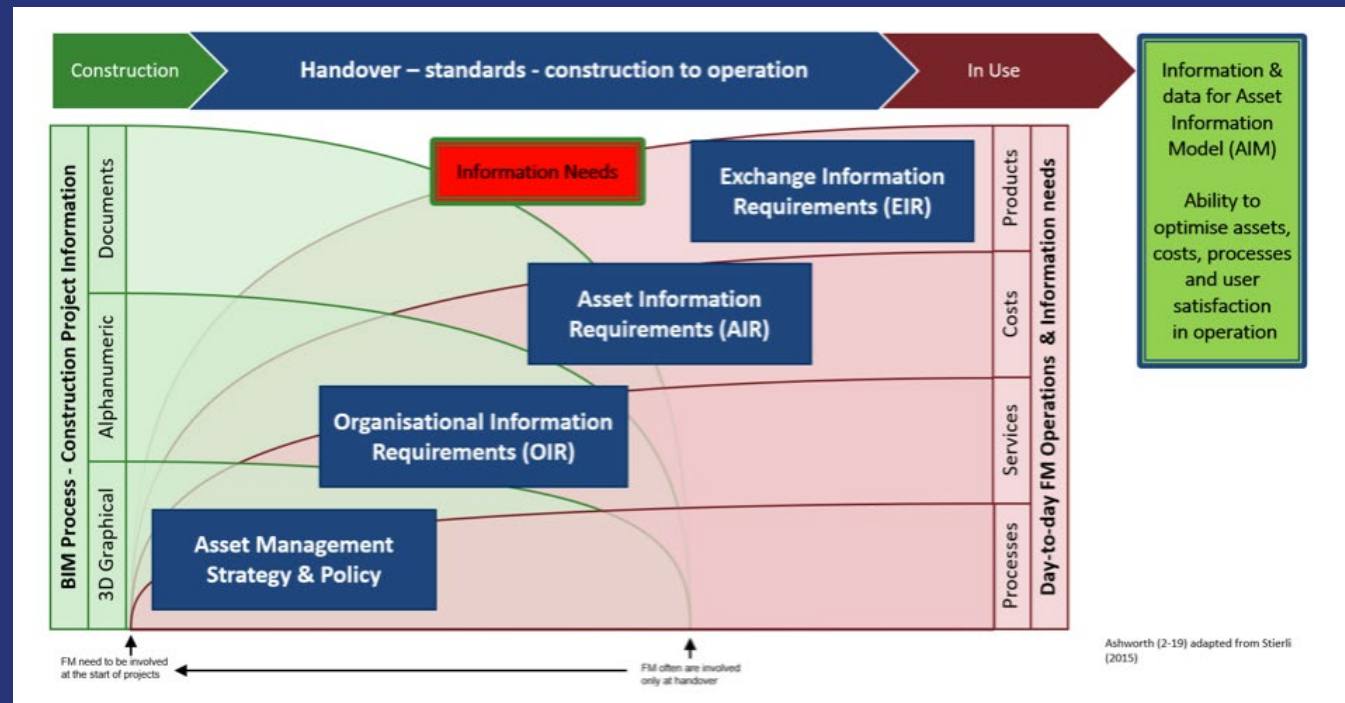


Figure 5

They note a reoccurring barrier and challenge across various research; "if FMs are not involved in defining the scope very clearly at the beginning then they will only get the best will of the rest of the design team, which may not be what they really need" (p3). The importance of early FM involvement is illustrated in Figure 5 (Ashworth, 2019). It reminds us the three information/data types

i.e. **3D graphical, alphanumeric and documents** which are collected during the BIM process then have to be turned by FM into **processes, services, costs and products** for use in **day-to-day FM operations**. This is much harder if FM are only involved at the point of handover. In order to plan the best project outcomes, they need to be involved from the start.

CSF 3:

Addressing and overcoming perceived barriers and challenges to the adoption and use of BIM

A more detailed picture of some of the challenges facing FMs was presented by Ashworth and Tucker in the 2017 report *'The FM Awareness of Building Information Modelling (BIM)'* (Figure 6) by Ashworth and Tucker (2017). The research highlighted "72% of respondents believe that the FM industry is not clear what BIM is" and "67.7% disagree or strongly disagree that the industry is well prepared to deal with BIM projects (p5)". The highest three ranking barriers/concerns (see Figure 7) were perceived as: 1) 72.5%: "CAFM software suppliers should work on tools that allow bi-directional transfer of data between BIM and CAFM", 2) 71.7%: "BIM training and how facilities managers will access data in 3D models at handover", and 3) 68.1%: "lack of training and cost of training associated with BIM" (p7).

However, on a positive note the research also indicated 83.5% of FMs believed "BIM will help support the delivery of FM" and 83.8% that "BIM is already having an impact or will do so in the next five years" (p5).

There are many issues that need to be addressed if BIM projects and digitalisation are to deliver successful outcomes including some that may not be immediately apparent such as legal issues of 'data ownership'. For example, Fan et al (2018, p2098) note in their paper *'A critical review of legal issues and solutions associated with Building Information Modelling'* that "roles for auditing a BIM delivery system must be included in the contracts to ensure the quality and compliance of BIM deliverables". As BIM becomes more commonplace there has often been a tendency to overcomplicate it. Kelly (2018) notes in his article *'Back to Basics - The What, How and Why of BIM and FM'* that "BIM-enabled facilities management has the potential to add significant value to assets and estates", but also, "there are many challenges that need to be considered to make the transition easier and the benefits clearer to all". The research indicates that the industry would be helped by an approach that aims to keep things simple, allowing people to focus on planning for the best outcomes and making data accessible and useful for end users.



Figure 6





CSF 3:





Addressing and overcoming perceived barriers and challenges to adoption and use of BIM





As such we need to think about how to avoid **data overload** and consider **how to structure data** so it can be easily accessed and retrieved. This was highlighted in an Ernst and Young research report *'Digitalisation Study on the Real Estate Sector in Switzerland'* (2019, p15). The findings indicate **“structuring of data”** as the highest-ranking challenge for most participants (92%). Importantly, the report also highlights the critical importance of people in the **“success in implementing a digitalisation strategy”** noting *“74% and 70% of respondents, respectively, see a lack of human resources or a shortage of skilled staff as the biggest challenge to implementation”* (p.5). As such we need to ensure people and their needs are put centre stage. Education, familiarisation and training need to be supported where people are involved in projects and processes, so they are confident and competent working with BIM standards and the technology which is increasingly becoming a critical part of the framework of delivery. People also need to have an appreciation of the wider issues around the **digitalisation of real estate** in order to be able to collaborate with all the stakeholders involved and produce **positive project outcomes**. This is becoming more and more important as increasing numbers of buildings are being constructed with BIM and there is an increasing drive to digitise and capture data about our existing buildings and assets.

Ranking of barrier	Type of barrier/concern (Please indicate your level of agreement with possible concerns/barriers relating to BIM)	Combined	Strongly Agree	Agree
1	CAFM/software suppliers should work on tools that allow bi-directional transfer of data between the BIM and CAFM	72.5%	33.1%	39.4%
2	BIM training and how FMs will access data in 3D BIM models at handover	71.7%	26.0%	45.7%
3	Lack of/cost of training	68.1%	23.6%	44.5%
4	Management/collection of data in the BIM process	62.6%	13.4%	49.2%
5	Ability of FM to write/specify the OIR, AIR and EIR documents for a client	61.5%	14.6%	46.9%
6	I feel I need more knowledge about BIM before being involved in a BIM project	61.0%	20.1%	40.9%
7	The cost of adopting/implementing BIM	53.2%	13.4%	39.8%
8	I don't feel our organisation is adequately prepared to engage in BIM projects	51.2%	14.2%	37.0%
9	Using COBie for transfer of data into CAFM/other systems	42.5%	12.2%	30.3%
10	The impact of BIM from a legal perspective	30.7%	10.6%	20.1%









Figure 7













CSF							
MT3: Addressing and overcoming perceived barriers and challenges to adoption and use of BIM							
Aim: Understanding perceived barriers, will help people overcome them and get to the core of how using BIM can help improve project outcomes							MOBILISATION STATUS CHECK LIST
ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
3.1	Upskilling FM teams to empower them for successful engagement in BIM projects	Engaging in a BIM project for the first time can be intimidating. People need time to adapt to the new processes, acronyms, terminology, technology etc. Upskilling peoples' digital skills is important to levels of confidence engaging with BIM. Adequate resources (funding and time) need to be made available to the right people to ensure they have the necessary BIM knowledge and skills . FMs and their teams will then be able to help the supply team understand the operational information needs and deliver the benefits of BIM. Research by (Ashworth and Tucker, 2017) indicates engagement as key; " <i>FMs need to play a pivotal role</i> " and many interviewees felt training will help to ensure people are " <i>on board with BIM</i> ". Adequate resources should be provided in terms of training, time and software. The research indicates keeping BIM models up to date is an important task. It needs to be clear in the operational phase how this will be done and by whom. Different age profiles should be considered when providing different approaches to learning.	As part of their BIM strategy organisations should consider what BIM Training is required for their staff. There are a wide range of BIM courses available including day (or multi-day) courses, online courses such as those from buildingSMART, to full degrees connected to the BIM topic. Training options are continuing to develop as many companies rush to be involved in BIM training. It is suggested a search is carried out and recommendations taken to find professional recognised organisations providing training. Some examples of organisations providing training include: <i>IWFM, Hitherwood Consulting, BRE, BSi, RICS, BSRIA</i> and <i>buildingSMART</i> .				









ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
3.2	Preparing people and organisations for full engagement in BIM projects	Professional FM Associations (IWFM, UKBIMA, RICS etc.) are increasingly taking a lead to ensure good quality BIM guidance is in place for various stakeholders across the industry. There has also been a noticeable increase in focusing on training which specifically addresses the FM/client perspective. To improve BIM readiness organisations should review their own ‘in-house processes’ and include assessing how they engage with, and where appropriate, invest in BIM. Where relevant early FM involvement may be beneficial, organisations should ensure staff are adequately trained with respect to BIM basics and the benefits of BIM. Research (Ashworth and Tucker, 2017) indicates involving people in decisions about how BIM will impact on them makes them more likely to engage with and fully embrace BIM.	Organisations should review the latest ‘ UK BIM Framework ’ guidance available on their website. Internal processes should be updated where necessary in line with the latest BIM standards/guidance (See MT8). This may require a change management project to move the organisation from a ‘current state’ to ‘where they need to be’ for full and successful engagement in BIM projects. BIM training and guidance can be found using the sources in ST2.1/ST1.3. FM specific guidance for BIM ‘ The role of FM in BIM projects ’ can be found on the IWFM website. Other BIM guidance which maybe useful include the RICS ‘ International BIM implementation guide ’. The US GSA have produced the ‘ BIM Guide 08 - Facility Management ’ which some may find useful.				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
3.3	Addressing concerns about costs associated with BIM and ROI	<p>Clear transparency of the benefits is important to ensure BIM is not oversold, and people can see clear added value in engaging in BIM projects. The ROI of BIM is a key issue which should be demonstrated. Clients and project teams should be clear about their investment in BIM and try to evaluate the overall benefits as well as ROI. Note: this may include quantifiable and non-quantifiable aspects e.g. improved communication, reduced RFI etc., and may be dependant on the complexity of the project. A common barrier that needs to be overcome is that BIM just 'adds cost'. Instead people need to assess how BIM can help reduce long-term ongoing maintenance costs. Research indicates organisations need to be realistic and allocate a budget line to keep their BIM models and data up to date - this should include implementing processes in order to do so.</p>	<p>Research indicates most 'upfront investment' in BIM occurs in the design/construction phases. From the client/FM perspective it is very important to be clear and realistic about the possible benefits and ROI. This includes what BIM can and cannot do. The PwC report 'BIM Level 2 Benefits Measurement Methodology' (BMM) provides a good account of the impact of BIM on asset planning, delivery and operation. The presentation from Autodesk on 'Achieving Strategic ROI: Measuring the Value of BIM' and the paper 'Capturing the ROI of All-in Building Information Modelling: A Structured Approach' by Stowe et al (2014) may be of interest.</p>				










ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
3.4	Clearly articulating the value and benefit of BIM to FM and the operational phase of assets	FMs (and other stakeholders) need to be able to clearly articulate the value proposition of BIM to FM and the ongoing operation of assets. This is especially important where FMs need to convince clients or senior management teams to engage with or invest in BIM projects. Research suggests that organisations try to link benefits to their business needs to show how BIM can support their vision, mission and business objectives.	As well as the ROI topic identified in ST2.3 organisations should consider the wider benefits of BIM to FM. There are several research papers which highlight individual benefits of BIM. For a collection of the benefits in one place the paper by Ashworth et al (2019) <i>'The benefits of building information modelling (BIM) to facility management (FM) over built assets whole life cycle'</i> as well as the accompanying report <i>'The Benefits of BIM to FM Catalogue'</i> can be used to help review benefits and articulate the value proposition. Other industry reports such as the <i>'Cost Analysis of Inadequate Interoperability in the U.S. Capital Facilities Industry'</i> (NIST, 2004), and 'SmartMarket' reports can help people understand the value of applying BIM.				
3.5	Setting realistic expectations of what BIM can deliver	Over-selling BIM and raising peoples' expectations by promising BIM as a 'silver bullet' for every problem has often resulted in clients being disappointed, giving BIM a bad name. The idea that 'BIM is just software' also needs to be addressed and people need to understand the software is important but it is just one part of the overall BIM process. FMs should focus on understanding what BIM can really deliver, and plan what information is needed and in what format, so that plans can be put in place for data transfer into FM management systems.	The paper <i>'A Framework for Developing a BIM Strategy'</i> can be used as a reference for helping projects clearly define the expected outcomes. The SFT website includes a section <i>'Determine the Info Management & CDE Strategy'</i> which provides advice about strategy development. <i>'BS 8536'</i> can also be useful for defining project outcomes. The <i>IWFM</i> have produced a series of BIM guidance documents which can help FMs set realistic targets for BIM projects.				









ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
3.6	Addressing pessimism about BIM	In BIM projects, it is important to have realistic expectations and set achievable goals and objectives. This will avoid disappointment and help ensure expectation levels are managed across all stakeholders. In order to help overcome peoples' concerns about BIM and what it can deliver, the advantages need to be made as transparent as possible.	The articles ' The challenges of BIM ' and ' Overcoming reluctance to BIM is the key to construction's future ' address how people can overcome pessimism with respect to BIM. They also consider the benefits BIM can deliver (see MT4). Other reports of interest can be found on the Bentley Systems and Dodge Data & Analytics website . These include ' BIM Success Factors ' and ' The Business Value of BIM '.				
3.7	Understanding the need to focus on the quality of data rather than quantity	Poor data quality has often been highlighted as a key issue when transferring from construction to operation. Two important and linked factors are 1) quality vs quantity of the data and 2) data relevance . It is much more important to get good quality data that is relevant to operations and can be used, rather than lots of unstructured data that is difficult to use and maintain. The focus of data capture and transfer should be on quality, relevance and accessibility rather than just the quantity of data. Trying to capture everything should not be the focus.	In order to ensure data quality it should be: 1) relevant, 2) well structured and 3) easy to access. The NBS article ' BIM: what information is in the model ' gives some guidance in this respect. The article ' Is BIM the solution to construction's quality issues ' raises some interesting issues; that often the quality comes down to the collaboration and culture of people working in projects. Therefore it is recommended that organisations develop an open and collaborative working environment where people are encouraged to share information. COBie and products like the ' LIBAL Building & Infrastructure software ' tool can also be used as tool to check data being transferred. However, with all such tools a human is usually needed to check that what has been transferred is actually of good quality.				





ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
3.8	Addressing concerns about the complexity of BIM	People often see BIM as an added complexity for projects. However, it is important that people remember projects were managed for many years without BIM. BIM offers new possibilities and opportunities to improve the way we work if adopted and used in the collaborative way it is intended. Therefore each project should determine where it makes sense to use BIM. In all cases a KISS approach should be adopted.	The report ' Measuring the Impact of BIM on Complex Buildings ' presents some useful discussions regarding the appropriate use of BIM in relation to the complexity of buildings. Olbina and Elliot (2019) argue in their paper ' Contributing Project Characteristics and Realized Benefits of Successful BIM Implementation: A Comparison of Complex and Simple Buildings ' that BIM is equally applicable to smaller less complex projects.				
3.9	Advising clients about BIM and how it might benefit them	In order to help advise clients about BIM projects there needs to be more FM-industry leadership with respect to BIM. FMs are often the custodians of client information systems. As such they are uniquely positioned to help clients identify what information is really needed in operation. Clients also need to understand the BIM procurement process so that they can clearly instruct the supply chain when ordering BIM projects.	FMs should consider reading the suite of IWFM documents which provide advice about how they can engage with and support BIM projects. Readers can also refer to several papers for advice including: ' The Role of FM in Preparing a BIM Strategy and Employer's Information Requirements (EIR) to Align with Client Asset Management Strategy ' (Ashworth et al, 2016) and ' BIM Guidelines Inform Facilities Management Databases: A Case Study over Time ' (Kensek, 2015).				
3.10	Deciding on the appropriate IT tools and whether to adopt an open or closed BIM approach	The IT landscape for projects and determine which software solutions will be involved is a key decision that needs to be taken at the start of the project. Teams also need to decide whether to use an ' open BIM ' or 'closed BIM' approach. These decisions are key to collaborative working, sharing of information and ensuring the best project outcomes.	Specialist advice should be sought on the IT landscape to ensure all the tools work together. Some advice is available at the following websites: BIM software tools for all occasions as well as BIM Software: Which is the Most Popular? and BIM collaboration and communication tools .				





ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
3.11	Using case studies to document the benefits of BIM to FM	Documented evidence in the form of case studies will provide evidence to organisations who are looking for reassurance before they invest in BIM.	The body of useful case studies is growing. Some that readers may find useful include: ‘PwC BIM Benefits Methodology and Report’ , ‘PCH BIM case study’ , ‘Manchester Town Hall Complex’ , the SFT article ‘BIM & Digital Working Case Studies - Interactive Map’ , the paper ‘BIM in FM applications: a case study of a large university complex’ , the article ‘Top 10 Case Studies in Europe that showcase the power of BIM’ , the BIMhub ‘Case studies’ and ‘UK BIM projects’ on the BIMAcademy website. The paper ‘How to measure the benefits of BIM: A case study approach’ may also be of interest. Various other case study papers are available via www.researchgate.net .				
3.12	Reviewing CAPEX/OPEX budgets to ensure a sustainable WLC approach	CAPEX/OPEX decisions ideally should be taken with a long-term perspective. Otherwise there is the risk that teams look to drive down the CAPEX price as low as possible, but at the risk of increasing long-term OPEX costs, which over the life of a building will be much more significant. Therefore CAPEX/OPEX teams need to work closely together if a WLC approach is to successfully deliver best value to clients over the long-term.	An explanation of CAPEX/OPEX costs can be found on the designingbuildings.co.uk website. The article ‘BIM and FM: removing barriers to uptake’ helps to explain how clients can use BIM to reduce long term CAPEX costs. The importance of bridging the gap between CAPEX and OPEX is highlighted in a video by activeplan.co.uk . The paper ‘Bridging the life cycle: a case study on facility management infrastructures and uses of BIM’ highlights the need to focus on OPEX costs; <i>“because most of the costs during the life cycle (from 67 to 85 per cent) occur after the construction is completed, the great challenge of BIM is its implementation to FM”</i> . Saxon (2016) suggests in the article ‘Are clients getting the most from BIM?’ , that <i>“Capital spend can be shaped to optimise ‘Totex’, the combination of Capex and Opex, to deliver the desired outcomes”</i> .				









ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
3.13	Understanding legal implications for BIM projects	People need to have a clearer understanding of the legal implications of BIM in projects. It is recommended that project teams take legal advice to ensure complete transparency to all stakeholders with respect to the 'ownership of data' in BIM projects and 'who has responsibility for what'.	Winfield et al (2019) discuss legal issues with respect to BIM in the article ' The legal section: UK Guidance Framework for ISO 19650 '. Other papers considering the legal aspects are; ' Emerging contractual and legal risks from the application of building information modelling '. Teams can also use the new UK BIM Framework Information Protocol on the UK BIM Framework website.				
3.14	Avoiding silo-working mentality and encouraging early FM engagement	BIM projects will not deliver the full potential benefits if people adopt a silo-mentality working approach . All the stakeholders in the supply chain need to adopt a collaborative approach where people use the same language and avoid adversarial behaviour. The BIM project team needs to encourage early FM engagement to help the design teams understand the outcomes and information requirements that will deliver real benefits in the operational phase.	The article ' The Silo Mentality: How To Break Down The Barriers ' suggests better ways of working. The thesis ' Cultural Impact of Implementing BIM in the UK Construction Industry ' (Baker, 2019) presents some interesting findings noting that "collaboration is not only needed within the organisation, but in the supply chain as communication and sharing will reduce rework, and improve efficiency and productivity whilst adding value" (pii). Readers may also be interested in the article ' Collaboration is key: How BIM helps a project from concept to operations '.				
3.15	Assessing security and risks associated with BIM information	People need to be aware of digital security and the possible risks associated with BIM information being potentially accessible. Project teams need to ensure appropriate security measures are in place to ensure any potential risks are addressed.	Project teams should make themselves aware of, and work to, guidance supplied in ' PAS 1192-5:2015 Specification for security-minded building information modelling, digital built environments and smart asset management ' which can be downloaded from the BSi website. The articles of interest on this topic include; ' Implementing a security-minded BIM approach ' by NBS and ' Analysis of information security risks with BIM work flow ' by the IET. Readers may also be interested in the thesis by Abruzere (2018) ' Analysis of information security risks with BIM work flow '.				





ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
3.16	Understanding and use of BIM acronyms	BIM terminology and acronyms can be a source of confusion for people who are not experienced in BIM projects. As such it is suggested any acronyms used should be those set out in the standards contained within the 'UK BIM Framework'.	Appendix 1 of this document contains a list of common abbreviations. Other sources for BIM terms can be found online at the following: the BIM Dictionary , the BIME Initiative , the SFT ' BIM Terminology ', the BRE ' BIM Terminology ', and Bond Bryan Architects ' BIM acronyms '.				
3.17	Use of BIM/other standards with a KISS to ensure people can engage with BIM	Complexity should be avoided wherever possible. A straightforward KISS approach to BIM should be adopted to minimise confusion for people in the BIM process. It is important that the BIM standards and UK BIM Framework should be used in the spirit they were intended and applied in an appropriate way.	The ' KISS (Keep it Simple, Stupid) - A Design Principle ' should be adopted in BIM projects. A lot of modern buildings are complex in their design but this is exactly where BIM should help to provide more transparency and support work flows. The SmartMarket report ' Measuring the Impact of BIM on Complex Buildings ' reflects and provides feedback on this topic.				
3.18	Using BIM for existing built assets and capturing 'as-built' records during construction	BIM and data capture for existing buildings is rapidly becoming a key topic as organisations think about ways to digitalise their existing RE portfolios. As such it is important organisations and FMs understand where BIM and other data capture techniques, e.g. laser scanning, could be useful for existing built assets (and the limitations). These techniques can also be applied to recording 'as-built' records during construction.	The use of BIM for existing buildings is explored in ' BIM for Existing Buildings: Potential Opportunities and Barriers ' by Hossain and Yeoh (2018), and ' Building Information Modelling (BIM) for existing buildings – Literature review and future needs ' (Volk et al, 2014). The paper ' The Impact of Field Data Capturing Technologies on Automated Construction Project Progress Monitoring ' provides an overview of how technology can be used for existing building data capture. The article ' Implementing a BIM process for existing building projects ' reports on how BIM helped achieve a 4.46% cost savings for Copenhagen airport. The BIM Task Group guide ' Client Guide to 3D Scanning and Data Capture ' can be used as a reference guide.				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
3.19	Understanding the link between BIM, CAFM and FM management systems	People need to understand the link between BIM, CAFM and FM management systems . Clients and FMs are interested in getting data and information from the BIM process into their CAFM and other management systems as these are used for the day to day management of dynamic FM processes. The BIM models and associated data are static repositories which should reflect the 'as-built' data at handover. They need to be kept up to date but will not be used for FM dynamic processes, more as a data repository.	The term ' Computer Aided Facility Management ' is explored on Wikipedia. More detailed explanations as to 'What is CAFM?' are given by WBDG and FSI . The company Planon also have a guide explaining IWMS and CAFM. Forward thinking companies with regard to CAFM and links to BIM and linked data include EcoDomus and OneEighty . The IWFM guide ' BIM Data for FM Systems ' can be used to help plan the transfer of information into CAFM systems. The NIBS provide guidance regarding which CAFM systems are COBie compatible.				
3.20	Ensuring standard classification systems are used to improve access and transfer of data /information	Selecting an appropriate classification system is a critically early decision in BIM projects to ensure that data and information can be coordinated, managed and tracked during the life of the project. It is also essential for the subsequent mapping into FM and operational management systems. If managed well, the BIM process can provide data to facilitate improved decision making .	The importance of 'classification' is highlighted on the UK BIM Framework website. In the UK the government's preferred system is ' Uniclass 2015 '. The article ' BIM - it's all about the classification ' by BSRIA discusses the need for classification. The BIMAXON and BIM&Co websites have good articles that cover the various classification systems that could be used in BIM projects.				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
3.21	Ensuring FM is fully and positively engaged with other stakeholders	<p>Stakeholder engagement of FM in the BIM process is critical in order to ensure BIM can deliver its full range of benefits over the longer operational phase of assets. There needs to be a proactive step to inviting FM and operations specialists to give inputs about the systems and information they will use in the operational phase. They should also be encouraged to review design solutions to ensure additional hidden operational costs are not being introduced (e.g. additional staff needed to maintain systems, building materials or systems that require higher maintenance or replacement more often).</p>	<p>The research article <i>'Engagement of Facilities Management in Design Stage through BIM: Framework and a Case Study'</i> (Wang et al, 2013) results "show that early adoption of FM in design stage with BIM can significantly reduce life cycle costs". The thesis <i>'A Critical Review of BIM for FM with an Emphasis on Offices'</i> notes that the lack of early FM engagement is often "due to the lack of client awareness of the benefits". Naghshbandi (2016) highlights in the paper 'BIM for Facility Management: Challenges and Research Gaps' a problem that needs to be directly addressed in order to bridge the gap between construction and operations; "construction does not understand FM". Project managers should ensure that design and FM teams work together closely to help each other understand what is needed to produce the best project outcomes.</p>				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
3.22	Understanding the possible impact of short-term FM contracts and data ownership in a BIM project	<p>The length and status of supplier contracts and data ownership is an issue that needs to be carefully considered in BIM projects. During the 'construction phase' clients need to ensure they have full ownership and access to data. This issue should be discussed between the parties and legal advice sought to avoid any potential issues if there are any contractual disagreements. During the 'operational phase' this is especially important where they employ FM suppliers on short-term contracts who manage their data and which are then terminated. In such cases the FM suppliers may have control over valuable data which should remain with the client or transfer to a new supplier. This will help minimize risk in terms of losing access to their data if suppliers are changed.</p>	<p>Several papers cover the sensitive issue of data ownership. These include; 'BIM in practice: ownership of design data and access to the CDE', the 'Legal Implications of BIM: Model Ownership and Other Matters Arising', and 'Contractual and ownership aspects for BIM'. The NBS also have an interesting article 'BIM: mapping out the legal issues'.</p>				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
3.23	Understanding the limitations of bi-directional transfer of data between BIM and FM systems	The issue of 'bi-directional data-capability' is an important topic. FM and operations teams tend to use CAFM and other management software systems (SAP etc.) as their day to day 'modus operandi'. As such, what is important to operations teams is the availability and access to data from the BIM process for use in these systems. For many BIM projects the plan (at handover to operations) is to transfer data from the BIM models into these tools. However, currently this process is mostly a 'one-way-transfer' and if the BIM model is later updated this transfer process has to be repeated to keep things up to date. What would really help FM and operations teams is a 'bi-directional data-capability' that allows easy updates between the BIM models and other software.	Section ST10.4 provides some useful advice about bi-directional data transfer. The papers <i>'Asset Management in a BIM Environment'</i> and <i>'Interoperability analysis of IFC-based data exchange between heterogeneous BIM software'</i> highlight the benefits and challenges to achieving 'bi-directional data exchange. The survey <i>'FM Awareness of Building Information Modelling (BIM): August 2017'</i> found the highest ranking concern of respondents was that "CAFM software suppliers should work on tools that allow bi-directional transfer of data between BIM and CAFM" . Clients should actively review and discuss with their system suppliers the degree to which the tools support bi-directional exchange with BIM. Many CAFM suppliers including EcoDomus, <i>Archibus, Planon, Spacewell</i> etc. are now actively developing plug-ins to facilitate this capability.				
3.24	Working with BIM processes and preparing good quality OIR, AIR and EIR documents	Proper use of the BIM process and using BIM standards in the spirit they were intended is very important. Adopting and using common standards and processes helps ensure all project stakeholders have a common language and framework to work with as well as being clear about their roles. It is also important that clients and FMs understand how to write/specify OIR, AIR and EIR documents to start the BIM process.	The <i>UK BIM framework</i> should be consulted when considering BIM processes. Readers may find a useful place to start is the UKBIMA <i>'ISO 19650 Guidance Part 2 - Processes for Project Delivery'</i> . The IWFM also have several guidance documents which will help with BIM processes including the <i>'EIR Template and Guidance'</i> which can be used to help define the initial client information needs and the <i>'The role of FM in BIM projects'</i> which can be used to guide FMs as to their role in BIM projects.				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
3.25	Understanding the use of IFC/COBie for transfer of data into CAFM/other FM management systems	Understanding IFC/COBie is important when considering the transfer of data into CAFM/other FM management systems. Data is often transferred into operational software tools such as CAFM if not is using IFC/COBie. This may change in the future but currently COBie is a key deliverable for UK government projects.	Section ST10.3 provides some useful advice about IFC/COBie. The NBS and UK BIM Framework websites highlight required ' BIM deliverables for UK BIM projects '. The paper ' BIM to CAFM: An Investigation of Adapting a Building Information Model to a legacy Computer Aided Facility Management ' provides some useful reflection of the issues involved.				

CSF 4:

Making the benefits of BIM to the operational phase of assets transparent, realistic and achievable

The PwC BMM report *'BIM Level 2 Benefits Measurement Methodology'* (2018), is available in four sections on the cdbb website. It provides a detailed analysis and a review of a range of benefits of BIM considered and framed across the eight stages of the *RIBA Plan of Work (PoW)* process. Section 1; the *'Summary Guide'* presents eight key benefit categories: 1) time savings, 2) material savings, 3) cost savings, 4) H&S improvement, 5) risk reduction, 6) improved asset utilisation, 7) improved asset quality, and 8) improved reputation. Each benefit is presented from two perspectives; the **nature of the benefit** and **measuring the benefit**.

Section 2; the *'Introductory note: Approach and benefits framework'* explains the methodology and key principles behind establishing the **22 high level benefits** which were then categorised into the eight measurement categories above. The framework highlights "BIM enablers", "intermediate benefits" and "end benefits" Section 4; the *'Application Report'* considers two examples where analysis indicated "gross total quantified benefits estimated were 1.5% and 3.0% of whole of life expenditure respectively" (p6). Studies suggested a "5% efficiency saving across the overall design process" (p60) and "6-7% savings in annual maintenance costs" (p62).

Extrapolating this to a wider level the report continues "across the design, build and commission, and handover phases, our quantified estimates were 0.7% and 1.4% of capital expenditure respectively. If this level of saving could be achieved across the National Infrastructure Commission's projected public sector funded infrastructure spend of £31.7 billion in

2018/19, this would imply savings to UK taxpayers of £226 - £429 million (in £2017 prices)". The research also highlights the work by PwC (2018) using the BMM to analyse two projects highlights the importance of BIM in the operational phase; "over 70% of the benefit value occurred during the operation phase" (Figure 8).

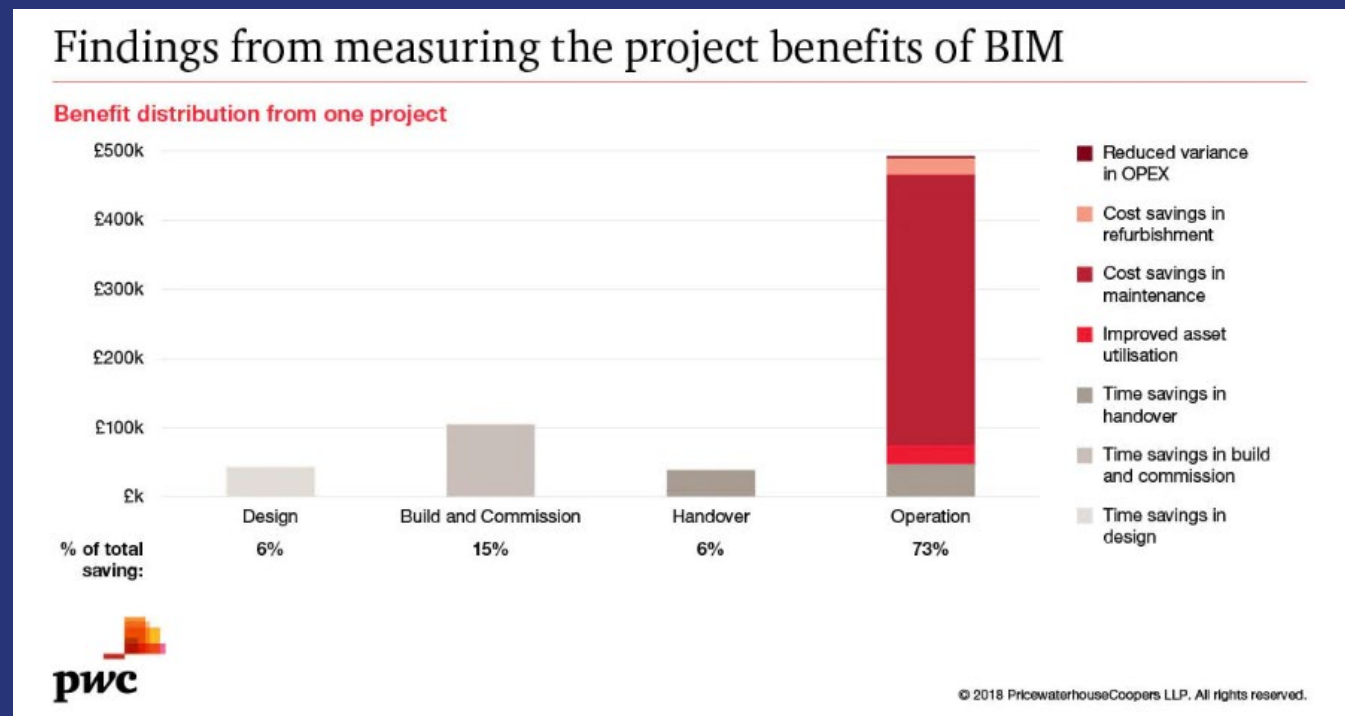


Figure 8

CSF 4:

Making the benefits of BIM to the operational phase of assets transparent, realistic and achievable

The blog 'Between the Poles' includes an article on 'First quantitative ROI analysis of the benefits of BIM for FM' by Broadbent (2018) which considers the ROI on BIM projects over a five-year period. A positive ROI was reported for all projects. The work "estimated that introducing BIM for FM saved on average 5 % of operating costs per annum".

In order to realise the full potential of BIM the **benefits need to be made transparent** and people need to be realistic about what BIM can deliver. There is a danger if BIM is **oversold** it will lead to unrealistic expectations. As such it is important that the reasons for using BIM on a project are clear and fully understood by all stakeholders.

Expected benefits should be clearly articulated at the start of a project so that they can be measured over the life of the project and lessons can be learnt for future projects. Research by [Ashworth and Tucker \(2017, p9\)](#) specifically focuses on FM feedback on key benefits of BIM to FM (Figure 9). The top three ranked benefits (based on "agree" and "strongly agree" answers) were: 1) "Strategic decision making about asset maintenance and management", 2) "Visualization of buildings/assets for customers, H&S and maintenance issues", and 3) "Data transfer from construction into CAFM and other software tools for operation".

Their research indicates a move from perceiving BIM purely in terms of cost saving and more as a way to **improve the strategic management** of RE portfolios.

Ranking of benefit	Type of benefits (Please indicate your level of agreement of possible benefit of BIM to FM)	Combined	Strongly Agree	Agree
1	Strategic decision making about asset maintenance and management	87.8%	39.4%	48.4%
2	Visualization of buildings/assets for customers, H&S and maintenance issues	87.0%	44.9%	42.1%
3	Data transfer from construction into CAFM and other software tools for operation	86.6%	41.7%	44.9%
4	Cost management/transparency (whole life, maintenance and asset replacement)	85.8%	42.5%	43.3%
5	Operational efficiency (in terms of cost/time)	83.8%	36.6%	47.2%
6	Space and move planning capability	77.9%	29.5%	48.4%
7	Simulation capability e.g. energy, fire evacuations etc.	77.2%	33.1%	44.1%
8	Sustainability in terms of reductions in energy use/carbon emissions	66.5%	23.2%	43.3%
9	Insurance costs for buildings due to availability and accuracy of information	58.3%	20.1%	38.2%

Figure 9

CSF 4:

Making the benefits of BIM to the operational phase of assets transparent, realistic and achievable









'The benefits of building information modelling (BIM) to facility management (FM) over built assets whole life cycle', by Ashworth et al (2019) carried out a review of possible benefits identified in literature. Figure 10 (p8) shows the benefits categorised into nine key categories, the top three being; 1) time savings, 2) productivity, and 3) cost savings. The full MSc thesis by Streeter (2017) is available online. *'MSc Building Information Modeling: An Analysis of BIM Benefits for Facility Management over Building Life cycle'* is available online . The research is also available as *'The Benefits of BIM to FM Catalogue'*. (Ashworth et al, 2019).

Ranking of frequency	Type of benefits category	Percentage
1	Time savings	21.98%
2	Productivity	18.23%
3	Cost savings	16.62%
4	Business values	14.21%
5	Data accuracy / quality	11.26%
6	Communication / collaboration	7.77%
7	Energy performance	4.02%
8	Improving safety and risk management	3.75%
9	Interoperability	2.14%





Figure 10





The paper *'How Facility Management can use Building Information Modelling (BIM) to improve the decision-making process'* (Carbonari et al, 2015, p53) may be of interest and considers how *"BIM offers FM an opportunity as a process tool to enable a more informed decision-making process"*.





CSF								MOBILISATION STATUS CHECK LIST			
MT4: Making the benefits of BIM to the operational phase of assets transparent, realistic and achievable											
Aim: Clearly articulating the anticipated benefits of BIM will help manage expectations and deliver realistic outcomes for all stakeholders											
ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A				
4.1	Using case studies to help provide evidence of the benefits of BIM to FM	Evidence of BIM benefits is key to establishing a good business case for its use on projects. Providing clear transparency of the benefits will help BIM buy-in from management teams to invest where appropriate. Case studies and standardisation are important to provide solid examples from practice. Having good guidance and ROI tools will also help convince management teams to invest in and work with BIM.	Project teams need to be clear and transparent about what benefits can be realised in a BIM project. <i>'The Benefits of BIM to FM Catalogue'</i> (Streeter et al, 2019) provides readers with an extensive list of possible advantages from literature. Articles of interest include <i>'Top 10 Benefits of Building Information Modelling (BIM)'</i> , <i>'How facilities management can take advantage of BIM'</i> and the RICS <i>'Utilising BIM to innovate the management of facilities'</i> . The SFT <i>'BIM & Digital Working Case Studies - Interactive Map'</i> , and the CITA <i>'Irish Case Studies'</i> may also be useful. Two Australian examples include the <i>'Sydney Opera House'</i> and the <i>'Perth Children's Hospital'</i> . Other websites showcasing BIM case studies include <i>'BIMhub'</i> , <i>'BIMCommunity'</i> , <i>'Graphisoft'</i> and <i>'BIM Facility AG'</i> . Readers may also be interested in the paper <i>'Developing a dynamic digital twin at a building level using Cambridge campus as a case study'</i> (Lu et al, 2019) and the RICS guide <i>'Building Information Modelling for Project Managers'</i> .								
4.2	Making the benefits of BIM clear and transparent	Transparency and credibility are key issues when considering the benefits of BIM. Some of these are illustrated in popular BIM books aimed at FM and clients. Where benchmarks and ROI examples are provided this will help make the benefits more transparent.	Benefits should be made transparent to ensure BIM is not oversold. Teams should target benefits which are achievable, and if possible measurable. Ashworth (2019) presents in two videos on the topic <i>'BIM Are You Aware'</i> and <i>'The benefits of BIM to FM over built assets life cycle'</i> . The thesis by Streeter (2019) <i>'BIM: An Analysis of BIM Benefits for FM over Building Life cycle'</i> and the follow up paper <i>'The benefits of building information modelling (BIM) to facility management (FM) over built assets whole life cycle'</i> (2019) provide an analysis of many of the benefits. The book <i>'BIM for Construction Clients'</i> and the cdbb <i>'Case Study: Towards a digitally enabled estate: the University of Cambridge'</i> provide some useful insights to benefits on the digital journey. Section ST3.3 provides more information about measuring the benefits of BIM and ROI.								









ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
4.3	Ensuring a WLC perspective is taken to realise the full potential of BIM to FM	In order to achieve long-term value and benefits clients and project teams need to consider the critical link between WLC to OPEX costs . Making short-term savings by cost cutting or value-engineering during the CAPEX phase can help deliver cheaper projects. However, great care should be taken that this is not at the expense of achieving the far greater potential savings from the long-term OPEX costs. As such BIM projects should focus on ROI over the long-term to ensure the best project outcomes from a WLC perspective.	In order to deliver long term value a WLC approach should be taken to BIM using 'Soft Landings' (Section ST7.7). Teams should refer to ' Government Soft Landings: Revised guidance for the public sector on applying BS8536 parts 1 and 2 '. Two slide sets which maybe of interest to readers are; ' Government soft landings and the benefits of BIM to FM ' (Rowland, 2012) and ' FM and BIM: The Employer's Information Requirements (EIR) and Whole Life Cycle (WLC) perspective ' (Ashworth, 2016). A more detailed look at the topic is provided in the thesis ' A Life cycle Approach towards Building Information Management: Technical and procedural implications for the facility management and operations sector ' (Parsanezhad, 2015).				
4.4	Measuring the benefits of BIM	The benefits of BIM are more credible where they can be measured . Examples from practice help people to understand what can be achieved with BIM and also where measurement may be appropriate. However, it is also true there are many soft benefits that may not be so measurable, but which are equally important, e.g. helping teams to work more collaboratively.	Teams should refer to the ' PwC BIM Benefits Methodology and Report ' (2018) which provides a detailed approach to measuring the benefits of BIM. This includes soft benefits and is available in four sections via the cdbb website. Another thesis which maybe of interest is ' How To Measure the Benefits of BIM: A Case Study Approach ' (Barlish, 2011). The Autodesk report ' Achieving Strategic ROI Measuring the value of BIM ' may also be of interest to readers. ARUP also offer a ' BIM Maturity Measure Model ' which can be downloaded from their website.				









ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
4.5	Planning realistic timelines for the realisation of benefits	People need to appreciate that the benefits of BIM may need time to be realised before the evidence is obvious. As BIM becomes the norm researchers and practitioners are finding better ways to measure the benefits. This is a natural part of the change management process. As more stakeholders become familiar with the BIM the benefits will become more apparent.	The ‘Gartner hype cycle for emerging technologies’ provides a way of assessing the maturity of technology trends. In 2018 the ‘digital twin’ was at the top of the cycle with the prediction of reaching full maturity (the plateau of productivity) between 2023-2028. As such organisations should be planning to be ready for the impact of BIM and the digital twin. Readers maybe interested in the SmartMarket report ‘The Business Value of BIM for Owners’ which highlights various ways that BIM will provide benefits to owners over time. In Chapter 2 of the ‘The BIM Manager’s Handbook’ Holzer (2015) discusses ‘change management’ and the drive to reduce time to see the benefits of BIM.				
4.6	Ensuring access of good quality data from one place	A key benefit is that BIM provides accurate information . The data models and process will provide a rich data set (3D models, documents and alphanumeric data). This will help the quality of data transfer, and the time needed for transferring data into CAFM systems. BIM will also help asset replacement and tenders to access data. This will reduce downtime and the time needed to fix assets that break down or need maintaining. These factors will add significant value to owners and the people who have to maintain the assets.	BIM teams should actively plan to ensure that they have a rich data set that will meet the needs of the client and FM team. The ideal approach is the Single Source of Truth (SSOT). People can refer to articles and blogs such as ‘Understanding the importance of single source of truth’ , ‘SSOT: Why Everyone in Construction Should Care About this Acronym’ and ‘Finding a Single Source of Truth for BIM Data’ . These have some good video examples of how data can be managed and handed over in a seamless way from construction to operation. Project teams will increasingly start using platforms like Autodesk’s ‘BIM 360 Docs’ or ‘Tribble Connect’ which are designed to provide a single cloud based platform solution. However, teams should also be mindful to ensure a ‘minimal useful’ approach so that the data is relevant to the operation of the assets. This is especially relevant where the operating team maybe small and need information/data to presented in an easy and straightforward way.				





ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
4.7	Increasing operational efficiency	The key benefits quoted for using BIM are time/cost savings . There is a growing body of evidence that BIM will help in both of these areas to improve operational efficiency. Linking BIM to mobile devices will provide many advantages to operational teams working in the field.	Project teams should consider ways they can use BIM to help save time and reduce project and ongoing operational costs. <i>'The BIM Imperative'</i> video by Excitech discusses some ways BIM can help operations teams and clients benefit from BIM. Some useful articles on this subject include <i>'5 Factors to save time and cost with BIM'</i> , 'Top 10 Benefits of BIM in Construction' and <i>'12 Advantages of BIM in Construction – Building Information Modelling Benefits'</i> . The article <i>'7 reasons the benefit of BIM is now'</i> also links reasons for the return on BIM investment. The article <i>'Back to Basics – The What, How and Why of BIM and FM'</i> by Kelly (2018) focuses on key ways BIM can help increase operational efficiency. Several papers are available on the topic including <i>'Improving FM task efficiency through BIM: a proposal for BIM implementation'</i> (Carbonari et al, 2018), <i>'The promise of BIM for improving building performance'</i> (Habibi et al, 2017), <i>'Benefit-Cost Analysis of Building Information Modelling (BIM) in a Railway Site'</i> (Ho Shin et al, 2018). Also <i>'Cost-benefit analysis of Building Information Modelling implementation in building projects through demystification of time-effort distribution curves'</i> (Lu et al, 2014) and <i>'Design and development of BIM models to support operations and maintenance'</i> (heaton et al, 2019).				





ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
4.8	Improving strategic management of assets	Research shows improving strategic asset management as one of the main benefits of BIM (Ashworth and Tucker, 2017). Improved cost planning and business intelligence are seen by practitioners as key. Digital twins will help organisations run scenarios and simulations and BIM will help improve the future flexibility of assets.	Project teams should collaborate to ensure that BIM helps support the strategic management of clients' assets. Workshops with clients can be used to discover what is key to the success of managing their assets. Section ST5.1 provides advice about using BIM to support an organisation's AM strategy. The paper <i>'The Role of FM in Preparing a BIM Strategy and Employer's Information Requirements (EIR) to Align with Client Asset Management Strategy'</i> (Ashworth et al, 2016) provides advice about ensuring that AM strategy is taken into account when preparing the EIR for a BIM project. Tucker and Masuri have several interesting papers on the topic: <i>'The rationale to integrate facilities management into the development process'</i> (2016), <i>'Critical strategic issues for the integration of facilities management into the development process'</i> (2017) and <i>'The development of facilities management-development process (FM-DP) integration framework'</i> (2018). Project teams should consider ways they can use BIM to help save time and reduce project and ongoing operational costs. Papers of interest on the topic include <i>'BIM business value for asset owners through effective asset information management'</i> (Munir et al, 2019) and <i>'Leveraging the relationship between BIM and asset management'</i> (Peacock et al, 2014). Trivedi (2018) from the Bentley Institute gives an interesting video interview entitled <i>'There are four elements involved in BIM Management: Technology, Processes, People and Policies'</i> which touches on key areas that are important to the link between BIM and strategic asset management. . EVORA has a video discussing <i>'optimising and future proofing buildings in a digital age'</i> .				





ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
4.9	Using the visualisation power of BIM models to help improve FM planning and safety	<p>Research indicates the visualisation capabilities of 3D BIM models are seen as one of the key benefits of BIM. This benefits operations teams with fault analysis, reporting and access to equipment manuals in the field, as well as the ability to assess H&S and access issues. The 3D models also help improve communication as many people find it difficult to visualise spaces from 2D plans. FM teams can visualise buildings during design and make suggestions to avoid costly operational issues, i.e. access etc. VR, AR and MR applications linked to BIM models also offer significant business opportunities including services such as ‘remote working’.</p>	<p>Project teams should think about what visualisation aspects are important both during construction and then in operation. Appropriate ‘BIM viewing tools’ should be selected to allow all stakeholders to visualise the models. These should be made available to allow operations teams to access the models without the need to understand complex BIM software. Teams should review clients’ target CAFM and other management software tools. It is important the CAFM are able to import IFC/COBie and visualise the 3D models directly. Companies like FM180 are driving BIM to CAFM integration using products like ‘MainManager’, which already allow interfacing between BIM and CAFM. The article ‘Using BIM & Visualisation technologies to save you time & money’ offers some useful tips and video examples of how visualisation can help in BIM projects. The blogs ‘The BIM Track guide to VR platforms’ and ‘VR and AR in Remote Work: Cases and Trends’ provide a useful overview of VR systems now being used to visualise BIM models. Readers may also be interested in papers on this topic ‘Real-time visualization of building information models (BIM)’ (Johansson et al, 2015), ‘V3DM+: BIM interactive collaboration system for facility management’ (Lee et al, 2018) and ‘BIM and 3D property visualisation’ (Andrée et al, 2018). The ‘Project Dasher’ from Autodesk is an interesting tool that provides a platform for visualising 3D-models connected to sensors in order to demonstrate building performance. The company Igllevision are now producing a ‘Shared VR for visualisation: The 360° visualisation platform’ which is an all immersive environment that may be of interest to project teams.</p>				





ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
4.10	Improving the prediction of maintenance costs and ROI of BIM	The rich data sets in BIM models enables more accurate prediction of maintenance and asset replacement costs. Teams managing tenders will benefit as they can access data and information about the building and its assets for use in tenders. Where BIM models are used for tendering they need to be kept up to date to ensure people are using accurate and current information.	BIM provides a wealth of data which can help operations teams to better manage their maintenance and deliver an improved ROI. From the start of a project teams should determine what benefits will help the operations teams to deliver the best outcomes. The BIM project should be tailored to collect appropriate data to support the client's management processes. Readers might be interested in the articles ' BIM ROI ', ' First quantitative ROI analysis of the benefits of BIM for FM ' and ' CMMS still has a future ' which discuss the rise of predictive maintenance. Papers on the topic include: ' Financial benefits for real estate sector by using technologies of AEC industry ' (Wills and Piazzolo, 2019), ' A BIM-based PSS Approach for the Management of Maintenance Operations of Building Equipment ', (Fargnoli et al, 2019), and ' A BIM-based Decision Support System Framework for Predictive Maintenance ' (Cheng et al, 2016).				
4.11	Improving sustainability and the transparency of WLC	BIM can help with WLC and sustainability . The 3D models can contain all the basic information required for WLC (i.e. the element cost, life span and the service costs associated with plant and equipment). BIM information and data will also help reduce risks from a decision making perspective. It will support a cradle-to-cradle approach to building, and ' Soft Landings ' to ensure better WLC and a lower carbon footprint .	Project teams should consider the sustainability targets of the client's organisation. The BIM process should support the construction of more sustainable assets as well as collecting data to demonstrate how buildings perform. Sections MT1, ST3.12, ST7.4, ST7.7 and ST9.4 all provide further guidance on BIM and WLC and their impact on sustainability. Readers may also find the following article by NBS useful ' BIM and its potential to support sustainable building '. The following papers may also be of interest: ' Bridging the life cycle: a case study on facility management infrastructures and uses of BIM ' (Miettinen et al, 2018) and ' Developing a Methodology for Integration of Whole Life Costs into BIM Processes to Assist Design Decision Making ' (Zanni et al, 2019). Also ' Case Study of Carbon Emissions from a Building's Life Cycle Based on BIM and Ecotect ' (Peng and Wu, 2017) and ' Utilizing BIM and Carbon Estimating Methods for Meaningful Data Representation ' Mousa et al, 2016).				





ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
4.12	Improving collaboration with the design and construction teams	BIM can offer significant benefits to collaboration between all stakeholders in the process. It especially helps decision making and collaboration between those planning and constructing the assets, and those running and maintaining them.	Project teams should look at ways to improve collaboration across the whole supply chain. A CDE can help and with modern cloud solutions people can access all data from one place with mobile and other devices. Sections MT6 , ST2.2 and ST3.10 provide further advice about collaboration in the BIM process between the various stakeholders. The articles ' Collaborative practices for building design and construction ', ' BIM collaboration ' and ' Collaboration at the construction and operations stages of a BIM project ' provide a good background to the need for more collaboration in the construction process. The article ' Ways BIM management software improves communication to field operations ' discusses new ways to collaborate using software and cloud based solutions. ALLPLAN also has a series of ' BIM guides ' that may be useful.				
4.13	Improving health, safety and risk management	BIM can help improve H&S not only in the construction process itself but also in the operations phase. The 3D models and associated data can provide a fully populated database for carrying out better risk assessments and safety planning.	Project teams should consider the H&S implications in a BIM project and familiarise themselves with ' PAS1192-6 ' which can be downloaded from the BIM Level 2 website . The NBS article ' What is PAS1192-6 ' may be useful. The ' Guidance Note for Clients writing an Employers Information Requirements ' provides useful advice in this respect. Increasingly ' BIM for Health and Safety in Construction ' is being integrated into software solutions e.g. ' BIMSafe ' and ' SafetiBase '. These are being used to improve H&S planning. Readers may be interested in the papers ' Integrating BIM and Planning Software for Health and Safety Site Induction ' (Godfaurd and Abdulkadir, 2011) and ' Integrating Building Information Modelling and Health and Safety for Onsite Construction ' (Ganah and Godfaurd, 2015).				





ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
4.14	Supporting innovation, commercial models and use of visualisation technologies (AR, VR and MR) and AI using BIM.	BIM will help innovation by providing a basis for capturing data and being able to store, visualise and retrieve information in a more transparent way. This will provide plenty of opportunities for innovative business solutions and developing new commercial models . This is evident from the current groundswell of start up companies using BIM.	Innovative success using BIM (and other technologies) will come from how they are used and integrated in everyday business processes. Project teams should encourage all of the supply chain to explore what innovative ideas can be brought in early to help the overall project. Some interesting videos are available discussing innovation on the Archdaily website and the blogs ‘Mixed reality: Experimenting with digital models’ and ‘How AI is improving BIM and helping the construction industry’ . The VINCI Facilities video provides some advice about how BIM can help FM in operation ‘Being innovative in building operations with the BIM FM’ . Some further examples are touched on in the article ‘How to integrate BIM with business processes?’ . The following papers may be of interest: ‘An Innovative Framework of 5D BIM Solutions for Construction Cost Management: A Systematic Review’ (Vigneault et al, 2019) and ‘Innovative Capability of Building Information Modelling in Construction Design’ (Selçuk Çıdık et al, 2017). The World Economic Forum is helping to promote innovation through its document ‘An Action Plan to Accelerate Building (BIM) Adoption’ .				





ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
4.15	Using BIM to improve procurement, tendering and insurance	BIM has the potential to be used to improve procurement . A well specified model with the right information will help tendering and WLC for various services like cleaning etc. before the building is constructed. Tenderers can be given access to the models for visualisation. This will help them review how their processes will work in the geometry of the building. They will be able to identify potential problems (e.g. equipment that needs to be cleaned at height etc.). They will also have access to all the information about surfaces, sq. metres etc. for pricing. WLC solutions can be calculated before construction starts by asking for services costs when procuring the building elements (costs for elevators, heating systems etc.).	Project teams should collaborate and look for innovative solutions for delivering client projects. Each stakeholder should confirm what they can bring to the table to benefit the overall project outcome. The ICE webinar discussing BIM procurement may help; <i>'BIM for procurement: selecting the right model for infrastructure projects'</i> . Papers addressing the theme include <i>'A Methodology for a Performance Information Model to Support Facility Management'</i> (Marmo et al, 2019) and <i>'Case study of BIM handover to support building operations'</i> (Cavka et al, 2013). The Swiss KBOB <i>'Recommendations on working with BIM'</i> provides some useful general advice on BIM procurement. The report <i>'BIM within the public procurement: A model-based approach for the construction industry'</i> may also be of interest.				





ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
4.16	Improving the handover from construction to operation	<p>If well planned, BIM will help improve the handover process from construction to operation. It will provide a rich data set of 3D models, alphanumeric data and documents which will be available as part of a BIM project. However, if the transfer process is not well planned, clients maybe disappointed. The key to success is planning in advance what information is required and in what format. The process for transferring information into FM management software must to be well planned. This will ensure that information can be mapped to the right destination and is not lost in the process. POE checks can also benefit from having clear transparency of what data and information should be available.</p>	<p>Project teams should ensure there is a clear process for managing the collection of 3D models, data and documents during a BIM project. It should be clear how this information will be transferred to the client and FM teams, and into which of their software systems. Helpful articles on the topic include 'Back to Basics – The What, How and Why of BIM and FM' (Kelly, 2018) and 'Adopting BIM for Facility Management: Handle With Care' from Planon, which discusses how BIM can benefit FM and the handover process. The Siemens 'BIM@ Siemens Real Estate' guide also gives lots of useful information for the planning process and 'data drops'. The paper 'A Framework for Developing a BIM Strategy' gives useful advice to define the BIM strategy for a project that clearly defines expected outcomes. Client and FM teams should familiarise themselves with 'BS 8536' and the IWFM series of BIM guidance documents, which help FMs set realistic targets for BIM projects. These include the 'EIR Template and Guidance' for defining the information needs and the 'BIM Data for FM Systems' to help guide the transfer of information into CAFM systems.</p>				





ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
4.17	Reducing the cost of transferring data from construction into FM management systems	BIM will help improve the process of transferring O&M information into (or linked to) CAFM/FM-management systems . In the past this process was often very inefficient, labour intensive and often data was poorly mapped into the target software or even lost. BIM can help improve the process significantly but still needs to be well managed.	Project teams should aim to ensure a robust process is in place to decide what data is needed in operation. This should collect the specified information during construction and then transfer or link it to the FM target management systems that will use it. The <i>'FM Awareness of BIM'</i> report (Ashworth and Tucker, 2017) highlights <i>"data transfer from construction into CAFM and other software tools"</i> as one of the top three benefits of BIM to FM. However, the top concern was <i>"CAFM software suppliers should work on tools that allow bi-directional transfer of data between BIM and CAFM"</i> . As such, at the start of each project the team should consider which CAFM or other tools will be the target repository for information/data. These tools should allow bi-directional data exchange. Interesting articles on the topic include <i>'The key to the future'</i> , <i>'BIM to CAFM'</i> , <i>'BIM for Facilities Management: 4 Tips to Improve Life cycle Performance and Reduce Costs'</i> and <i>'BIM Guidelines Inform Facilities Management Databases: A Case Study over Time'</i> . Papers on the topic include <i>'BIM-based facilities information streamlining the information exchange process'</i> and <i>'BIM for FM: A literature review and future research directions'</i> both by Matarneh et al (2019).				





ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
4.18	Avoiding abortive, disruptive or wasteful work	Some of the biggest waste factors in the traditional building process include teams having to accommodate variations . Often there are many changes which result in significant costs and sometimes time delays, especially if requested after construction has already started. The waste includes peoples' time, material costs and waste in the materials themselves. In the operation phase this is often reflected in time 'looking' for information. If the process is well organised and the handover managed then this will not be the case.	The WRAP guidance ' Reducing your construction waste ' highlights approximately "100 million tonnes of waste in the construction industry with 25 million going in landfill". Waste should be avoided in the process wherever possible. As such it is key that project teams review designs thoroughly with client and FM teams before construction work starts. With BIM this can be done with 3D models and AR/VR to ensure the number of variations is reduced to a minimum once construction starts. Teams should ensure the transfer to FM management systems is well planned and captures all the right information. This will avoid operational staff wasting time having to look for things later. The WRAP document ' Resource efficiency through BIM: a Guide for BIM Users ' and the article ' 7 ways to cut waste in BIM implementation ' provides guidance as to how BIM can help reduce overall waste. The articles ' Do workers still waste time searching for information? ' from Xenit, ' The social economy: Unlocking value and productivity through social technologies ' from McKinsey and ' Definitive Guide to America's Most Broken Processes ' from Ninetex highlight the cost of not being able to find relevant information. The paper ' Designing out construction waste using BIM technology: Stakeholders' expectations for industry deployment ' (Akinade et al, 2018) also highlights how waste can be reduced in the construction sector using BIM.				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
4.19	Using BIM for benchmarking RE	BIM will provide rich data sets which can be used actively with other tools to help improve the benchmarking of real estate.	<p>Project teams should discuss with clients how they benchmark their RE portfolio. This process should actively identify any key information/data which can be collected during the BIM process in order to help clients with their benchmarking. This might involve looking at existing tools within the organisation to see what information they need in order to perform their benchmarking activity. There are lots of products available from suppliers like Planon and Archibus to help with benchmarking. These can link with, and use, data from the BIM process. The article ‘How building information modelling will help the real estate industry’ helps to explain how the RE industry can benefit from BIM including benchmarking. Interesting papers on this topic include ‘Exploring the value of BIM for corporate real estate’; (Wilkinson and Jupp, 2016) and ‘Closing the gap in building performance: learning from BIM benchmark industries’ (Tuohy and Murphy, 2104). Also ‘BIM Cloud Score: Benchmarking BIM Performance’ (Du et al, 2014) and ‘BIM-based benchmarking system for healthcare projects: Feasibility study and functional requirements’ (Choi et al, 2018).</p>				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
4.20	Providing added value by integrating BIM with other technologies	The increasing integration of technology means that systems which in the past were often stand alone are becoming increasingly integrated and cloud based. Many of the big BIM software suppliers are developing new platforms which can connect with sensors . They are also looking at innovative ways to provide new business solutions.	Project teams should consider how technology can be used to help provide better communication in their BIM projects. This should include what cloud based systems will be used at the start of the project but also in the operational phase. Section MT2 provides more detail about the impact of technology. The article by David Philp ‘Welcome to the Digital Estate’ and BIM2050 report ‘Built Environment 2050: A Report on Our Digital Future’ explain the drive for increased digitalisation of RE. The articles ‘Best 20 Building Information Modelling (BIM) Software in 2020’ , ‘Best Building Design and Building Information Modelling (BIM) Software’ and ‘Which software BIM is the best for me?’ provide an overview of many of the best known BIM modelling software. Companies like Autodesk are providing tools such as ‘Autodesk Forge’ which allow independent developers to design new BIM apps and tools. CAFM suppliers are starting to actively look at integrating their tools with BIM software. The articles ‘BIM into CAFM – The Why and The How’ and ‘Reaping the benefits of linking BIM and CAFM’ explain some of the key benefits and issues. The paper ‘BIM: A disruptive process towards traditional practice’ (Ahmad et al, 2016) discusses the disruptive nature of BIM and how organisations need to adapt to it in key areas including technological change. ‘BIM in facilities management applications: a case study of a large university complex’ (Kassem et al, 2015) describes a case study at Northumbria University’s city campus and ‘Effective Facility Management and Operations via a BIM-based Integrated Information System’ (Parsanezad and Dimyadi, 2014) highlights important issues to streamline and integrate technologies. ‘IFC BIM-Based Facility Management Approach to Optimize Data Collection for Corrective Maintenance’ (Shalabi and Turkan, 2017) discusses how IFC can help the transfer of data from BIM to CAFM. Companies like Archibus who provide CAFM and other FM management tools are starting to integrate BIM with CAFM and create tools/interfaces to help the bi-directional exchange of data as shown in the video ‘Horizant’s ARCHIBUS-BIM Webinar’ .				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
4.21	Using Retro-BIM techniques to provide additional information about existing assets	The topic of using BIM (and data capture techniques) to create Retro-BIM models of existing assets/buildings is becoming gradually more important. Increasingly organisations are capturing data in relation to their existing property and digitising it to help them manage their portfolios more effectively.	<p>Clients wishing to digitise their existing RE assets or buildings should review sections ST3.18 and ST6.8 which provide further information which may be helpful. It is important to understand that collecting any information about what you can't see (i.e. behind walls) can be very expensive. A balance needs to be struck as to what is worth collecting vs. the available budget. Various data collection methods are available and should be reviewed to see what is applicable to the project. Scan-2-BIM (or methods) usually require specialists who can carry out the data capture and modelling if required. The articles ‘Digital transformation a futurewise built environment’ by David Philp for BSRIA, ‘How digitizing building information transforms the built environment’ (Whyte and Hartmann, 2017) and the ‘The LIQUID Report: Leading the digital transformation of global Real Estate’ touch on how digital transformation will impact on many areas of RE and FM. The video ‘Historic Building Information Modelling’ helps explain how scanning and BIM are used to record historic buildings. The ‘BIM & Existing Building - Magazine’ describes examples of why it is important to consider digitising existing buildings/assets. Several videos are of interest: ‘What is “Scan to BIM”?’ helps explain the process; ‘BIM Facility Zurich HB Scan to BIM’ gives a good idea of what is possible with technology. The ZHAW Life Sciences and Facility Management video ‘BIM 2 AR - ZHAW Facility Management’ from the authors own university illustrates how BIM and VR are being brought together in existing buildings. The following papers are also of interest: ‘Building Information Modelling (BIM) for existing buildings: Literature review and future needs’ (Volk et al, 2014), ‘BIM mixed reality tool for the inspection of heritage buildings’ (Brito et al, 2019), ‘Using BIM to Retrofit Existing Buildings’ (Khaddaj and Srour, 2017) and ‘BIMification: How to create and use BIM for retrofitting’ (Scherer and Katranuschkov, 2018).</p>				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
4.22	Improving the handover process of quality information from construction to operation	BIM can be used to carry out quality checks with respect to what data is in the models and the transfer/export for use in other FM management systems. Data drops can be used to check if the specified information (outlined in the EIR) has actually been delivered at the required time in the life of a project.	Project teams should be clear about what quality system will be in place to check the information/data handed from construction to operation to ensure its quality and that it matches the clients' information requirements. The BIM process should start with good quality product data as described in the article 'Creating quality BIM data' . The paper 'A Framework for Developing a BIM Strategy' and the standard 'BS 8536' can be used to help define a BIM strategy for the project that clearly defines the expected outcomes. The IWFM have produced a series of BIM guidance documents including the 'EIR Template and Guidance' for defining the information needs and 'BIM Data for FM Systems' to help guide the transfer of information into CAFM systems. The video 'Delivering New Royal Adelaide Hospital with BIM' provides some good insights from practice. Siemens have a useful guide 'BIM@Siemens Real Estate' , which details the idea of data drops. Interesting articles on the topic include, John Ford's 'Quality Check your BIM Data (PDCA Guide)' and Rob Jackson's 'Testing OpenBIM data Exchange for Client Specific Data Sets' . For those wanting a detailed understanding of COBie, the book 'Construction-Operation Building information exchange (COBie) Quality Control' (East and Bogen, 2016) and the blog-guide 'A Guide for Validating and Checking BIM Submittals' maybe of interest. Other useful papers include 'Building Information Modelling for Quality Management in Infrastructure Construction Projects' (Wang, 2014) and 'Examining the quality and management of non-geometric building information modelling data at project hand-over' (Fitz and Saleeb, 2019).				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
4.23	Using BIM to advertise property and improve space management activities	BIM will provide useful information for a range of RE services including managing and marketing space . The BIM models can be used as a marketing tool to help with the prompt leasing of properties hopefully before they are even finished. Detailed 3D models and 2D plans can be used for marketing properties to tenants or buyers . They can also be used in everyday FM operations to help space management operations. This includes planning moves and way-finding for contractors and others needing to locate property, spaces and individual pieces of equipment.	Project teams should assess how the BIM models (and data as appropriate) can be used for marketing purposes. This could include the initial project itself. It will also benefit the client during the ongoing operational phase The team can make use of the BIM models to produce rendered images, sections and elevations from literally any perspective. The 3D models can also be used with VR to allow potential clients to explore a property before it is built. This enables properties to be reviewed with buyers during the design phase and adapted to meet their requirements before construction starts. It also enables the visualisation of a completed property to help people decide if they want to rent or buy. BIM can help FMs in change-management projects involving the allocation of space or relocation of people. The RICS article ' BIM and commercial property: opportunities for property professionals ' discusses the opportunities of using BIM for marketing property. Papers which might be useful on this topic include ' Project and facilities management using BIM: University of Salford relocation management to Media City ' (Onyenobi et al, 2010), ' Exploring the value of BIM for corporate real estate ' (Wilkinson and Jupp, 2016) and ' Application Areas and Data Requirements for BIM-Enabled Facilities Management ' (Becerik-Gerber et al, 2012) which discuss visualisation and marketing using BIM.				

CSF 5:

Planning the strategic and operational information needs for FM in the BIM process

FMs are ideally placed during a BIM project to **help represent the needs of the owner and end users** to ensure that assets are built so that they can be operated, maintained and managed effectively over the much longer operational phase. In BIM projects one often hears the expression “**starting with the end in mind**”. This includes the essential task of clearly articulating *what information* is needed in the operational phase to run and report on assets in day-to-day operation. The international ‘**ISO 19650**’ standard uses the term *hierarchy of information requirements* which is made up of a series of key BIM documents. These are described in the standard and include: the **Organisational Information Requirements (OIR)**, **Asset Information Requirements (AIR)**, the **Project Information Requirements (PIR)** and the **Exchange Information Requirements (EIR)**. The OIR and AIR essentially describe what information is needed to meet organisational business objectives and reporting purposes for operating the organisation’s portfolio of assets. The PIR explain the information needed to answer or inform high-level strategic objectives and should be identified for both project management process and the asset management process.

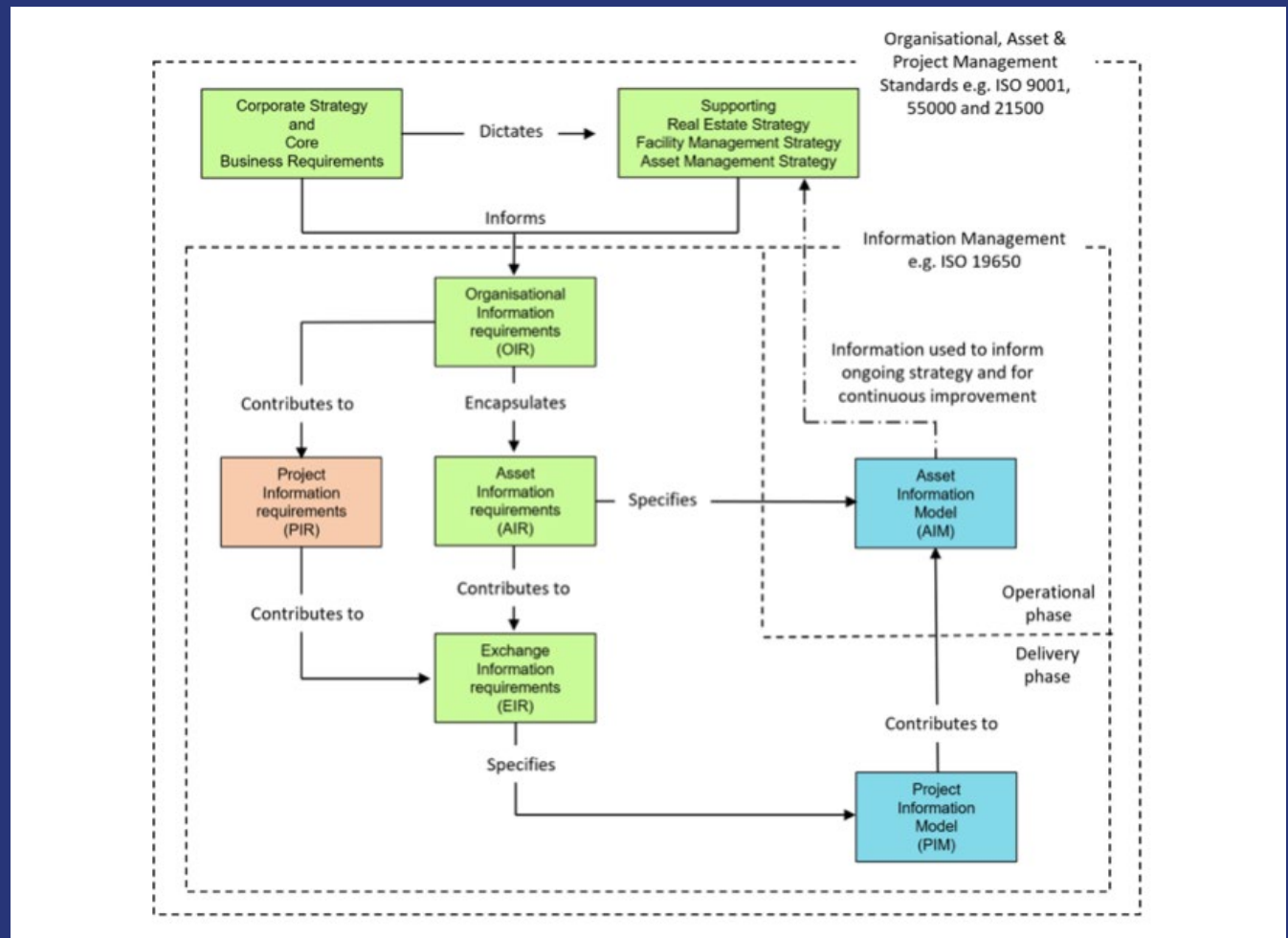


Figure 11

CSF 5:

Planning the strategic and operational information needs for FM in the BIM process

The **EIR** is then based on these and is used during a formal appointment of a project team to provide the delivery supply chain with clear guidance so that they can collect the information requirements in an organised and structured way. This is done during the design and construction phase using the **Project Information Model (PIM)**. This is subsequently handed over for use by the organisation during its operation phase and is then referred to as the **Asset Information Model (AIM)**.

