EUBIM TASKGROUP

Handbook for the introduction of Building Information Modelling by the European Public Sector

Strategic action for construction sector performance:
driving value, innovation and growth

Co-funded by
the European Union

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Foreword

Dear reader,

The European construction sector is at the centre of a tough but also promising set of economic, environmental and societal challenges. The sector represents 9% of EU GDP and employs 18 million people. It is a driver for economic growth and home to 3 million enterprises, most of which are SMEs.

Climate change, resource efficiency, greater demands on social care, urbanisation and immigration, an ageing infrastructure, the need to stimulate economic growth, as well as constrained budgets: these are challenges faced by governments, public infrastructure owners and society as a whole. An innovative, competitive and growing construction sector is a crucial component for tackling these challenges.

Similar to other sectors, construction is now seeing its own "digital Revolution", having previously benefitted from only modest productivity improvements. Building Information Modelling ("BIM") is being adopted rapidly by different parts of the value chain as a strategic tool to deliver cost savings, productivity and operations efficiencies, improved infrastructure quality and better environmental performance.

The future is here, and the moment has now come to build a common European approach for this sector. Both public procurement – which is accountable for a major share of construction expenditure – and policy makers can play a pivotal role to encourage the wider use of BIM in support of innovation and sustainable growth, while actively including our SMEs – and generating better value for money for the European taxpayer.

The EU BIM Task Group, which is supported by the European Commission, was recently conferred the first ever European BIM Summit Award for its pioneering work on a common framework for the wider introduction to and provision of a common definition of BIM for the public sector in Europe.

I would therefore like to thank the Group for its excellent work as an enabler of the digitalisation of the construction sector through its collective European action and acting as a central authority and source of information for public stakeholders in Europe.

I believe this handbook and its wide use will contribute to an open, competitive and world-leading digital single market for construction and I would like to call for its broadest possible adoption and use. I also would encourage a wider conversation across the public and private sectors for further collective action.

EU Commissioner Elżbieta Bieńkowska
Internal Market, Industry, Entrepreneurship and SMEs

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Belgium ..... Belgian Buildings Agency
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Finland ..... Senate Properties and Finnish Transport Agency
France ..... France PTNB; MediaConstruct; AIMCC
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- **The European Commission Directorate-General for Internal Market, Industry, Entrepreneurship and SMEs (DG-GROW)**
- **The UK Government's Department for Business, Energy and Industrial Strategy (BEIS), in its capacity as lead coordinator of the programme**

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Executive Summary

This handbook responds to the growing challenges faced by governments and public clients to stimulate economic growth and competitiveness while delivering value for public money through the wider introduction of BIM

Building Information Modelling (BIM) is at the centre of a digital transformation of the construction sector and the built environment. Governments and public procurers across Europe and around the world are recognising the value of BIM as a strategic enabler for cost, quality and policy goals. Many are taking proactive steps to foster the use of BIM in their construction sectors and public asset delivery and operations to secure these economic, environmental and social benefits. This handbook responds to the growing challenges faced by governments and public clients to stimulate economic growth and competitiveness while delivering value for public money through the wider introduction of BIM.

Collective European Recommendations

It is produced by the EU BIM Task Group, which gathers the collective experience of public policy makers, public estate owners and infrastructure operators from over twenty European countries to make recommendations to these questions:

- Why have other governments taken action to support and encourage BIM?
- What benefits can be expected?
- How can governments and public clients provide leadership and work with industry?
- Why is public leadership and European alignment critical?
- What is BIM? And what is the common European definition?

What is BIM?

BIM is a digital form of construction and asset operations. It brings together technology, process improvements and digital information to radically improve client and project outcomes and asset operations. BIM is a strategic enabler for improving decision making for both buildings and public infrastructure assets across the whole lifecycle. It applies to new build projects; and crucially, BIM supports the renovation, refurbishment and maintenance of the built environment – the largest share of the sector.

The Prize

BIM is not new, but it is a global trend that is growing. Reports[1] forecast that the wider adoption of BIM will unlock 15–25% savings to the global infrastructure market by 2025. And it is the technology-led change most likely to deliver the highest impact to the construction sector[2].

The prize is large: if the wider adoption of BIM across Europe delivered 10% savings to the construction sector then an additional €130 billion would be generated for the €1.3 trillion market[3]. Even this impact