Figure 11 (Ashworth, 2019), is based on **'ISO 19650'** and outlines the relationship and links between the organisation's strategy and the hierarchy of information requirements. It also illustrates the relationship between **'ISO 19650'** and other well-known standards such as **'ISO 9001'** for **quality management**, **'ISO 55000'** for **asset management** and **'ISO 21500'** for **Project Management**, and how these relate to the PIM and AIM. All these acronyms can be confusing at first and seem complex. It is essential that all stakeholders have a good understanding of the BIM terminology so that information requirements can be explained in a common language that other stakeholders will understand.

The IWFm **'The Role of FM in BIM Projects'** (Turner, 2017) provides explanations behind each of the terms and guidance for developing the information requirements.





It is suggested a **minimal useful** approach is adopted when planning the information requirements, rather than trying to collect **everything**. Research and practice indicate the later often leads to wasted time, effort and increased cost. Two papers by Ashworth et al (2018); **'Critical success factors for facility management employer's information requirements (EIR) for BIM'** and **'Employer's Information Requirements (EIR): A BIM case study to meet client and facility manager needs'** provide guidance on critical aspects when considering the operational information needs. Note: the term for the document **'Employer's Information Requirements'** was changed to **'Exchange Information Requirements'** in the **'ISO 19650'** BIM standards published in 2018, however the contents remain largely the same. The **'EIR: Template and Guidance'** (Ashworth, 2017) as shown in Figure 12 can be downloaded from the IWFm website and used as a guidance tool for creating a project EIR. The IWFm EIR can be used to help successfully define the information needs which are so critical to the successful outcomes of the project and which can then be used by the delivery team to develop their contractual response.





The lead appointed party and their appointed parties are responsible during the RIBA PoW stages for ensuring the whole supply chain provide the required **BIM model(s)**, **alphanumeric data** and **documents** (PDFs, Excel, JPEGs etc) to provide the final





As Built Information in the agreed formats for the **In Use** phase. If all project stakeholders collaborate, significant time and money can be saved in getting this information in a structured way to facilitate easy transfer into FM management systems (e.g. CAFM, SAP etc). However, like any good project in order to get the best results one needs to collaborate and start planning from the beginning of the project.







Figure 12

CSF							
MT5: Planning the strategic and operational information needs for FM in the BIM process							
Aim: Defining the information/data needed to run and optimise built assets in operation to help ensure a smooth transition from construction to operation							
MOBILISATION STATUS CHECK LIST							
ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
5.1	Using BIM to support an organisation's AM strategy	Organisations need to ensure the BIM strategy for a project aligns with their own business and AM strategy. Research shows many organisations have AMS in place. This is critical as the AMS is fundamental to the start of the BIM process and it will define many aspects of the key BIM documents (i.e. OIR/AIR/EIR). Organisations need to take time to define OIR/AIR and these should be written/ owned by clients/FM-teams . They provide the critical starting point to inform all stakeholders at the beginning of the BIM process about the way the organisation manages its day-to-day business. Careful consideration should also be given to the organisation's business strategy and risk management approach. The project team should ensure the outcomes always align and support these.	The NBS article ' Aligning your BIM strategy with your client's asset management strategy ' highlights the importance of aligning BIM to existing AM strategy in an organisation. Several articles discussed in the online BIM Journal ' BIM for FM, Clients, Owners and Operators ' may be of interest to readers. One of these, ' Defining FM and Client Information: OIR, AIR, PLQ and EIR ' by Ashworth (2017) highlights that the OIR and AIR are unique to individual organisations and the EIR are individual to specific projects. Therefore it is important that time is taken at the start of a BIM project to clearly define their own needs in these documents. This is normally done using a set of questions referred to as PLQ. The concept of PLQ is discussed in the NBS article ' What are Plain Language Questions (PLQ) '. Essentially the questions highlight issues which should be covered in the documents. The EIR is subsequently developed based on the OIR and AIR. The paper ' Employer's Information Requirements (EIR): A BIM case study to meet client and facility manager needs ' by Ashworth et al (2017) explains how the EIR should be developed to ensure alignment with the OIR/AIR and AM strategy. The ' BIM Guide for Asset Information Delivery ' from Singapore gives a good overview of the whole process.				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
5.2	Defining what FM information is needed from the CAPEX phase for the OPEX phase	<p>A minimum useful approach should be adopted. The temptation to create huge spreadsheets with 100s or thousands of attributes for BIM models should be resisted. Research shows many are not really needed or then maintained in operation. Therefore careful consideration should be given to OPEX thinking and defining what information is actually needed and its source. This should be defined in the EIR (this might include information outside the BIM models). Research suggest starting by considering what PPM, statutory and facility/asset maintenance tasks are undertaken. This could include reviewing systems such as 'SFG20'. Practitioners have a set of what they call 'W-questions' to help establish the important information. These include: What assets are managed and matter? What level of information do you need? Who is responsible for supplying data and managing the model/data? Where is it managed and stored? Who owns it and Where/how do you find data? This should include identifying critical systems. It should also be transparent and clear to all parties who is contractually responsible for the delivery of specific information.</p>	<p>The UKBIMA 'Data Requirements for the Construction and Management of Buildings – A Guide for Clients' offers good advice. Organisations should establish a list of critical and general assets and information needed to ensure their optimal running. 'The 'PAS 1192-3:' standard, downloadable from the 'standards' section of the UK BIM Framework website, should be referred to when thinking about the information for the operational phase of assets. Note: this will shortly be replaced by 'ISO 19650-3'. The video by Mills (2015) from The B1M 'PAS1192-3 in 4 Minutes' provides a useful overview. The article 'PAS 1192-3 and BIM Training for FM & Asset Managers' (Chrurcher , 2018) provides a good overview of the scope are purpose of the standard as well as training for operators. Careful consideration should be given to what information will actually be in the BIM models and what will come from other sources. The list of asset information might be checked against a standard such as 'SFG20'. Another source is to check current CAFM data and also ask the CAFM suppliers for their help. The NBS article 'Building Information Modelling: What information is in the model?' touches on this subject. The paper 'Integration of FM and BIM: A review of key issues and challenges' (Dixit et al, 2019) highlights the importance of the FM in deciding what information is needed; "<i>the single most important issue is the lack of FM involvement in project phases when BIM is evolving</i>".</p>				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
5.3	Ensuring a good EIR is in place which addresses client and FM needs	<p>The BIM process should ensure information is cascaded through all stages of the project. In terms of BIM documents and the information needed by clients and FM, this starts with the OIR. This then informs the AIR and both are then used to define the EIR. It should be noted all of these documents are the responsibility of the client in the BIM process. They need to be specific to each project, clear and simple and avoid any excessive wording. The end repository (i.e. software tools) for information should be clearly identified.</p> <p>FM knowledge should be captured early in the process by engaging the FM team, as they are the ones who will use the software tools (e.g. CAFM) on a daily basis. Roles and responsibilities need to be clarified and it is recommended that the EIR is developed in collaboration with other stakeholders to ensure transparency and avoid any surprises. An EIR template can be used to shorten the process, however, it must be amended to suit each project and not just copy-pasted from another example.</p>	<p>Section ST7.2 provides readers with guidance on the EIR. The importance of ensuring a well defined EIR which aligns with the wider organisation’s strategy is discussed in various articles including; ‘<i>Aligning your BIM strategy with your client’s asset management strategy</i>’ and ‘<i>Defining FM and Client Information: OIR, AIR, PLQ and EIR</i>’. The <i>bimsense</i> website presents seven important reasons for organisations having an EIR. The SFT BIM portal article ‘<i>Create the Employers Information Requirements</i>’ also highlights the importance of the EIR as both a pre-contract, and a contract document. The papers by Ashworth et al ‘<i>The Role of FM in Preparing a BIM Strategy and Employer’s Information Requirements (EIR) to Align with Client Asset Management Strategy</i>’ and ‘<i>Employer’s Information Requirements (EIR): A BIM case study to meet client and facility manager needs</i>’ suggest how FMs can help develop the EIR to ensure it is in alignment with the corporate vision, mission and strategy.</p>				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
5.4	Ensuring BIM models and quality information are updated and maintained after handover	<p>A change control process needs to be put in place to ensure BIM models/data are kept up to date after handover from construction to operation. This will probably require organisations to set up a contract for professional BIM services as the updating process requires specialist skills. The model ownership and update responsibility should be openly discussed to ensure it is clear who has ownership of all the models, and where there is an ongoing responsibility, to maintain or update them. These issues should be included in the EIR and form part of the contractual requirements. A process for checking the quality of models and data should also be in place to ensure validation at the point of handover. This should include checking data-fields in the target repository systems to ensure the required data has been included and mapped to the correct location. COBie data drops should be used to check what data has been exported from the BIM model(s). Note: this will not validate the quality of what has been exported; a human being is required in the process to check these final quality issues.</p>	<p>Section ST7.10 provides readers with guidance on validating data in BIM projects and keeping models up to date. Teicholz (2013), notes in case study 3 of the book <i>'BIM for Facility Managers'</i> that <i>"the intent of the as-built BIM models was to keep them as record drawings, just as 2D CAD drawings have been used for past projects"</i>. This highlights the importance of organisations putting in place a process to ensure the models and data are kept up to date. He goes on to note <i>"as more BIM models are received, it is anticipated the challenge of keeping BIM models up to date will be similar to those experienced in keeping as-built drawings up to date"</i>. The article <i>'3 Powerful Strategies for a Successful BIM Project'</i> presents arguments for updating models to ensure that they pay off after handover into the building's life cycle. The literature also suggests a <i>"significant advantage of a BIM approach is that if the models data is kept up to date, the model can continue to be used to plan and manage safe, efficient and proportionate maintenance"</i>.</p>				

CSF 6:**Improving stakeholder collaboration and understanding of the BIM process**

Mondrup et al (2012, p3) make the important observation in their paper *'Communicate and collaborate by using building information modeling'* that "BIM is a Socio-technical System". They observe "BIM is as much about people and processes, as it is about technology" (p4). Figure 13 illustrates this as a concept where BIM can be thought of as having a core of 'technical parts'. However, in order to deliver successful outcomes BIM requires more collaboration and cooperation between all stakeholders, and specifically the further social parts or layers of 'collaboration', 'coordinated work practices' and 'institutional and cultural frameworks' that support the overall BIM process. For BIM projects to be really successful people must be empowered and provided with the right technology and tools to communicate effectively. There should be open discussion and agreement about using **standardized exchange formats** to assist and empower the free flow of information. We also need to remember that the adoption of BIM, especially where people are inexperienced, often requires significant **cultural change**. **Especially early in this process the BIM project team may require additional support, time and resources.**

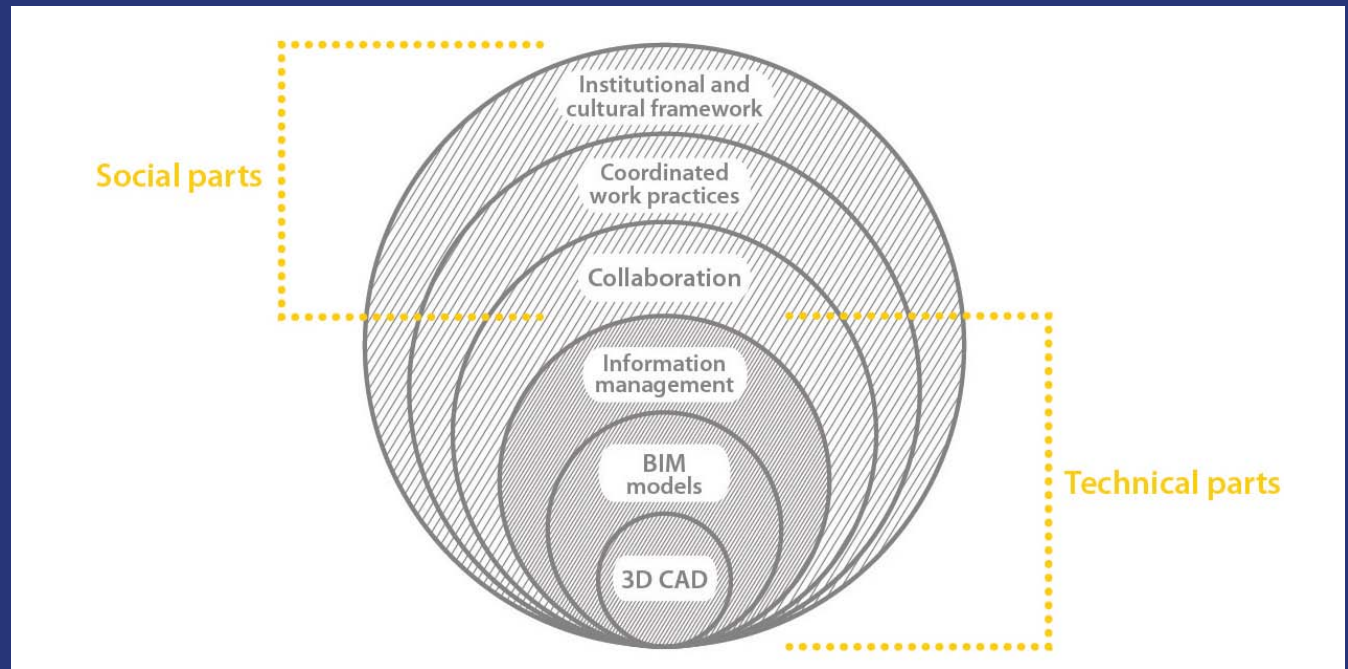


Figure 13

CSF 6:

Improving stakeholder collaboration and understanding of the BIM process

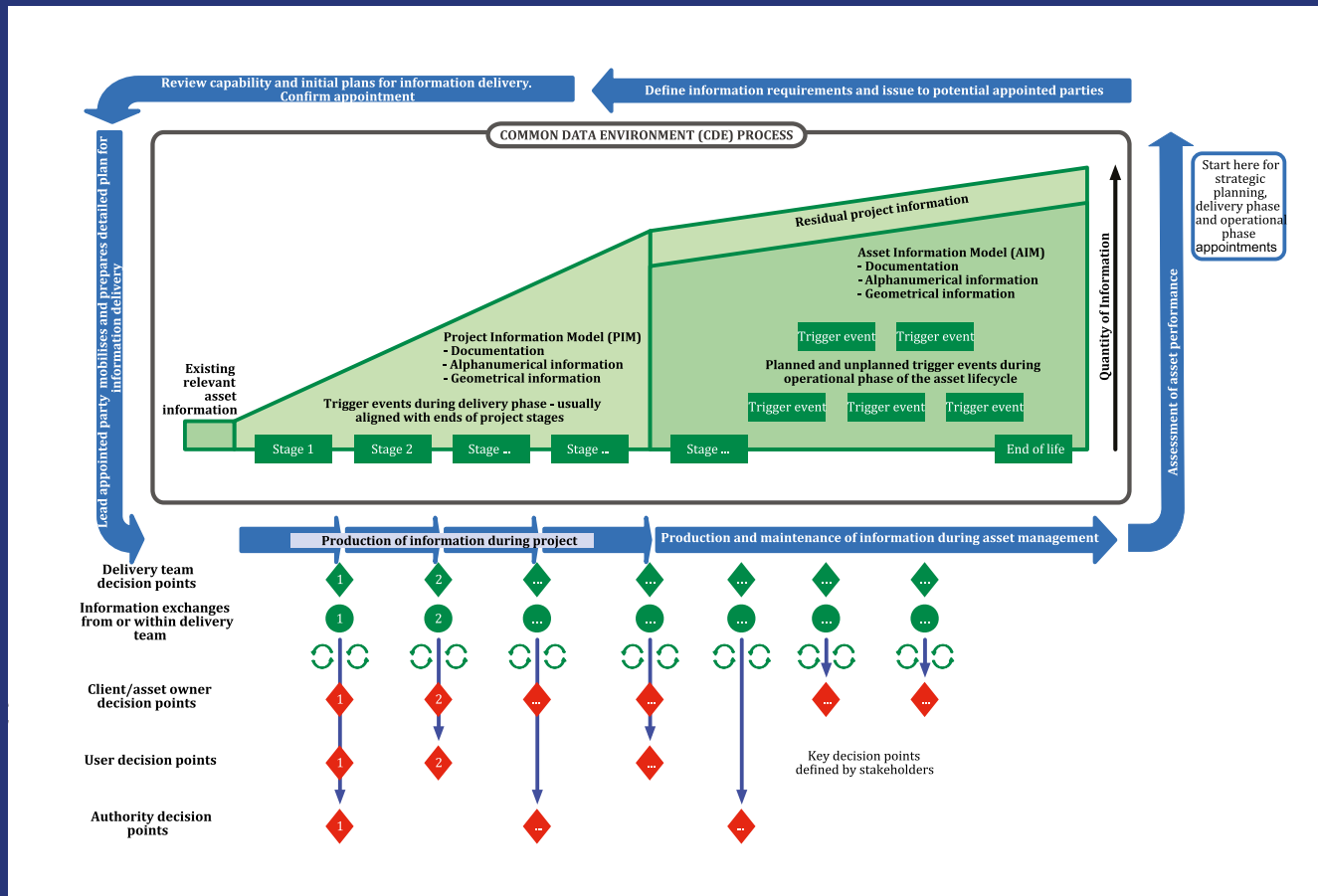


























Figure 14





Creating an effective collaborative working atmosphere between all stakeholders also depends heavily on all involved having a good overall understanding of the BIM process and each other's roles. Figure 14 from Section 13 of 'ISO 19650-1' (ISO, 2018, p28) provides a good concept model and overview summary of the BIM process. People should be able to articulate and explain the process in a clear way that supports good communication between all stakeholders. The process should start with reviewing existing asset information and then building this information up gradually over each of the project stages. 'ISO 19650' also suggests the information management process "should be applied in a way that is proportionate to the scale and complexity of the project or asset management activities". Having clear processes and a well-controlled **Common Data Environment (CDE)**, which everyone understands, and can work with is critical to supporting collaborative work flows for the production, management, sharing and exchange of all information during operational and delivery phases. The IWFM 'Role of FM in BIM projects' touches on some important 'collaborative requirements' in BIM projects and another important aspect **legal considerations**. The important topic of legal aspects is touched on in the article 'The legal section: UK Guidance Framework for ISO 19650' (Winfield et al, 2019).





CSF								MOBILISATION STATUS CHECK LIST			
Aim: Ensuring people can engage meaningfully with other stakeholders in the BIM process will help deliver improved project outcomes											
ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A				
6.1	Improving the perception of FM in BIM projects	<p>FM professionalisation with respect to BIM is essential to the ongoing improvement of BIM projects. Training and familiarisation are essential to help people engage with the BIM projects. FMs should provide knowledgeable inputs into the BIM process to help projects achieve better outcomes. It is essential FMs can demonstrate how they can add value to BIM projects. Many clients and FMs have no or little construction or design process experience so good communication between them and the rest of the supply chain is key to ensuring that BIM delivers assets which meet the needs of clients and operational teams.</p>	<p>Organisations such as IWFM and RICS are working to provide their members with information, guidance and training focuses on; the role of FM in the BIM process, how FMs can benefit from BIM; and understanding the RIBA PoW and design process itself. The importance of communication is highlighted in the article 'Without Trust and Transparent Communication BIM Projects Will Fail'. The paper by Boton and Forgues (2018) 'Practices and Processes in BIM Projects: An Exploratory Case Study' notes the increasing importance of both client and construction BIM managers and suggests "it is necessary to clearly redefine the connections and the interactions between the workflow and the information flow".</p>								

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
6.2	Using BIM to improve collaboration between stakeholder groups	Collaboration is key to the successful outcome of projects. BIM has the potential to break down silo-mentality working and improve the way people work together. An essential part of this is empowering people by giving them the right resources and tools to do their work. This is especially important for clients and FMs who need to effectively brief the design team as to what they need in order to achieve a successful outcome. 'BS 8536' can help client and FM teams prepare for this process.	The article ' Collaboration is key: How BIM helps a project from concept to operations ' highlights some of the critical success factors for BIM projects. The thesis by Bel (2018) ' BIM as a communication and collaboration tool for the design and operation phase of hospital buildings ' notes that "for a good collaboration with BIM, clear objectives should be communicated between stakeholders". Another papers which may be of interest to readers are; ' A Framework for Collaboration Management of BIM Model Creation in Architectural Projects ' (Lin and Yang, 2018) who suggest clear guidelines and a framework to help improve collaboration when creating models. ' A BIM/FM interface analysis for sustainable facility management ' (Wills et al, 2018) considers the interfaces between BIM and sustainable FM guidelines . For clients and FMs ' BS 8536 ' is a useful starting point for preparing to brief a design team. The SFT article ' Determine the Soft Landings Approach: Summary of BS 8536-1 & 2 ' explains how.				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
6.3	Ensuring FM readiness for early engagement in the BIM process	Facility managers are well placed to support BIM projects as they have a good understanding of the organisation's vision and mission and how to translate these into specific needs in a BIM project. There should be early FM engagement and FM teams should be ready and involved in assisting design teams to ensure their knowledge and that of their supply chain is used to help the BIM planning process and ensure the 'Soft Landings' process is adopted and followed.	The survey <i>'FM Awareness of Building Information Modelling (BIM): August 2017'</i> (Ashworth and Tucker, 2017) highlights why FM teams should be engaged early and given adequate training and resources as outlined in <i>Section MT9</i> . The paper by Ashworth and Tucker (2016) <i>'The Role of FM in Preparing a BIM Strategy and Employer's Information Requirements (EIR) to Align with Client Asset Management Strategy'</i> helps explain how FMs can help ensure a BIM strategy is developed that meets the needs of the client. The BSRIA article <i>'BIM and Facilities management'</i> (Harris, 2014) also helps to explain why early FM engagement is so important.				
6.4	Using BIM to meet government targets for improving assets and adding value to the wider society	BIM will help deliver a significant social impact . It will do this by enabling the delivery of better buildings and assets for people and organisations. The BIM process should deliver assets which are more fit for purpose and also optimised both from a cost, and meeting users needs perspective. In turn this will help to improve the infrastructure which supports our society. BIM and a range of other digital trends will also provide the research backdrop to underpin the future development of our smart buildings and cities.	The article <i>'How Building Information Modelling contributes to the Global Economy'</i> highlights the contribution BIM will make worldwide. The World Economic Forum report <i>'Shaping the Future of Construction: A Breakthrough in Mindset and Technology'</i> notes, "for nearly the entire population of the world, the built environment heavily influences quality of life". The business benefits of BIM are touched on in reports such as <i>'The Business Value of BIM for Infrastructure 2017'</i> and the CIB paper <i>'The Economics of BIM and added Value of BIM to Construction Sector and Society'</i> (Shultz et al, 2013) which "concludes that it is the 'I' in BIM that creates the integration between the computer models, software interoperability, project requirements and specification, stakeholders, and the overall economic and added value impact of BIM on the construction sector and society". The wider impact of BIM on the digitalisation of RE is touched on in the article <i>'The key to landing smart city contracts lies with BIM'</i> .				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
6.5	Motivating and supporting people in the BIM process	BIM offers a way of motivating people especially when they understand how their contribution makes a difference to the success of a project. People should be encouraged by ensuring that everyone involved understands the value proposition and what the team is trying to achieve.	The article <i>'The best way to teach people about BIM is to show them how it works'</i> (Rossiter, 2016), touches on ways to motivate people in BIM projects. Several papers maybe of interest to readers which consider how BIM can motivate people and improve collaboration, these include; <i>'An optimisation process to motivate effective adoption of BIM for refurbishment of complex buildings in New Zealand'</i> and <i>'BIM collaboration: a conceptual model and its characteristics'</i> . The paper by Kori and Makarfi (2018) <i>'Impact of employees in human capital development on BIM innovation in sme firms'</i> concludes "regular training, willingness to accept innovation and self-motivation" as critical indicators to consider in BIM projects.				
6.6	Preparing for the impact of BIM on the FM and AEC industries	The Gartner hype cycle shows trends such as 'BIM/Digital Twins' as having peaked in 2018 with the expectation that the predicted 'plateau of productivity' where the trends become 'the norm' will be reached between 2023 and 2028. A bit like trends in the past such as the arrival of the mobile phone, BIM is rapidly moving from being just a trend to becoming the norm. As such, companies need to move to adopt BIM and ensure they are prepared for its impact.	The report <i>'An Action Plan to Accelerate Building Information Modelling (BIM) Adoption'</i> serves as a useful source for considering how to ensure BIM adoption in an optimal way. Eyon (2015) provides some useful perspectives in the video <i>'BIM: People + Process - B1M University Class 2'</i> .				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
6.7	Using BIM to gain a competitive advantage	The survey 'FM Awareness of BIM' (Ashworth and Tucker, 2017) found that 80% of respondents felt BIM will offer companies who adopt and use it a competitive advantage . In order to make the most of the potential benefits offered by BIM companies need to consider how they can specifically add value to their organisations. The benefits can be perceived from both an operational and a marketing perspective. BIM is becoming increasingly important for a wide range of stakeholders in the WLC process of creating buildings. This includes architects, engineers, operators of assets etc., as well as organisations who are tendering for international projects.	The article ' The BIM advantage ' suggests that companies wanting to remain competitive need to ensure they have "in-house expertise to provide adequate assistance and guidance on the functionality of BIM". Readers may be interested in the following paper which presents arguments as to why BIM will help offer competitive advantages; ' Knowledge-based Building Information Modelling (K-BIM) for Facilities Management ' (Charlesraj, 2014). The author suggests that systems "developed on the basis of as-constructed information of the facility has the capability for effective and efficient FM and thereby enhance the competitive advantage of a FM organisation". Smith (2014) notes in ' BIM Implementation - global strategies ' that "firms will increasingly struggle to secure work on international projects if they don't have BIM capabilities".				
6.8	Using BIM and other technologies to support FM delivery for existing buildings	BIM and other technologies such as laser scanning, sensors etc., will be increasingly used to support and enhance delivery of services for existing buildings . Digital data capture techniques are developing very fast and FM organisations should be aware of how these technologies will impact on, and offer new opportunities to improve the management of existing RE portfolios.	Organisations should consider where BIM and other data capture technology might add value to existing assets in their organisations. A useful reference for BIM and existing buildings is the paper ' BIM implementation for existing buildings for FM: a framework and two case studies ' (Carbonari et al, 2015). The articles ' How 3D scanning is used for asset and facility management ' and ' An Application Oriented Scan-to-BIM Framework ' touch on how organisations can benefit from laser scanning for existing RE.				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
6.9	Using BIM to help improve data transfer	One of the key benefits of BIM is the potential to improve data transfer from construction to operation. This process is critically important to clients and FM teams if they want to be able to optimise the running of their buildings and assets, and also make informed decisions in the future about asset replacement and renovation work.	Section ST10 provides advice about ways to improve the data transfer process. It is important that FM and operational teams are consulted about what information and data is needed at handover, and that this process is planned in order to avoid losing data during the transfer process. It is also important to target how information and data can be accessed from, integrated with, or transferred into, other operational software. FMs should refer to the IWFM <i>'BIM data for FM systems'</i>				

CSF 7:

Clarifying the role and tasks of FMs in the BIM process

The IWFM guide *'The role of FM in BIM projects'* (Thomas, 2017) outlines how FMs can engage with other stakeholders to achieve the **best outcomes from BIM projects**. The guide (Figure 15) provides a general introduction to BIM and highlights how and when FMs should get involved. It can be downloaded from the [IWFM](#). Thomas (2018) also provides some tips about the *'Facilities Manager's Role in a BIM project'* focuses on what FMs should do before, and once a project has started, as well as at handover and in use.

FMs are in a unique position to help communicate between clients and design teams as they have detailed knowledge of the organisation they support and its real estate and information needs. They understand the **corporate and AM/FM strategy** and are ideally placed to help define the critical information requirements that feed into the key BIM documents, i.e. the OIR, AIR and EIR. The IWFM guide is structured around the [RIBA Plan of Work](#) and addresses a wide range of issues including: how the FM can help define and state the requirements of FM, planning the data which is essential to the daily operation of the asset and thinking about the end destination i.e. the **AIM**.



Figure 15

Other important issues are covered including security requirements as outlined in 'PAS 1192-5: *Specification for security-minded building information modelling, digital built environments and smart asset management*' which is available from the [UK BIM Framework](#) website, as well as data drops, the operational use of the AIM, risks of BIM and legal considerations.

Ashworth et al (2016) have two papers outlining *'The Role of FM in Preparing a BIM Strategy and Employer's Information Requirements (EIR) to Align with Client Asset Management Strategy'* and the *'Integration of FM expertise and end user needs in the BIM process using the Employer's Information Requirements (EIR)'*. These papers describe the role of FM in helping define the **information requirements** for the OIR, AIR and EIR from the existing corporate and RE/FM/AM strategy.

CSF 7:

Clarifying the role and tasks of FMs in the BIM process

Figure 16 (Ashworth, 2019) illustrates a possible **FM-BIM Strategy Concept Model** which gives an overview of the process. It shows how FMs can act as **appointed representatives** and use their FM/AM/BIM knowledge to help define information requirements clearly using the BIM documents and ensure these are communicated to the design team. This will help to ensure that the **right information** is provided to deliver project outcomes, which in turn support the core business and the ability of FMs to improve the management of assets over their whole-life. There is also a **lessons learnt** feedback loop to improve the BIM process for future projects.

It is also important to remember that for most organisations a BIM project is just one part of managing an **existing asset portfolio**. The digitalisation of existing real estate using BIM and other data capture methods is thus becoming increasingly important. Further information can also be found in the paper by Ashworth and Druhmann (2015) *'Integration of FM and asset management expertise in digital 3D building models'* which considers how organisations can add value to their asset management strategy by **digitalising their existing RE portfolios**.

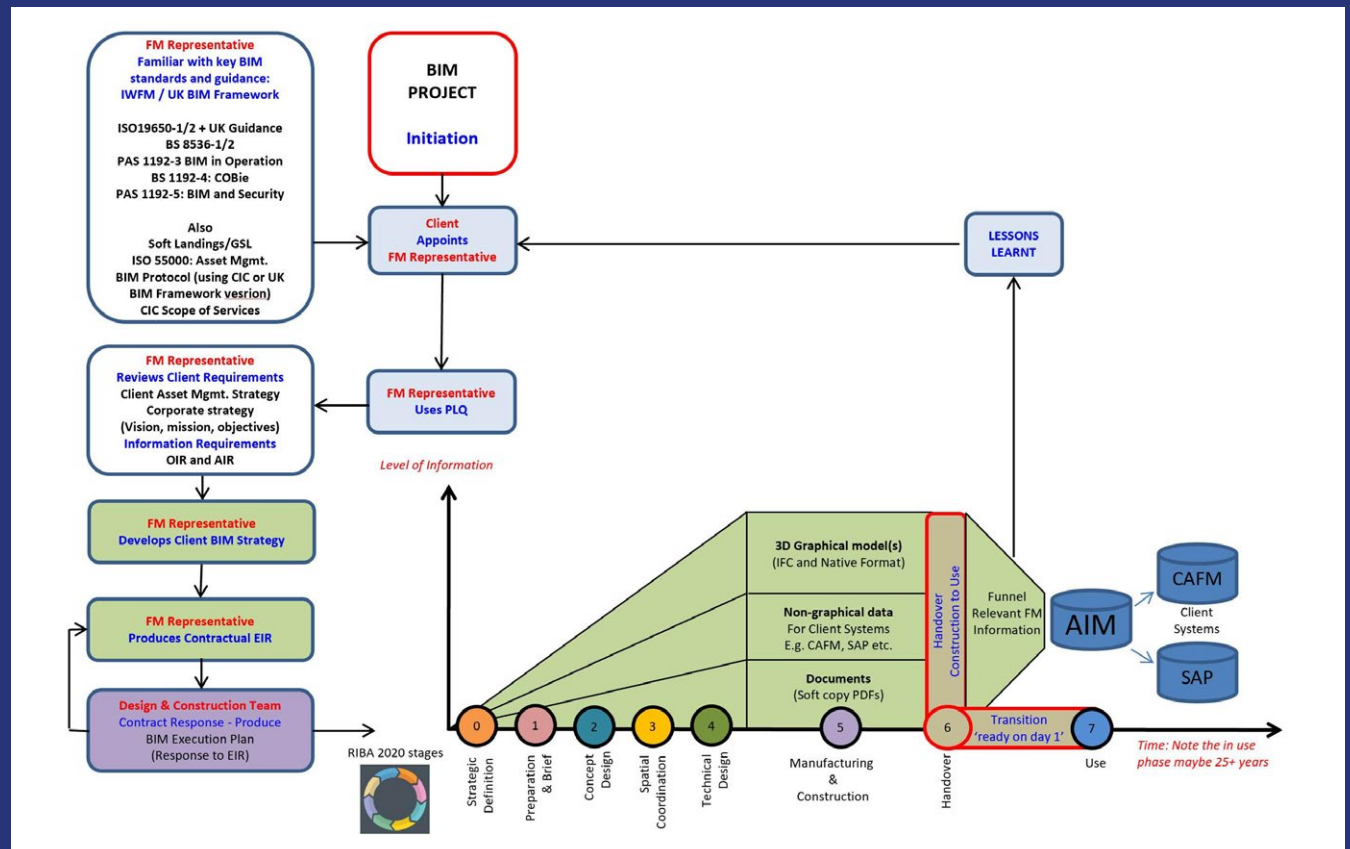


























Figure 16





CSF							
MT7: Clarifying the role of, and tasks of FMs in the BIM process							
Aim: Clarifying the role of, and tasks of FMs in the BIM process							
MOBILISATION STATUS CHECK LIST							
ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
7.1	Supporting and advising clients in BIM projects	FMs need to be able to help clients to articulate the ROI/benefits of BIM. This is especially important where FMs are helping to manage client information in a 3rd party role. FMs might also consider taking on the role of a BIM champion to help drive BIM from a client perspective. In every case, if BIM is being introduced into an organisation, senior buy-in is essential to ensure success.	The PwC report ' BIM Level 2 Benefits Measurement Methodology (BMM) ' sets out a measurement rational and model for ROI on BIM. The paper by Stowe et Al (2015) entitled ' Capturing the ROI of All-in Building Information Modelling: A Structured Approach ' outlines possible approaches to consider savings from a client perspective. Autodesk have produced a report entitled ' Achieving Strategic ROI ' and the SFT have a ' BIM Return on Investment Tool ' available on their website. TheBIMhub have also produced a series of articles focused on BIM ROI .				


ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
7.2	Defining the EIR, OIR, AIR and FM information requirements to support the AM strategy	<p>The research shows up to 60% of FMs have no direct experience of writing key BIM documents and only 12.2% an asset management strategy. Having a clear AM and information strategy is critical to the success of a BIM project. Understanding the client's OIR and AIR will help ensure a well defined EIR which can then be used by the supply chain. The OIR and AIR should ideally be owned and driven by the client/FM who know the business and not be written exclusively by external consultants. The client's EIR must give clear and unambiguous guidance to the supply chain as to what they should deliver. A minimal useful approach should be adopted which focuses on relevant information/data (not just asking for everything). This will ensure the amount of information/data is manageable. Some example templates (EIR etc.) can be found online for people to use as reference documents.</p>	<p>Ashworth et al (2017) recommend an EIR which is specifically tailored to meet client's information needs. Further guidance on the production of the OIR, AIR, PLQ and EIR is provided by Ashworth (2018) on theBIMhub website. The UK BIM Alliance provides a guidance document 'Information Management according to BS EN ISO 19650' to help people understand the management of information in the BIM process using the 'ISO 19650' standard. The B1M website has a video explaining the purpose of the EIR. The SFT and the Designing Buildings Wiki websites also provide some good guidance for creating an EIR. FMs can use the following examples as reference for the creation of key BIM documents: 'example OIR' and 'example AIR'. The IWFM 'EIR Template and Guidance' provides an editable EIR which can be downloaded from the IWFM website.</p>				





ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
7.3	Defining the data structure for BIM projects	<p>Standards for structuring data should be considered. An agreed classification system (e.g. Uniclass) and schema e.g. IFC/COBie should be used. Standard naming and numbering conventions should be adopted to ensure information/data is structured in a standard way. This will ensure transparent and easy referencing in models as well as supporting the exchange of models between different software packages. It also supports a standardised way to export and move data. Projects should ensure that the authoring tools used for producing BIM models are capable of COBie exports. COBie data drops can then be easily produced at selected intervals to check what data is available for quality purposes. Scheduling early workshops with operational/FM teams can help to define what data should be captured, and also importantly, what is included in the modelling process versus what can be captured elsewhere. The NBS-BIM Toolkit might also be considered by the project team to help the overall digital process.</p>	<p>Details about Uniclass and other classification systems can be found in Section ST10.3. Details about IFC/COBie can be found in Section ST10.1 and Section ST10.4. The paper 'Application Areas and Data Requirements for BIM-Enabled Facilities Management' by Becerik-Gerber et al (2012) makes some useful observations about FM orientated data for the BIM process. A further article 'Back to Basics – The What, How and Why of BIM and FM' is available on the CIOB BIM+ website. Kensek (2015) also produced a paper 'BIM Guidelines Inform Facilities Management Databases: A Case Study over Time' which offers some valuable insights from an FM perspective. The NBS BIM Toolkit is available from the NBS website, an explanation of which is provided by Stephen Hamil on the B1M website.</p>				





ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
7.4	Considering the long-term OPEX budget in BIM projects	There is plenty of scientific evidence suggesting that the main cost of buildings is in their operational phase. Consequently FMs and other project stakeholders should consider BIM to improve WLC as a recommended approach. Essential WLC information/data can be attached to each of the elements in BIM model(s). This information/data can then be used as the basis for carrying out WLC calculations and to generate lists of when various assets should be replaced over the life cycle of the asset.	The BSRIA/ZHAW/LJMU presentation by Ashworth (2016) helps to explain the logic for a WLC approach to the EIR. The paper by Dawood and Vukovic (2015), <i>'Whole life cycle information flow underpinned by BIM: technology, processes, policy and people'</i> , helps to underline the essential elements to underpin BIM and WLC. Meslec et al (2018) also present a paper <i>'Integrating Life Cycle Sustainability Analysis with BIM'</i> which explores how WLC and BIM can help sustainability analysis. The RICS guidance <i>'BIM for cost managers: requirements from the BIM model'</i> can be used to help set up BIM models to optimise WLC benefits.				
7.5	Writing key BIM documents and providing guidance for clients	The writing of BIM documents (especially the OIR, AIR and EIR) is an important early task. These documents should use FM knowledge from local FM teams to help clearly define client's information needs to give the supply chain clear direction for the BIM project. The client should ensure a competent person is in place with good FM, BIM and people skills to help define these requirements clearly from an FM/client perspective. The research indicates clear links between confidence in writing documents and training and experience. Appropriate BIM training courses should be implemented to help the FM team understand how to define these requirements. The early definition should start by assessing the needs of the organisation/individual and then matching the level to the requirements.	Section ST9.3 and Section ST9.7 have useful links for helping to write key BIM documents. The <i>'FM Awareness of Building Information Modelling (BIM)'</i> by Ashworth and Tucker (2017) indicates "more needs to be done before FMs feel fully confident to engage in writing key BIM documents for BIM projects". Further guidance about appropriate BIM training is available in Section ST9.6 .				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
7.6	Helping design teams understand the information needs of FM	The FM team need to support the BIM design team by clearly explaining the demand on assets . This may include highlighting critical assets and the information/data needed to run them, as well as how assets are tagged, monitored and managed. FMs should also be involved in reviewing design team inputs to ensure that they do not cause unnecessary extra maintenance tasks. As each business is unique, the design team should be supported by the operational teams to help understand users' needs . This may have a direct impact on how they develop the design, BIM models and where data is included within the BIM model or alternatively provided in other external databases.	It is important that FM play a key supporting role with the design team during early phases of a BIM project. The 'BS 8536-1 & 2' standards, available from the UK BIM Framework , website should be used as guidance for developing briefing advice for design teams. The SFT BIM portal provides a summary of how 'BS 8536-1 & 2' can be used. The designingbuildings.co.uk website also provides guidance about the standards. The EIR should be used to define requirements early in the BIM process. Ashworth et al (2019) provide guidance about 'Critical success factors for facility management employer's information requirements (EIR) for BIM' . Other papers that may be useful are by Ibrahim et al (2016) discussing 'BIM for FM: Input versus Output data' and Liu and Issa (2015) who discuss 'BIM for Facility Management: Design for Maintainability with BIM Tools' .				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
7.7	Giving feedback to D&C teams to improve operational and WLC decisions	In order to deliver value over the long term a WLC approach should be taken. FMs should review design solutions to ensure they do not introduce avoidable increases in long-term costs (e.g. access at height where additional equipment is needed or designs that require extra manpower over the whole life of an asset, which could amount to 30 years+). This is especially important as the 'ISO 15686-5' standard notes that, in general, 80% of long-term costs are fixed in the first 20% of the design. FMs should seek energy efficient designs and ensure designers are working to real scenarios as to how assets will be used in practice. POE should be put in place to ensure a review is carried out and lessons learned as to how improvements as a whole can be made.	BIM projects should adopt a 'Soft Landings' approach as outlined in Section ST8.1 . The ' ISO 15686-5 ' can be used as a reference for ensuring a WLC approach. The paper by Zanni et al (2019) ' Developing a Methodology for Integration of Whole Life Costs into BIM Processes to Assist Design Decision Making ' maybe a useful reference for including WLC thinking in the BIM process. Ozturk et al (2012) have a paper which considers ' Post Occupancy Evaluation (POE) in Residential Buildings Utilizing BIM and Sensing Devices: Salford Energy House Example '. The SFT BIM Portal and designingbuildings.co.uk also give advice on ' Soft Landings and Operation In Use: Post Occupancy Evaluation '.				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
7.8	Using BIM to improve the handover process from construction to operation	<p>For a good handover process the ‘Soft Landings’ approach and key standards e.g. ‘BS 8536’ should be used in planning. It should be clear if and how COBie, IFC etc. can be used to ensure good quality ‘as built’ information/data can be achieved at handover. Key to the successful BIM project outcomes are clearly defining model and information formats in the OIR, AIR and EIR and to articulate explicit client expectations for handover. This will then enable the supply chain to deliver ‘federation strategy and breakdown structure for information containers’ as per ‘ISO19650’ and be clear what data is included in the BIM model(s) and what can be delivered in another format. Lessons learnt from previous handover experiences should be taken into account including experience in BIM projects. Also how to produce the OIR, AIR and EIR and how the final BIM models/data/documents will be received and quality checked by the BIM Manger on the client side for use in the AIM. Innovative ways can be found to use BIM to improve handover e.g. using models for training and commissioning with linked videos etc.</p>	<p>‘Soft Landings’ and ‘BS 8536’ are referred to in Section ST8.1. Both note the importance of measuring the outcomes from projects to support efficient and cost-effective asset/facilities management. The UK BIM Alliance ‘Information management according to BS EN ISO 19650: Guidance Part 2: Processes for Project Delivery’ provides advice on the process to help achieve a good handover. The ‘BSRIA Soft Landings Framework - Appendix A’ checklist can be used to help handover planning. The ABAB have produced the very helpful guide ‘AIR Guide: Information required for the operation and maintenance of an asset’ which can be used to help plan what information to aim for at handover. The NIST have an older guide ‘General Buildings Information Handover Guide: Principles, Methodology and Case Studies’ which is still very useful. The designingbuildings.co.uk website has some useful tips on ‘Handover to Client’. Useful reference papers include Cavka et Al (2013) ‘Case Study of BIM Handover to Support Building Operations’ and Sadeghi et Al (2019) ‘Developing building information models (BIM) for building handover, operation and maintenance’. Companies like EcoDomus are also providing integrated solutions which can help the handover of data in a project. The SFT/AEC ‘Implementation of a Common Data Environment’ is also a useful guide to ensuring the CDE is well set up for handover.</p>				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
7.9	Identifying client needs and using FM know-how to help improve BIM project outcomes	<p>Required project/performance outcomes which can be verified should be defined early in the project in line with 'BS 8536-1'. This requires that <i>"clear targets should be set for the expected outcomes at the start of the project, which should be aligned with the owner's business objectives"</i>. FMs should provide data about how existing assets are currently used and expectations for future use. This information can then be used to help define expected outcomes. FMs should impart their knowledge about workplace productivity targets and how the project designs can help support these goals, as well as ensuring best value solutions (not just the cheapest) are provided. As well as final project outcomes this might also include setting up checking mechanisms via COBie drops, or other means, to help ensure the project deliverables are on target and of the required quality for handover.</p>	<p>Section 4.3 of 'BS 8536-1' addresses specific targets for project outcomes: environmental, social, security and economic. These can be used at the start of the project to set outcomes which should then be monitored throughout the project and used to steer its success. The <i>'Soft Landings Framework 2018'</i> and associated BSRIA guides as listed in Appendix 3 provide a range of guides that are useful when planning a client project and projected outcomes. The inception and briefing stage is very important as this effectively sets the scene for how the project outcomes will be delivered. Another work which maybe of interest is the report <i>'Productivity In The Buildings Network: Assessing The Impacts Of Building Information Models'</i>. Franz and Messner (2017) have a white paper <i>'Evaluating the Impact of BIM on Project Performance'</i> which shows a <i>"significant positive relationship between BIM use adoption and the speed of delivery, perceived facility quality and group cohesion within the project team"</i>. Sandberg's (2015) MSc thesis <i>'Impact of BIM on the productivity in design process'</i> may also be a useful reference and research by Hadzaman et al (2016) <i>'Building Information Modelling (BIM): the impact of project attributes towards clients' demand in BIM-based project'</i> can be referred to when defining project attributes.</p>				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
7.10	Validating data in BIM projects and keeping the BIM models up to date	<p>Clients should be clear about how information/data will be handed over from construction to operation, and importantly, how it will be validated and checked for quality. A Client Information Manager role should be considered to ensure correct data hand over and quality. This person should liaise with the construction information Manager. Note: these two roles are separate and should be appointed in line with the UK BIM Framework 'Information Protocol' (currently 2018 edition) and CIC 'Outline Scope of Services for the Role of Information Management'. The Construction Information Manager is responsible for the overall delivery of all information/data to the client team. These roles should be clarified in the BIM project responsibility matrix. Project data drops should be established at regular intervals to allow for joint quality checks to be carried out. Updating BIM models/data is critical if they are to be used over the whole life of an asset. They need to be actively managed to ensure they are kept up to date. Updating of the master BIM files may require a contract with BIM specialists who have the right skills. The updating process should also include how data for future projects, e.g. refurbishment, asset replacement, etc., are updated and also fed into CAFM and other FM systems.</p>	<p>The Information Manager should be formally appointed in line with the UK BIM Framework Information Protocol. The CIC 'Outline Scope of Services for the Role of Information Management' helps define the responsibilities of the Information Manager. These should be formalised under the contract. The designingbuildings.co.uk and SFT BIM Portal provide advice about the role. Examples of a BIM Responsibility Matrix are available on the SFT website. The RIBA website has downloads people can use for the RIBA 2020 PoW. The Bond Bryan BIMBlog article 'Client BIM Briefing Note: Information Management Role' provides further guidance. The B1M website video 'Do I Really Need an Information Manager?' is worth watching. The Book 'BIM for Estates: A guide to managing BIM projects and developing a digital estate' by Yeo (2018), chapter 10, provides advice relating to ongoing model/data maintenance. Other interesting resources are the NBS article 'BIM: What information is in the model?' Heaton et al (2019), which outline ways to consider 'Design and development of BIM models to support operations and maintenance'.</p>				

CSF 8:

Acquiring essential knowledge of key BIM standards/guidance documents for practical use in a BIM project

A good **familiarisation of key BIM standards** is essential to ensure that people and stakeholders involved in BIM projects can clearly communicate using the same language, with established terminology and expressions (including the many acronyms). Importantly, standards provide guidance to set up BIM processes and empower people to clearly understand one another when discussing BIM projects, which avoids confusion and wasted time and effort. A more standardised approach helps stakeholders involved to deliver the required project outcomes and the many benefits BIM promises. However, in order to do so people need to be familiar to some degree with key BIM standards and guidance. It is recommended people familiarise themselves with the **'UK BIM Framework'** promoted as the *"overarching approach to implementing BIM in the UK"* by the **UK BIM Alliance**, **BSI** and **cdbb** which aims to help individuals and organisations understand the fundamental principles of BIM. This short video by **Hooper (2019)** helps explain the framework and standards built around the new international 'ISO 19650' BIM standards and includes remaining relevant PAS and BS standards and guidance documents. These are also available from the **BIM Level 2 website**.



Figure 17

A good starting point is 'ISO 19650 Part 1' (Figure 17) which is central to understanding the BIM process. It addresses *"concepts and principles"*. The reader should then consider **'Part 2'** which addresses the *"delivery phase of assets"*. The UK BIM Alliance guides can be used to help people get a good understanding of the ISO 19650 standards which include:

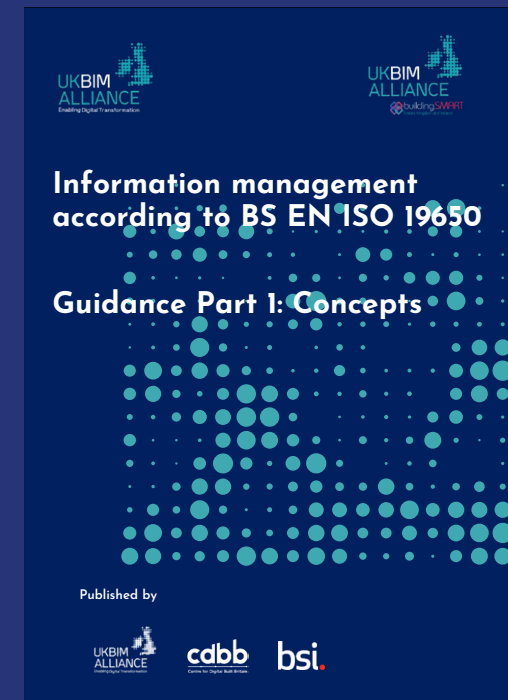


Figure 18

1) **'Information management according to BS EN ISO 19650: Guidance Part 1: Concepts'** (Figure 18) and
 2) **'Information management according to BS EN ISO 19650: Guidance Part 2: Processes for Project Delivery'** (Figure 19). Also the **'PD 19650-0:2019'** Transitional Guide for moving from the old 'BS 1192' and 'PAS 1192' standards to the new 'ISO 19650' standards.

CSF 8:

Acquiring essential knowledge of key BIM standards/guidance documents for practical use in a BIM project

Fundamental to a successful BIM project is ensuring the **organisation's information and existing asset management strategy** are taken into account. Where no asset management strategy exists the international standard '[ISO 55000: Asset Management: Overview, Principles and Terminology](#)' can be helpful for setting one up. Facility Managers and clients should also be familiar with '[BS 8536: Briefing for design and construction. Code of practice for facilities management \(Buildings infrastructure\)](#)' (Figure 20). This standard addresses how FMs should prepare to brief project teams about the required outcomes from a BIM project.

Where there is a need to transfer data from the BIM process into FM management systems FMs may need to use **COBie** which is explained in '[BS 1192-4: Collaborative production of information. Fulfilling employer's information exchange requirements using COBie. Code of practice.](#)' 'BS 8536 (Part 1 and Part 2)' and 'BS 1192-4' can be downloaded from the [UK BIM Framework](#) website or [BSi websites](#).

'**Soft Landings**', also sometimes referred to as 'Government Soft Landings', (Figure 21) is aimed at ensuring the "project team focus more on the client's needs throughout the project, to smooth the transition into use" and improve the overall operational performance of buildings. It also supports environmental assessments, energy performance certification and POE etc. The guidance documents are available from [BSRIA](#).

[Appendix 3](#) gives a detailed list of FM relevant guidance and standards for further reading.

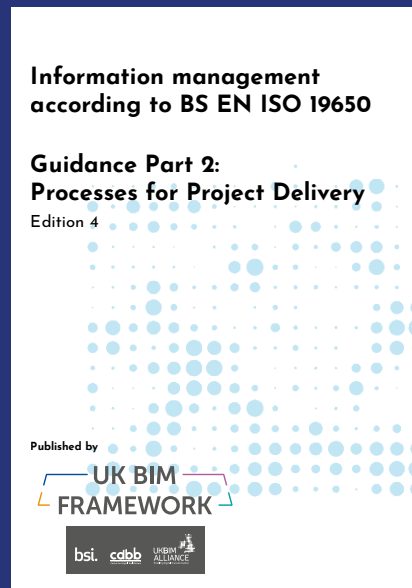


Figure 19

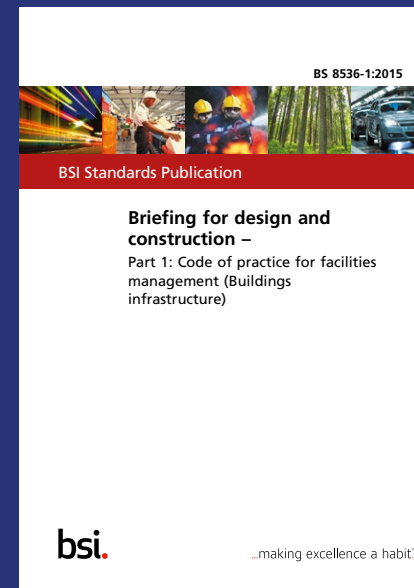










Figure 20



Figure 21

CSF							
MT8: Acquiring essential knowledge of key BIM standards/guidance documents for practical use in a BIM project							
Aim: Having a good understanding of key BIM standards and guidance will help improve communication and standardisation in BIM projects							
MOBILISATION STATUS CHECK LIST							
ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
8.1	Using BIM standards and guidance in projects to achieve better outcomes for all stakeholders	Research shows positive links between 'confidence in working in BIM projects' and 'levels of familiarisation and use of BIM standards and guidance in practice'. FMs should consider the list of BIM standards and guidance in Appendix 3 . These provide useful sources for achieving a more in-depth understanding of the BIM process and how the standards should be used in practice. It is important that FMs involved in BIM projects are familiar with the standards as these will be used as the basis for the 'common language' and standardisation within BIM projects. The BSi Group have provided some guidance on the transition process from the UK BIM standards to the new BIM 'ISO 19650' standards which are gradually replacing some of the UK PAS documents.	Appendix 3 lists relevant <i>BIM standards</i> and guidance with links to access them (note: some are free and others have to be purchased). FMs should familiarise themselves first with the IWFM BIM Guides which discuss the role of FM in BIM projects, BIM and FM standards and how to set up the EIR. A critical success factor with respect to BIM is having a clear early understanding of the organisation's ASM strategy. If one needs to be set up or improved ' ISO 55000 ' provides good advice. There is a lot of reading required to cover all the BIM standards. It is suggested FMs start with those that are more relevant to FM. ' BSRIA Soft Landings ' aims to ensure all decisions made during the project are based on improving operational performance of the building and meeting the client's expectations. ' BS 8536 ' (parts 1 and 2) for an understanding of how FMs can help to brief design teams about the expected performance of a building in use. ' ISO 19650 ' (parts 1 and 2) gives a good understanding of the overall BIM process, terminology and production of information. ' PAS 1192-3 ' specifies how an AIM should be created and how that model should be used and maintained through the life of the asset up to final disposal. ' BS 1192-4 ' gives an overview of COBie. The ' RIBA Plan of Work ' helps provide an understanding of the various stages in a BIM project and ' ISO 16739 ' gives an overview of IFC. Although not necessary to go into detail an understanding of classification systems like ' Uniclass 2015 ' will be helpful.				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
8.2	Other useful BIM guidance documents	There is a lot of BIM guidance available online which caters for the needs of different stakeholders in the BIM process. Research has shown FMs are using a mix of UK and international guidance in practice. The BIM books in Section ST1.3 may be useful for providing a good overview of the BIM process.	For a wider overview of the BIM process the books in Section ST1.3 should be considered. Other BIM guidance worth reading include those provided by the US National Institute of Building Sciences (NBIMS) , the ' GSA BIM Guidance for FM ' and the RICS ' International BIM Implementation Guide '				

CSF 9:

Ensuring people have adequate BIM training and competency skills to successfully engage in BIM projects

FMs need be able to offer **strategic advice** to clients about BIM and general issues around digitalisation of the FM sector. They should also be able to **support design teams** with FM knowledge and design input. Figure 22 from the *'FM Awareness of BIM'* (Ashworth and Tucker, 2017) shows that levels of “experience of preparing/using key BIM documents” are generally quite low. The industry needs to support training FM professionals with regard to BIM as research indicates that people having adequate “BIM training and competency skills” are critical to the success of any BIM project. Churcher (2018) provides some useful guidance and advice about *'PAS1192-3 and BIM training for FM and Asset Managers'* which readers may find useful.

BIM/digital-skills training options open to organisations and individuals include basic familiarisation training to full degree programmes offered by different universities. The IWFM guides; *'The Role of FM in BIM Projects'* (Thomas, 2017) and the *'Operational Readiness Guide'* (Beadle et al, 2016) (Figure 23) are a good starting point for FMs wanting to familiarise themselves with key aspects of the BIM process specifically from an FM perspective. **Section ST9.6** provides further details about a range of professional associations offering **BIM training courses** as well as links for university degree courses.

RESPONDENTS WERE ASKED IF THEY HAD ANY EXPERIENCE OF PREPARING OR USING A RANGE OF KEY DOCUMENTS USED IN THE BIM PROCESS. FEEDBACK WAS AS FOLLOWS:

	HAVE WRITTEN AND IMPLEMENTED	HAVE IMPLEMENTED BUT NOT WRITTEN	KNOW OF BUT NOT IMPLEMENTED/WRITTEN	NO EXPERIENCE
Asset Management Strategy (e.g. ISO 55000 or other)	12.2%	8.3%	38.2%	33.1%
BIM Strategy	17.3%	9.4%	34.6%	30.3%
Organisational Information Requirements (OIR)	15.0%	9.4%	33.1%	34.3%
Asset Information Requirements (AIR)	18.9%	12.6%	31.5%	28.7%
Employers Information Requirements (EIR)	20.1%	10.2%	26.4%	35.0%
BIM Execution Plan (BEP)	12.6%	8.7%	30.7%	39.8%

Figure 22

CSF 9:

Ensuring people have adequate BIM training and competency skills to successfully engage in BIM projects

Several online BIM training possibilities are available such as those offered by [buildingSMART](#), [BRE](#) and [RICS](#). BuildingSMART also offer some specific training on COBie.

A range of useful **reference documents and templates** are outlined in [Section ST9.3](#) and [ST9.4](#). It is interesting to see construction companies such as the US Pepper Construction have recognised the importance of FM in their course '[BIM for Facility Management: How to Get Started](#)' and [Autodesk University](#) host a range of online talks and presentations also covering FM and BIM.

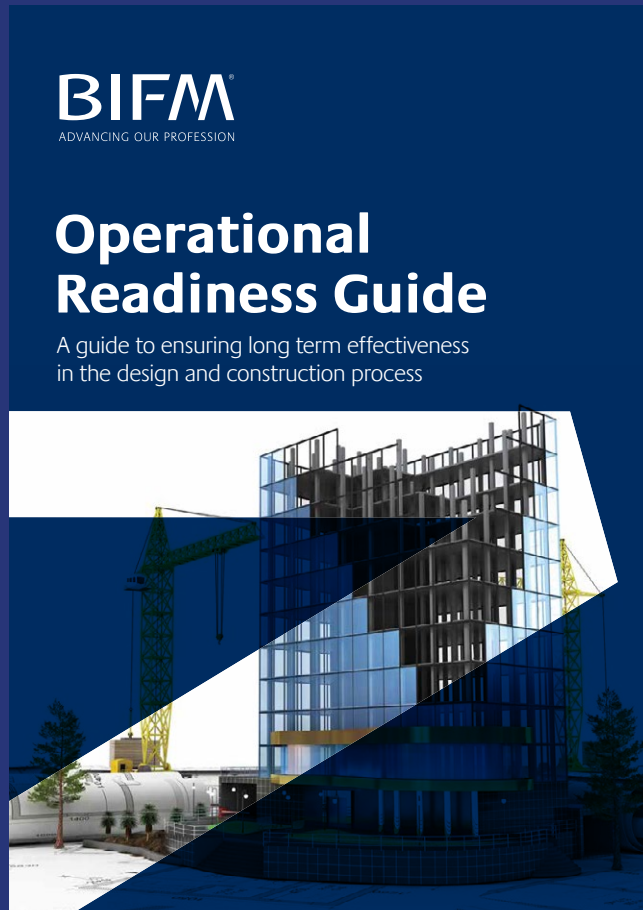


















Figure 23

CSF							
MT9: Ensuring people have adequate BIM training and competency skills to successfully engage in BIM projects							
Aim: Ensuring people have adequate BIM training and competency skills to successfully engage in BIM projects.							MOBILISATION STATUS CHECK LIST
ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
9.1	Acquiring essential knowledge about BIM standards and guidance documents	Most new buildings are now delivered using BIM. As such FMs need a basic overview of key BIM standards/guidance in order to understand BIM jargon, engage knowledgeably with other stakeholders and give their input to design teams. The IWFM BIM guidance documents are a good starting point for FMs looking to get up to speed on BIM. These help hasten the process and focus on standards more relevant to the FM role. Having a good AMS is important, especially as a basis for starting a BIM project ('ISO 55000' might be useful if FMs don't already have a strategy). Familiarisation with BIM standards is important. However, reading all of the standards will take some time and therefore FMs should focus on 'the more FM relevant' ones first.	FMs should start by referring to key BIM guidance documents and standards. The following IWFM documents are a good starting point: ' The Role of FM in BIM projects ', ' The Operational Readiness Guide (ORG) ' and the ' EIR Template and Guidance '. Appendix 1 of the ORG is also helpful to FMs as it lists relevant standards/guidance documents. The RICS also have an ' International BIM Implementation Guide ' and the US GSA ' BIM Guide 08 - FM '. FMs can also refer to MT8 for further information about BIM standards.				
9.2	Using key BIM standards/guidance in practice	Adopting standardisation is essential to ensuring that all stakeholders in the BIM process are working to the same standards and use the same 'BIM language'. UK BIM standards in practice are generally well written and already cover what people need to know when engaging in BIM projects. FMs should consider first familiarising themselves with the IWFM BIM guides and then the BIM standards for more detail. Networking with BIM practitioners will help FMs understand how the standards are being used in practice. Online videos and seminars can provide further detail. There are several websites with BIM standards , free access is available to some via the BIM Level 2 website. Alternatively they can be purchased from BSI.	Research suggests FMs should read the ' IWFM BIM guidance ' first. Where an organisation needs an AMS ' ISO 55000 ' can be referred to. Guidance to this standard is available from the Institute of Asset Management . Where an adequate AM strategy already exists this should be used as the basis for assessing what information is needed by FMs in the operational phase of assets. BIM standards can be downloaded from the UK BIM Framework website and also the BSi website . Note: Section MT8 provides further detail about relevant BIM standards and guidance which should be referred to.				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
9.3	Sources for EIR guidance, BIM books and BIM training courses	There are many resources available to help FMs on their BIM journey. For example several example EIRs are available to help people when creating the EIR (contractually the client's responsibility but often completed with the help of FM). The document should be an FM orientated EIR driven by the client, which gives the supply chain clear and unambiguous guidance so that they know precisely what the client's information requirements are. The research highlights other BIM guidance (some specific to FM) such as webinars, BIM familiarisation training, case studies, BIM books , online resources and BIM websites . In addition, BIM training courses have become widespread and can be found online.	The IWFM 'EIR Guidance and Template' can be downloaded and amended to suit a specific project. Other EIR examples include: the cdbb, Procure22, Airgeadis Department of Finance, CLAW, NHS and MOJ . Several books (available through most retailers) may also be useful to FMs including: 'BIM for Facility Managers' (IFMA Foundation), 'The BIM Handbook: A Guide to Building Information Modeling for Owners, Designers, Engineers, Contractors, and Facility Managers' and 'Building Information Modeling For Dummies' . Other useful BIM resources include the 'NBS's BIM Toolkit' , 'BIM Periodic Table' and 'BIM Object Standard' , the 'NRM Digital Life Cycle Toolkit' and the US NBIMS guidance websites are referred to in MT1.7 . For information about BIM training courses see MT9.6 . Many BIM case studies can be found on the BIM+, the SFT and the NATSPEC BiM websites .				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
9.4	Ensuring FM have the right guidance for engaging in BIM projects	<p>Professional organisations like IWFM, RICS and the US GSA are providing practice orientated BIM guidance. FMs should also be aware of LCC and WLC. The international standard 'ISO 15686-5' is important for understanding the difference between LCC and WLC, and the RICS have produced LCC guidance documents and evaluation tools. OIR and AIR guidance is something FMs should be familiar with. 'ISO 19650-1' defines the OIR as "information requirements in relation to organizational objectives" and AIR "in relation to the operation of an asset". BIM-2-CAFM guidance is important to ensure the accurate transfer of data to FM systems. Another hugely debated topic is LOIN which describes what level of information is needed at handover. Data analytics will have a big impact in the future on how data from sensors etc. can be processed and understood.</p>	<p>See MT9.1 for IWFM, RICS and GSA guidance. Guidance about 'Life cycle costing' (LCC) can be found on the RICS website. 'ISO 15686-5' is the International LCC standard. The 'BCIS life cycle evaluator tool' can also be found on the RICS website. Few examples of OIR/AIR are in circulation as these are unique to every organisation e.g. English Heritage, Procure22, ABAB and SFT. However each organisation should look at the guidance available here and create their own OIR and AIR. The IWFM BIM-2-CAFM guide is referred to in MT10.4. Guidance is given in Section 11.2. The 'ISO 19650-1' describes the 'LOIN' which should "include the appropriate determination of quality, quantity and granularity of information". NBS also have some guidance on 'LOD'. The RICS provides some information about 'Big Data' and some theses are available on data analysis including 'The Future of Big Data Analysis in FM' and 'The future of big data in facilities management - opportunities and challenges'.</p>				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
9.5	Bridging the digital knowledge gap between construction and operation	There has been a natural gap between those using BIM in practice as part of their day job and those who don't (in the AEC and FM industries). Technology skills are seen as key to the BIM process; not necessarily the actual software skills but a thorough understanding of the process and what the technology can be used to achieve, as well as its limitations. Research indicates getting involved and having practical experience (learning by doing) is often seen as the best way of learning about BIM. Client and FM support and engagement at a senior level is key to the success of projects.	Several reports on digital skills shortages are available such as the FM focused ' BIM and FM: Bridging the Gap for Success ' and more general ' Supporting Worker Success in the Age of Automation '. Kassem et al (2015) highlight the "shortage of BIM skills in the FM industry" in their paper ' BIM in Facilities Management Applications: A Case Study of a Large University Complex '. Araszkiwicz (2017) has also presented a paper ' Digital Technologies in Facility Management – the State of Practice and Research Challenges ' which addresses some of the challenges. Ebbesen (2016) wrote his PhD thesis on ' Adding Value to FM with Information Technology '.				
9.6	BIM training for FM staff to ensure they have the necessary BIM and digital skills competencies	FMs need be able to offer strategic advice to clients about BIM as well as giving design teams FM input. Research indicates many organisations need to do more to put in place quality FM-BIM training , and a high percentage of respondents indicated employees would benefit from training which should be provided for FMs and operational staff. This should include working with data and models and the use of BIM viewing tools etc. in order to support operational tasks. Both a budget and time for training should be allocated accordingly. Research indicates a step-by-step approach is recommended depending on existing knowledge and the complexity of the project. There are an ever-growing supply of BIM training courses offered by professional institutions and other organisations ranging from basic awareness to full bachelor and master degree courses. It is suggested a 'training needs analysis' is undertaken for organisations/ individuals and then training matched to their specific needs.	Davies et al (2015) note the importance of "skills such as communication, conflict management, negotiation, teamwork and leadership as important components of a BIM project". For 'BIM familiarisation' it is recommended people look at the ' IWFM BIM guidance '. Professional associations offering BIM training include: buildingSMART , BRE , BSi , BSRIA and RICS . 'University degree courses' with a focus on BIM can be found online and are often tailored around stakeholder group's needs. Some other courses include modules about BIM alongside the main topic. The CIOB BIM+ website provides advice on BIM degrees. Degree search sites can be used to look for BSc or Master's courses with BIM content. There are also many organisations promoting BIM training. Organisations should satisfy themselves that whatever training they choose it is appropriate and of high quality.				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
9.7	Using the IWFM BIM guides to help improve FM engagement in BIM projects	The IWFM has produced a series of BIM guidance documents which can be used by FMs involved in BIM projects.	The guides include: ‘EIR Template and Guidance’ (Ashworth and Tucker, 2017) , ‘Operational Readiness guide’ and the ‘Role of FM in BIM projects’ . The paper by Ashworth et al (2017) ‘Employer’s Information Requirements (EIR): A BIM case study to meet client and facility manager needs’ provides further background to the use of an EIR in practice.				
9.8	Essential tips for developing BIM guidance	Professional institutions are continually updating their BIM guidance as BIM adoption and use increases. Organisations such as the SFT are developing practical tools which can help FMs and other stakeholders. There is a lot of information about BIM on the internet (some very poorly written, inaccurate or used solely for marketing). For essential reading it is recommended that people first look to trusted professional institutions and websites for quality content (see ST1.7 and MT8). The <i>‘RIBA Plan of Work (2020)’</i> is important to understand as a reference framework on how a BIM project is managed using specific stages. An increasing amount of online resources are being developed to help training on BIM (see ST9.6). When associations or organisations develop further BIM guidance the KISS principle should be adopted in order to keep it simple and easy for people to access.	The Scottish Futures Trust BIM portal provides a wealth of information and practical tools (ROI calculator etc.) that can be used in BIM projects. Sections ST1.7 and MT8 can be referred to for essential reading about BIM standards and guidance from well respected professional organisations. The ‘RIBA PoW (2020)’ can be downloaded from the RIBA website . Guidance about online learning is referenced in ST9.6 . Many of the professional associations and organisations are producing online distance courses on BIM. The KISS principle is something which perhaps people should consider in the context of BIM. Research shows there is often a tendency to overcomplicate BIM which sometimes leads to confusion and disappointment.				

CSF 10:

Ensuring successful transfer/ongoing management of information/data for the operational phase of assets

Over time an increasing number of buildings in organisations' portfolios will become digitalised and new buildings will be procured as standard using BIM. Organisations are increasingly likely to consider creating a digital representation of their existing RE portfolio, creating essentially a series of digital twins. This might include *'retro-BIM models'* and means FM teams will progressively receive increased amounts of digital information. This is illustrated in Figure 24 and shows how the amount of information/data increases during the BIM process and eventually will require a reduction process as the information needs to be transferred (or linked) into FM management systems. The information will be made up of **3D graphical models, alphanumeric data and documents** (PDFs, Jpegs, Excel sheets etc.) some of which may be held in external databases outside the BIM models. Where a new BIM project or existing RE is being digitalised FM teams should be involved early in order to **define and manage the capture and transfer of information and data**. This will ensure FMs can actively plan what data is required from the construction phase for a new build; or required digitalisation process where existing assets are being digitalised for use in **FM management systems** (e.g. CAFM, SAP etc.) in the operational phase. The IWFM has produced several guides specifically aimed at planning this transition.

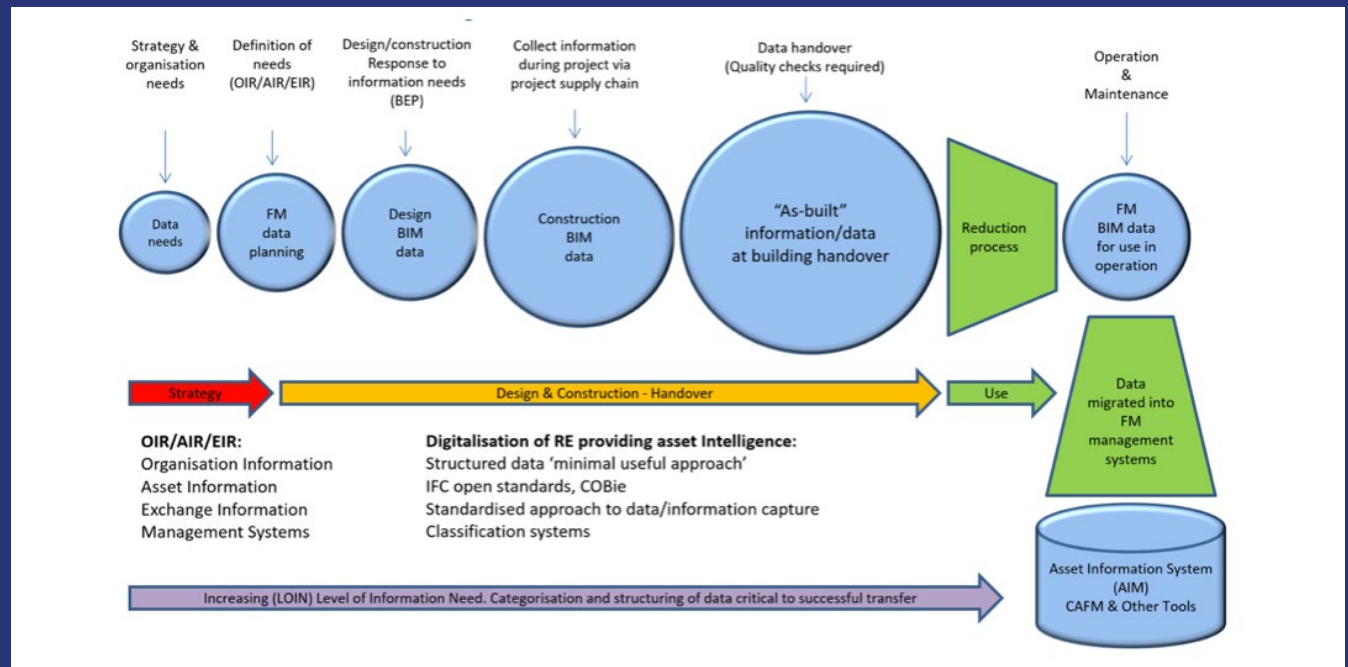


Figure 24

The *'EIR Template and guidance'* (Ashworth, 2017) can be used at the start of the BIM process and the *'BIM Data for FM Systems'* (Ashworth et al, 2019) can be used to help FMs prepare for such projects. The guides are available from the [IWFM website](#).

CSF 10:

Ensuring successful transfer/ongoing management of information/data for the operational phase of assets

Figure 25 from 'BS 8536: Part 1' (BSi, 2015, p13) illustrates the overall approach which should be taken as well as highlighting the importance of performance reviews and feedback in terms of **POE**.

For both new build BIM projects and digitalisation of existing RE it is important to have a well thought out BIM strategy and associated BIM processes, as well as a **competent person** (possibly an information manager on the client side) in place. This allows checking of **the quality of the information/data deliverables** as they are handed over (during the build/data capture process and for practical completion). This may involve using **COBie drops** to check data exported from the BIM model(s) and possible use of both Native and **IFC** files. As such FMs should also familiarise themselves with IFC and the work of buildingSMART. Some practical guidance on **COBie** is available from the Bond Bryan BIM Blog. It is important to note IFC/COBie exports/drops are just a **snapshot in time** and will need to be revised if any updates are made in the native software.

People should understand one can **only export what is already in the model(s)**. In native software such as Revit the COBie exports can be tailored to only include specific attributes required for a defined purpose so that you get what is really needed (and not everything). Therefore, during the planning process decisions need to be taken

as to what data is actually put in the BIM model(s). A **minimum useful** approach should be adopted with respect to what is included in the model. **All other information can be held in external databases**. The FM team should also consider where such documents and data can, and where appropriate could be, **linked to objects in the model**.

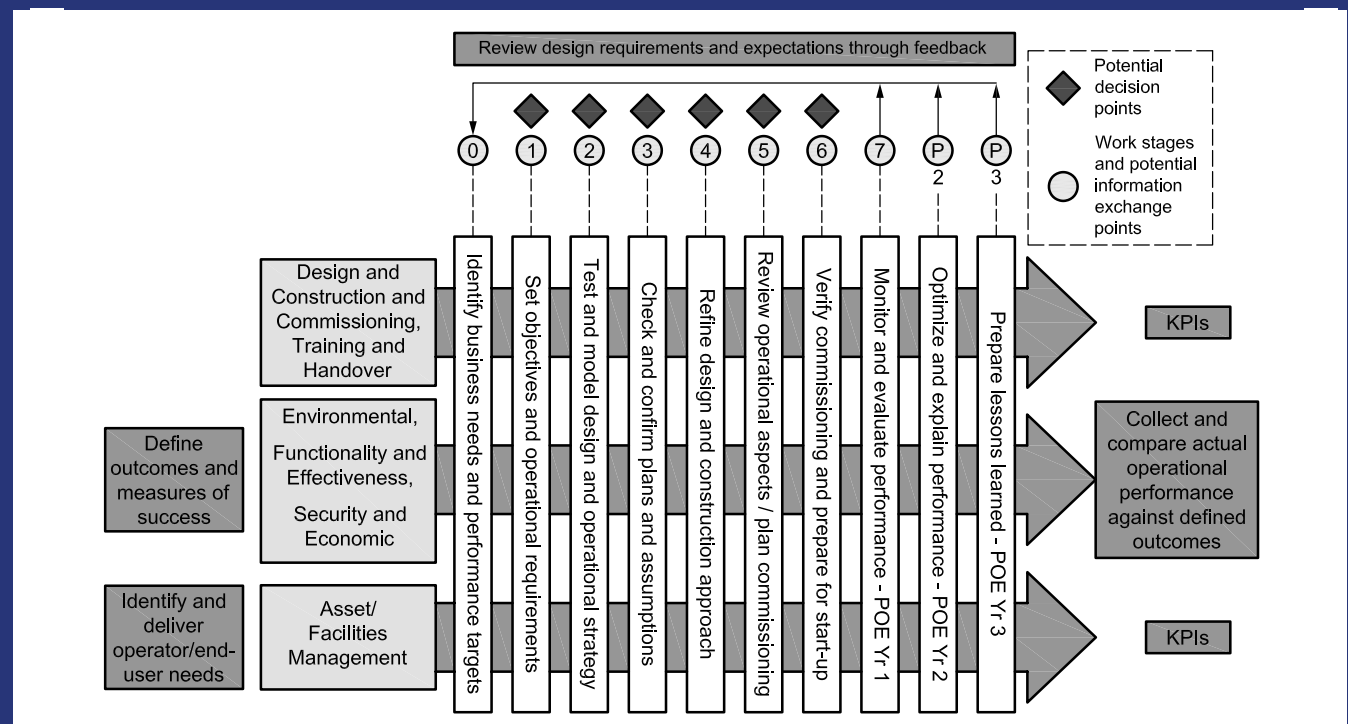


















Figure 25

CSF							
MT10: Ensuring successful transfer/ongoing management of information/data for the operational phase of assets							
Aim: Planning the data transfer and quality checking process for BIM projects					MOBILISATION STATUS CHECK LIST		
ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
10.1	Planning the data transfer and quality checking process for BIM projects	BIM information/data transfer will provide rich 3D models, PDF documents and alphanumeric data. Having the end in mind is key to planning which systems require what data. A quality check process should be enforced to validate that what is required is being supplied (e.g. COBie data drops with automatic validation checks). FMs should consider linking documents e.g. O&M manuals to objects in BIM models to improve access for FM teams. Ongoing management to ensure BIM models/data remain relevant requires early answers to key issues i.e., which assets are critical or matter, what level of information is needed, how are models/data retrieved, where are they stored and who legally owns the models/data?	The targeted FM systems for data to be transferred into must be clearly identified. Checks should be made to ensure systems are capable of exchanging information using COBie/IFC. Advice on CAFM COBie compatibility can be found on the NIBS website . The 'EIR Template and Guidance' document available from the IWFM website is an editable download to set up an EIR. The FM/client must take time to define in the EIR what 'FM attributes' or 'criteria' they want included in models and adopt a 'minimal useful' approach. Starkov (2015) suggests using 'COBie for FM' and outlines how software like Ecodomus can be used to connect systems. A 'quality checking process' is essential with the supply chain to ensure the quality of data handed over. This might include using COBie drops, visual checks, clash detection, conforming to certain standards and model/data integrity checks. Sarel and Jawadekar (2014) wrote up, which readers may find useful. However a data quality check manual check still needs to be done manually. Information about COBie can be found in the standard 'BS 1192-4' .				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
10.2	Planning what data to collect and how to transfer it into FM management systems	Significant time/cost savings can be achieved when transferring data using BIM. FMs should establish the target FM systems for data and whether they are compatible with IFC/COBie (if not this needs further investigation). The FM should work with the CAFM supplier to establish the BIM-2-CAFM data mapping process and how this will be managed. A ' minimum useful ' approach should be adopted to collect relevant information, not excessive data that will cost money and often not be used. This can be achieved by holding workshops with FM teams to establish what is really needed.	FMs can use the ' BIM data for FM systems ' available on the IWFM website to advise on planning for a BIM-2-CAFM process. It is also recommended that the FM discusses with the CAFM supplier the data-mapping process from the BIM models to the CAFM and who will do this. FMs should also have a basic understanding of COBie and IFC. Information about IFC can be found on the buildingSMART website . The UKBIM Alliance also provides helpful information and reports about enabling digital transformation.				
10.3	Using standards and a specific classification system to ensure data is well-structured to enable easy transfer from BIM models using COBie/ IFC	A common complaint about BIM is that at handover data is often unorganised and unstructured. This is usually due to poor planning and not adopting a suitable standardised classification system from the start which is IFC compatible . Classification systems can be thought of as a 'common language' to empower data mapping and ensure all stakeholders are discussing the same topics. Several classification systems exist e.g. Uniclass, OmniClass, etc. It is important that everyone utilises the same system to enable clear understanding. COBie or COBieLITE should be considered along with IFC. It is important that the required FM attributes are defined and that it is clear what data is in the BIM model vs what is provided in linked databases . FMs should also make themselves aware of the buildingSMART standards such as the bsDD and IDM. MVD and the BCF should also be understood.	A classification system for the project should be agreed early on and defined in the EIR to ensure all stakeholders follow the same system of structuring data. It should be a requisite that project teams can work with IFC and COBie. This will reduce possible loss of data at hand-over and allow quick and efficient transfer into FM management systems. In the UK the current BIM Level 2 compliant classification system is ' Uniclass2015 '. Advice on classification systems can be found on the NBS website and the BIMAXON website . The UK COBie standard ' BS 1192-4 ' can be downloaded from the BIM Level 2 or the BSi websites. Advice about COBie and IFC mapping can also be found on the bimtoolbox.org website. Information about IFC and videos are available by Petrie (2016) and Baldwin (2018) explaining the buildingSMART ' Data Dictionary ', Guidance about the IDM 'ISO 29481-1:2016' is given on the buildingSMART website and NBS website available from BSi. Baldwin (2018) explains MVD in a video. Information about BIM standards can also be found on the buildingSMART website .				

ST Ref	CSF Sub-Themes (ST)	Explanation	Examples	Completed	Initiated	To-do	N/A
10.4	Bi-directional data transfer and improving data handover processes and future possibilities	<p>Most BIM data transfer currently is one-way e.g. BIM to CAFM, but not bi-directional. This requires one-off exports being produced every time data needs to be transferred into FM systems. When data in the BIM model(s) is updated the process needs to be repeated. the IWFM has provided a 'BIM data for FM systems guide' to help FMs plan the data transfer process. Considering an openBIM approach can be used to ensure sharing of data using standard and open formats rather than proprietary systems. BIM servers using IFC to access information from one central place should be considered as a future oriented approach. Early supplier engagement should also be considered across the board to ensure suppliers support the gathering of data for FM.</p>	<p>The 'BIM data for FM systems' is available from the IWFM website. Other guidance is available from the North West Construction Hub. The concept of openBIM is explained on the buildingSMART website and discussed in the BIMhub journal edition 'Closed BIM versus openBIM'. It is also something that FMs should be aware of as a way of improving the data transfer process. FMs should discuss with the supply chain and the CAFM supplier, how the data gathered and mapping process can be improved to ensure the CAFM/other FM management systems receive the required data needed. This might include discussing where IFC/COBie exports are used and how the data can be quality checked as it is handed over, validated and verified. Note: some of the checking can be done automatically, however a human may need to check the actual quality of content which can not be automated. The use of an open source BIM Server may also be considered. More information about the concept of the BIMserver is available online.</p>				

5. Conclusion

In the BIM process we are often reminded to **start with the end in mind**. This 'FM-BIM Mobilisation Framework' together with the associated PhD research, allows contemplation of which success factors will help to achieve the intended objectives from the outset of a BIM project. The 10 CSF MT identified in the framework, together with their 102 associated ST, provide FM and all stakeholders involved with a way to help them on their BIM journey, whether they be right at the very start, or already well on the road. The MT and ST describe specific topics with associated resources, which can be tracked, and when acted upon, will help deliver better project outcomes and encourage everyone involved to work more collaboratively. BIM and digitalisation will provide new and exciting opportunities to add significant strategic value to the management of organisation's RE portfolios. Used appropriately BIM and digitalisation can help empower people to manage assets in more cost-efficient ways with a longer-term WLC perspective. However, in order for organisations and people to positively engage the **benefits** need to be made clear and transparent to everyone involved from the start of a project.

BIM and digitalisation are already having a significant impact on the AECO industries. Some of the change brought about is sometimes seen as challenging and adds complexity.

But, we need to remember project teams were managing building projects for many years before these topics became the new trends of today. BIM can help us address a key issue, which was often a problem in the past: namely the successful and timely transfer of valuable data, which was often lost between the construction and operation phases. What BIM and digitalisation do offer, are new opportunities to improve the way we work, deliver better built assets, and to be able to manage the wealth of information that results over the life of the assets. In order to adopt, use and benefit from such digital technologies a paradigm change in thinking and approach to collaborative working is required. We all need to think about how we can capture and work with the increasing amounts of information that will be generated. As [\(Munir et al, 2019, p1\)](#) argue in their paper 'BIM business value for asset owners through effective asset information management';

"for most asset managers, the problem is not the lack of information about their assets, but the abundance of it, and most especially the absence of established processes and protocols to effectively manage large sets of asset data. Therefore, it is crucial to develop a strategy to control and manage this information in order for asset managers to harness its potential and realise value from their organisation's information assets".



In order to deliver successful BIM projects, the researcher's PhD and personal experience has shown a need to focus on the CSF identified and to consider some key success elements which, when brought, together will help deliver successful BIM projects. These include: clarity about the benefits BIM will deliver, helping people with digital skills and collaboration; adopting a standardised approach and processes; consideration of information management over an assets whole life; and being open to the adoption and use of supporting technology.

Benefits: BIM needs to deliver clear benefits otherwise there is little point in its use or adoption. Organisations need to be transparent about what benefits they expect, and set realistic expectations, ensuring BIM is not oversold. The people involved in the BIM process need to be clear from the outset about how they, their organisation, and their jobs will benefit from BIM. These should include how BIM can help improve the quality and maintainability of built assets making them easier to manage and maintain, thereby delivering more sustainable benefits with a WLC approach. Both organisations and people are also much more likely to positively engage when they have a clear understanding of how BIM will benefit them.

Empowering people: experience shows the success of most projects hinges on the people involved. They need to be empowered: access to adequate training increases confidence, and being equipped with the right digital skills, competencies and tools allows

successful engagement with other stakeholders in the process. Project teams also need to encourage people by establishing collaborative working environments, which will benefit the whole project team. Roles and responsibilities should be well defined so people clearly understand what each person should deliver. Together these factors will have a very significant impact on the overall success of BIM projects.

Adopting a standardised approach and processes: people need to be familiar with the BIM standards, as laid out in the '[UK BIM Framework](#)', as well as other useful BIM guidance such as that offered by [IWFM](#). Organisations need to incorporate these into their BIM strategy and BIM processes to ensure everyone can work within a common framework and can communicate using the same language. The project team should also use agreed classification systems, and naming and number, convention for the whole project.

Information management: project teams need to deliberate and clearly plan what information is required in the operational phase. Starting with the end in mind, they should consider how the information will be used in an operational context in the AIM and determine the organisation's approach and needs to managing information (these should be clearly articulated in the organisation's OIR and AIR documents). It is critical to take the time to start the project properly before the EIR is generated which will direct the project team's generation of the PIM.

It is also important to be clear about what information will actually be in the BIM model(s) and what may come via other external databases. Finally, thought needs to be given to adopting a minimal useful approach and how the information will be created, collected, quality controlled, transferred into, and finally managed on an ongoing basis in the organisation's target management systems.

Technology: the project team needs to be clear from the start what the IT landscape of a project will look like. This will include reviewing decisions about what software will be used, whether an open or closed BIM approach will be adopted, what CDE will be in place for the project etc. All of these aspects should be incorporated in the project BIM strategy. All parties need to be able to demonstrate competency in the different technologies and to be able to demonstrate they can easily and openly share data between systems and use IFC and COBie as appropriate.

These success elements are reflected in the Figure 26 from '[ISO 19650-1:2018](#)' (ISO, 2018, p7) which illustrates the gradual development of information management from analogue to digital in three 'maturity stages'.

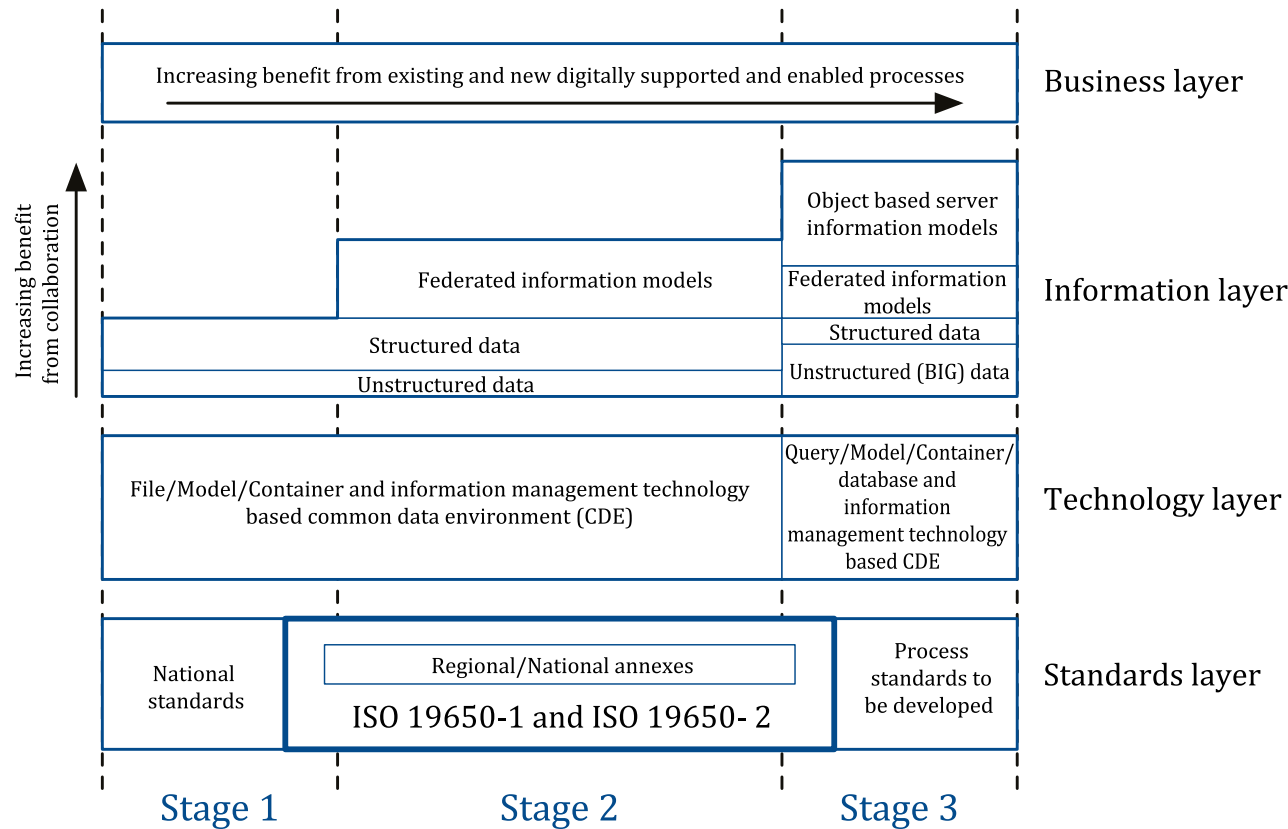


Figure 26

Note: these have replaced the previously used 'BIM Levels' many people knew from the 'BIM Wedge' diagram and 'PAS' documents. The layers show how standards, technology, information and increased collaboration build towards delivering an improved business benefit for organisations at the business layer.

Figure 27 (Ashworth, 2019) also brings these elements together and illustrates how the CSF underpin the success elements which in turn will help deliver the benefits of BIM. The CSF combined with the success factors reflect the evolution of FM in the BIM process and how we have an opportunity to use the CSF for optimising our built assets.

The 'FM-BIM Mobilisation Framework' will continue to be updated as my research develops. If anyone has any suggestions for improvements or additional links or resources, please contact me directly. As facility managers and stakeholders involved in BIM process, we all need to come together and share our knowledge and experience to help deliver better assets for organisations, society and future generations to live and work in.

Simon Ashworth

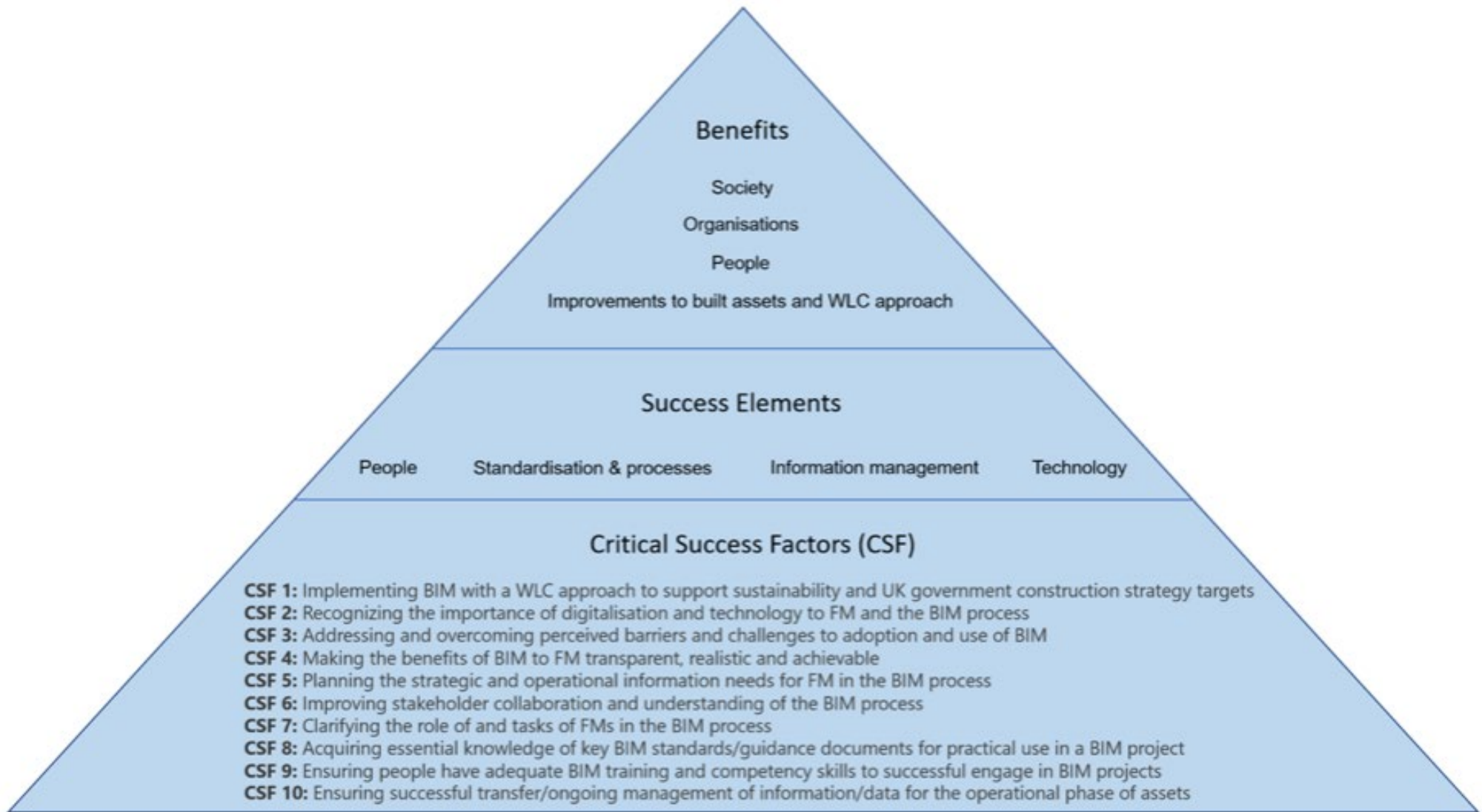


Figure 27 - How CSF and success elements work together to underpin the benefits of BIM

6. Further literature and papers by the Author

Readers who are involved in BIM projects maybe interested in the papers and sources from the author and fellow co-authors listed with links below.

Note: Hyperlinks to the sources to download the work can be found by hovering over the text.

Ashworth (2020), [‘FM-BIM Mobilisation Framework - Critical Success Factors to Help FM Deliver Successful BIM Projects’](#), PhD Thesis, Liverpool John Moores University.

Ashworth et al (2019), [‘BIM Data for FM Systems’](#)

Ashworth et al (2019), [‘The benefits of building information modelling \(BIM\) to facility management \(FM\) over built assets whole life cycle’](#).

Ashworth et al (2019), [‘The Benefits of BIM to FM Catalogue’](#).

Ashworth et al (2018), [‘Critical success factors for facility management employer’s information requirements \(EIR\) for BIM’](#).

Meslec et Al (2018), [‘Integrating Life Cycle Sustainability Analysis with BIM’](#).

Ashworth et al (2017), [‘Building a bridge to BIM’](#).

Druhmman and Ashworth (2017). [‘Das FM und seine Daten’ \(German\)](#).

Ashworth et al (2017), [‘Employer’s Information Requirements \(EIR\): A BIM case study to meet client and facility manager needs’](#).

El-Arousy et al (2017), [‘Swiss-COBie: Development of a Design for Information Exchange Between Planners, Contractors and FM in Switzerland’](#).

Ashworth and Tucker (2017), [‘Introduction of Employer Information Requirements \(EIR\) Template and Guidance for Facility Management’](#).

Ashworth (2017), [‘BIFM Employer’s Information Requirements \(EIR\) Template and Guidance’](#).

Druhmman and Ashworth (2016), [‘Rating Systems in Conjunction with BIM Deliver Outstanding Possibilities for Sustainable Construction’](#).

Ashworth et al (2016), [‘The Role of FM in Preparing a BIM Strategy and Employer’s Information Requirements \(EIR\) to Align with Client Asset Management Strategy’](#).

Ashworth et al (2016), [‘Integration of FM expertise and end user needs in the BIM process using the Employer’s Information Requirements \(EIR\)’](#).

Ashworth and Druhmman (2016), [‘BIM: Die Sicht der EU’, \(German\)](#).

Ashworth and Druhmman (2016), [‘What Switzerland can learn from England \(What Switzerland can learn from England\)’](#).

Druhmman and Ashworth (2015), [‘FM Expertise und Digitale Gebäudemode modelle’ \(German\)](#).

Carbonari et al (2015), [‘How Facility Management can use Building Information Modelling \(BIM\) to improve the decision making process’](#).

Ashworth (2015), [‘BIM and FM: Research and Practice Workshop’](#).

Ashworth (2015). [‘BIM und FM - Schweiz 2015’, \(German\)](#).

Ashworth and Druhmann (2015), *'Integration of FM and asset management expertise in digital 3D building models'*.

Ashworth et al (2015), *'The challenges and added value benefits of introducing the EN 15221 FM Standards into practice'*.

Ashworth (2015), *'BIM and FM in Switzerland: A survey of the perception of BIM by FM professionals in Switzerland'*.

Ashworth (2013), *'Added Value of FM Know-how, In The Building Whole Life Process'*.

Ashworth (2013), *'Added Value of FM Know-how, In The Building Whole Life Process', (MSc Thesis)*.

Appendices

Appendix 1:
Abbreviations

Appendix 2:
FM Relevant BIM guidance and
standards

Appendix 3:
List of figures



Appendix 1 - Abbreviations

ABAB	Australasian BIM Advisory Board	BSRIA	Building Services Research & Information Association	DPoW	Digital Plan of Work
AEC	Architecture, Engineering and Construction	CAD	Computer Aided Design	EDMS	Electronic Data Management System
AECO	Architecture, Engineering, Construction and Owner	CAFM	Computer Aided Facility Management	EIR	Exchange Information Requirements (previously Employer's Information Requirements)
AI	Artificial Intelligence	CAPEX	Capital Expenditure	EN	European Norm
AIM	Asset Information Model	CBRE	Company name	EUBIM	European BIM
AIR	Asset Information Requirements	cdbb	Centre for Digital Built Britain	FM	Facility Management
ALLPLAN	Company name	CDE	Common Data Environment	FMS	Facility Management Standard
AM	Asset Management	CIB	Conseil International du Bâtiment (in English: International Council for Building).	FMs	Facility Managers
AMS	Asset Management System (or Strategy)	CIBSE	Chartered Institute of Building Service Engineers	FSI	Company name
AR	Augmented Reality	CIC	Construction Industry Council	GSA	General Services Administration
ARUP	Company name	CIFM	Computer Integrated Facilities Management	GSL	Government Soft Landings
BCF	Building Collaboration Format	CIOB	Chartered Institute of Building	HM	Her Majesty
BCIS	Building Cost Information Service	CLAW	Consortium of Local Authorities in Wales	H&S	Health & Safety
BEP	BIM Execution Plan	CLC	Construction Leadership Council	ICE	Institute of Civil Engineers
BIFM	British Institute of Facilities Management	CMMS	Computerized Maintenance and Management System	IDM	Information Delivery Manuals
BIM	Building Information Modelling	COBie	Construction Operations Building Information Exchange	IET	The Institution of Engineering and Technology
BIMAXON	Company Name	CSF	Critical Success Factor(s)	IFC	Industry Foundation Classes
BIMe	BIM excellence	CSFT	Critical Success Factor Themes	IFD	International Framework for Dictionaries
BIM&Co	Company Name	CST	Critical Success Themes	IFMA	International Facilities Management Association
BMS	Building Management System	D&C	Design & Construction	IM	Information Manager
BRE	Building Research Establishment	DFM	Dansk (Danish) Facilities Management association	IoT	Internet of Things
BREEAM	Building Research Establishment Environmental Assessment Methodology			ISO	International Organization for Standardization
BS	British Standard			IT	Information Technology
bsDD	BuildingSMART Data Dictionary				
Bsi	British Standards Institution				

IWFM	Institute of Workplace and Facility Management	NHS	National Health Service	SGNI	Schweizer Gesellschaft für Nachhaltige Immobilienwirtschaft (Swiss Sustainable Building Council)
IWMS	Integrated Workplace Management System	NIBS	National Institute of Building Sciences		
KBOB	Koordinationskonferenz der Bau- und Liegenschaftsorgane der öffentlichen Bauherren (Coordination conference of the building and real estate bodies of the public building owners)	NIST	National Institute of Standards and Technology	SIA	Schweizerische Ingenieur- und Architektenverein (Swiss Association of Engineers and Architects)
KISS	Keep It Simple, Stupid	NRM	New Rules of Measurement		
LCC	Life-Cycle Costing	OIR	Organisational Information Requirements	SME	Subject Matter Expert
LEED	Leadership in Energy & Environmental Design	OPEX	Operating Expenditure	SSOT	Single Source of Truth
LIBAL	Company Name	ORG	The Operational Readiness Guide	ST	Sub-Themes
LJMU	Liverpool John Moores University	O&M	Operation & Maintenance	UK	United Kingdom
LOD	Level of Detail or Level of Development	PAS	Publicly Available Standard	UKBIMA	UK BIM Alliance
LOI	Level of Information	PDT	Product Data Templates	US	United States
LOIN	Level of Information Need	PIM	Project Information Model	VDC	Virtual Design and Construction
MCS	Model Collaboration Systems	PIR	Project Information Requirements	VINCI	Company name
MEP	Mechanical, Electrical and Plumbing	PLQ	Plain Language Questions	VR	Virtual Reality
MIDP	Master Information Delivery Plan	PM	Project Management	WBDG	Whole Building Design Guide
MOJ	Ministry of Justice	POE	Post Occupancy Evaluation	WLC	Whole Life Cycle or Whole Life Cost(ing)
MPDT	Model Production and Delivery Table	PoW	Plan of Work (Refers to RIBA Plan of Work 2013)	WRAP	Waste and Resources Action Programme
MR	Mixed Reality	PwC	PricewaterhouseCoopers	ZHAW	Zürcher Hochschulen für Angewandte Wissenschaften (Zurich University of Applied Sciences)
MT	Main-Themes	PwC BMM	PricewaterhouseCoopers Benefits Measurement Methodology		
MVD	Model View Definitions	RE	Real Estate		
NATSPEC	National Specification System of Australia	RFI	Request for Information		
NBIMS	National Building Information Model Standard	RIBA	Royal Institute of British Architects		
NBS	National Building Specification	RICS	Royal Institution of Chartered Surveyors		
		ROI	Return on Investment		
		SAP	Systems, Applications and Products (Note: this is the company name)		
		SFT	Scottish Futures Trust		

Appendix 2 - FM relevant BIM guidance and standards

Notes:

1. International 'ISO' standards can be downloaded from the [UK BIM Framework, ISO website](#) or the [BSi website](#). The [BIMregions website](#) provides online readable versions of 'PAS' and other BIM guidance. These can be downloaded from various websites.
2. The list of standards and guidance below is not intended to be exhaustive but to include key documents that are important to FMs in the BIM process.
3. Some standards are free and others need to be purchased.
4. The IWFM 'Operational Readiness Guide - Appendix 1' includes further FM related standards that might be of interest.

Short Title	Full Title	Key Aim
IWFM Role of FM in BIM Projects	<i>'The Role of FM in BIM Projects'</i>	This guide is designed to help FM professionals understand BIM and support them in their role as a productive member of any project or design team using BIM.
IWFM Operational Readiness Guide	<i>'Operational Readiness Guide'</i>	A guide to aid FM professionals in their role as a key stakeholder in the design and construction process. It aims to provide the perspective of the operational end user and offers advice on the processes, activities, tools and frameworks applied to deliver and operate buildings that are fit for purpose, operate optimally and provide a high level of occupant satisfaction.
IWFM EIR Template and Guidance	<i>'Employer's Information Requirements (EIR): Template and guidance'</i>	This document's aim is to assist FM professionals and clients by providing an EIR template which can be edited and amended by the client, or facility manager, to meet their individual requirements for a project that is using the BIM process.
IWFM BIM Data for FM Systems	<i>'BIM Data for FM Systems: The facilities management (FM) guide to transferring data from BIM into CAFM and other Management systems'</i>	This guide supports developing appropriate and more timely exchange of asset data / information and is aimed at helping teams to think ahead when planning BIM projects and to be clear about what they want and how to get it smoothly into their CAFM and other asset management systems. The idea is this should be approached using a 'minimal purposeful' approach, rather than the 'everything' scenario that is often requested.

Short Title	Full Title	Key Aim
UK BIM Alliance: 'Information management according to BS EN ISO 19650: Guidance Part 1: Concepts'	<i>'Information management according to BS EN ISO 19650: Guidance Part 1: Concepts'</i>	This guidance has been written to help individuals and organisations in the UK understand the fundamental principles of BIM according to 'BS EN ISO 19650 Parts 1 and 2'. These are referred to in the rest of this guidance as the 'ISO 19650' series.
UK BIM Alliance: 'Information management according to BS EN ISO 19650: Guidance Part 2: Processes for Project Delivery'	<i>'Information management according to BS EN ISO 19650: Guidance Part 2: Processes for Project Delivery'</i>	Standard of good practice. It defines information management principles and requirements within a broader context of digital transformation in the disciplines and sectors of the built environment (including construction and asset management industries). Its implementation in the UK is supported by UK National Forewords in 'ISO 19650' Parts 1 and 2, and a UK National Annex in 'ISO 19650' Part 2. This Guidance Framework is being developed particularly to support implementation of the 'ISO 19650' series in the UK.
ISO 55000	<i>'Asset management - Overview, principles and terminology'</i>	This standard provides an overview of asset management, its principles and terminology, and the expected benefits from adopting asset management. Where an organisation does not already have such a strategy in place this is a useful framework.
BS 8536-1:2015	<i>'Briefing for design and construction. Code of practice for facilities management (Buildings infrastructure)'</i>	This guidance aims to include the operations team and their supply chain in the design process. It also aims to extend the involvement of the supply chain for the project's delivery through to operations and defined periods of aftercare. It gives recommendations for briefing design and construction teams to ensure that designers consider the expected performance of a building in use. The standard applies to all new building projects and major refurbishments. It also includes briefing requirements for 'Soft Landings', BIM and POE.
BS 8536-2:2016	<i>'Briefing for design and construction. Code of practice for asset management (Linear and geographical infrastructure)'</i>	This standard gives recommendations for briefing design and construction teams in relation to energy, telecommunication, transport, water and other utilities' infrastructure. It aims to ensure that design takes into account the expected performance of the asset in use over its planned operational life. It is applicable to the provision of documentation supporting this purpose during design, construction, testing and commissioning, handover, start-up of operations and defined periods of aftercare. It incorporates the principles of briefing associated with BIM Level 2 and government 'Soft Landings'.

Short Title	Full Title	Key Aim
ISO 19650-1:2018	<i>'Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) -- Information management using building information modelling -- Part 1: Concepts and principles'</i>	This standard outlines the concepts and principles of BIM and provides advice on how to manage information including exchanging, recording, versioning and organizing for all stakeholders. Note: this document replaced the UK 'BS 1192'.
ISO 19650-2:2018	<i>'Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) -- Information management using building information modelling -- Part 2: Delivery phase of the assets'</i>	This standard specifies requirements for information management in the BIM process. This is in the form of a management process, within the context of the delivery phase of assets and the exchange of information. Note: this document replaced the UK 'PAS 1192-2'.
PAS 1192-3:2014	<i>'Specification for information management for the operational phase of assets using building information modelling'</i>	This standard provides guidance to AMs on how to integrate the management of information across the longer term activity of asset management, with the shorter term activity of asset construction for a portfolio of assets. Note: this will be replaced by ISO '19650-3' when released.
BS 1192-4:2014	<i>'Collaborative production of information. Fulfilling employer's information exchange requirements using COBie. Code of practice'</i>	This standard addresses COBie which is an internationally agreed information exchange schema for exchanging facility information. It is the UK government's chosen schema for information exchange. Its spreadsheet format can be used to exchange the alphanumeric information between BIM and other FM systems. COBie ensures that information can be prepared and used without the need for knowledge of sending and receiving applications or databases. The information exchange can be reviewed and validated for compliance, continuity and completeness. Note: COBie does not address the geometrical information.
PAS 1192-5:2015	<i>'Specification for security-minded building information modelling, digital built environments and smart asset management'</i>	This PAS specifies requirements for security-minded management of BIM and digital built environments. It outlines the cyber-security vulnerabilities to hostile attack when using BIM. It provides an assessment process to determine the levels of cyber-security for BIM collaboration which should be applied during all phases of the site and building life cycle. Note: this will be replaced by ISO '19650-5' when released.

Short Title	Full Title	Key Aim
PAS 1192-6:2018	<i>'Specification for collaborative sharing and use of structured Health and Safety information using BIM'</i>	This PAS specifies requirements for the collaborative sharing of structured H&S information throughout the project and asset life cycles. It supports the development of H&S information for all construction projects progressively from the outset. It sets out a framework (risk information cycle) for the application of H&S information-use through BIM processes and applications.
Government Soft Landings (GSL)	<i>'Government Soft Landings' (GSL)</i>	'GSL' is a building procurement initiative developed by BSRIA and the Usable Buildings Trust. It encourages designers and constructors to stay involved with buildings beyond practical completion. This will assist the client during the first months of operation and beyond, to help fine-tune and de-bug the systems, and ensure the occupiers understand how to control and best use their buildings.
BRSIA Soft Landings	<i>'BRSIA Soft Landings Framework 2018'</i>	'Soft Landings' Framework 2018 is a six-phase approach to help the project team focus more on the client's needs throughout the project, to smooth the transition into use and to address issues that POE has shown to be widespread. It is not just about better commissioning, fine-tuning and handover. 'Soft Landings' can be used for new construction, refurbishment and alteration and is designed to run alongside all forms of procurement. It allows for a full programme of post-occupancy evaluation that the project team can use to improve a building's performance and make it sustainable over the long term.
Information Protocol	<i>Information Protocol to support 'EN ISO 19650-2'</i>	The Information Protocol has been developed as part of the 'BS EN ISO 19650-2:2018' requirements and provides an example of what could be included in an Information Protocol to be used when confirming to 'BS EN ISO 19650-2:2018' for projects and their appointments.
CIC Outline Scope of Services	<i>'Outline Scope of Services for the role of Information Management'</i>	This document describes the role of information management. It details the scope of services, covering CDE management, project information management, collaborative working, information exchange and project team management.
CIC Best Practice Guide for Professional Indemnity Insurance	<i>'Best Practice Guide for Professional Indemnity Insurance when using BIM'</i>	This document provides advice to support the construction industry's take up of Stage 2. It summarises the key areas of risk which Professional Indemnity insurers associate with Stage 2 and what can be done to mitigate or eliminate those risks.

Short Title	Full Title	Key Aim
RIBA Plan of Work: 2020	'RIBA Plan of Work: 2020'	This framework organises the process of briefing, designing, constructing and operating building projects into eight stages (0-7). It details the tasks and outputs required at each stage. It is important as most construction projects refer to it to describe where a project is in a timeline of events.
ISO 15686 (parts 1-7)	'This suite of standards deals with 'service life planning'	The 'ISO 15686' standard is broken down into the following parts which address 'service life planning' issues: <i>Part 1: General principles and framework</i> <i>Part 2: Service life prediction procedures</i> <i>Part 3: Performance audits and reviews</i> <i>Part 4: Service Life Planning using Building Information Modelling</i> <i>Part 5: Life cycle costing</i> <i>Part 7: Performance evaluation for feedback of service life data from practice</i> <i>Part 8: Reference service life and service-life estimation</i>
ISO 16739-1:2018	'Industry Foundation Classes (IFC) for data sharing in the construction and facility management industries -- Part 1: Data schema'	This standard addresses IFC which is the open international standard for BIM. It describes how data can be exchanged and shared between software applications used by the various stakeholders in the construction and FM industry sectors. It includes definitions that cover data required for buildings over their life cycle.
Digital Plan of Work	'NBS 'Digital Plan of Work' (DPoW)	The DPoW is intended to help employers who are responsible for defining the deliverables required at each stage of a construction project. The plan covers the entire project timeline - from developing a strategy to managing the built asset.
Uniclass 2015	'Uniclass 2015'	This classification system provides a consistent classification structure for all disciplines in the construction industry. It contains tables classifying items of any scale from a large facility such as a railway, down to products such as a CCTV camera in a railway station. It achieves this by way of identifying and managing the vast amount of information that is involved in a project. It is a requirement for BIM projects, as set by the 'ISO 19650' series of standards.
Success Criteria for Soft Landings Projects	'Success Criteria for Soft Landings Projects (BG74/2019)'	This guide provides a simple and structured approach for setting success criteria on 'Soft Landings' projects. It is aimed at clients and client advisers to enable them to identify success criteria and to help them to achieve those criteria at the end of the project.

Short Title	Full Title	Key Aim
Success Criteria for Soft Landings Projects	<i>'Design Framework for Building Services 5th Edition (BG 6/2018)'</i>	This guide contains design activity proformas and drawing/model definitions that are used to support contract documentation and to encourage efficient collaborative working between building services and other designers such as architects, structural engineers and also along building services supply chains.
BSRIA Pitstopping	<i>'Pitstopping - BSRIA's reality checking process for Soft Landings (BG 27/2011)'</i>	BSRIA's Pitstopping guide describes a process that allows construction teams to periodically reconsider critical design issues by focusing on the perspective of the end user. The guide is specifically designed to run within 'Soft Landings' Framework (BG 54/2014), a form of graduated handover for new and refurbished buildings. 'Soft Landings' activities will assist in gaining credits under 'BREEAM'.
BSRIA How to procure Soft Landings	<i>'How to procure Soft Landings - Specification and supporting guidance for clients, consultants and contractors (BG 45/2014)'</i>	How to Procure 'Soft Landings' is written primarily to help public and private sector clients and main contractors procure 'Soft Landings' services from their construction supply chains. The guide is split into three main sections, with requirements worded for clients appointing professional designers, clients appointing main contractors/builders and contractors appointing sub-contractors.
BSRIA Life Cycle Costing	<i>'Life Cycle Costing (BG 67/2016)'</i>	It presents a simple process for the practical calculation of life cycle costs, with examples to show how the different stages of the process relate to one another, to show how the results are obtained and what they really mean. Life cycle costing focuses on economic assessment using profiles of current and future costs and benefits to arrive at a discounted net present value of the life cycle costs.
BSRIA Building Performance Evaluation in Non-Domestic Buildings	<i>'Building Performance Evaluation in Non-Domestic Buildings (BG 63/2015)'</i>	Recent research from academia and industry has shown that buildings do not always perform in the way that was originally intended. This results in inefficiencies in energy performance, and occupant dissatisfaction. BPE is the process of evaluating how a building performs and can be carried out on both new and existing buildings. This guide is intended to support the industry by explaining how to use BPE to address issues of inefficiency and user dissatisfaction. It is a general introduction to BPE, and explains why it is important and how it can be carried out. It is aimed at clients, designers, developers, constructors and FMs, to improve their understanding about BPE and how they can benefit from it.

Short Title	Full Title	Key Aim
<p><i>BSRIA Building Manuals and Building User Guides</i></p>	<p><i>'Building Manuals and Building User Guides - Guidance and worked examples (BG 26/2011)'</i></p>	<p>The Building Manual is intended to be an operator's guide to the building and will capture the building's design and operation needs. It is a single document that can be used to capture all future building changes and annual summaries of energy use and maintenance work. The Building User Guide provides the occupants with a simple, quick and easy guide to the everyday functions of the building. BSRIA's new guide provides worked examples and links to editable templates. These provide building information compilers and building operators with a standard method of capturing information about their buildings. Editable Word versions of the templates are attached to the pdf of this guide, and are available as a free download to anyone purchasing a hard copy of the guide.</p>

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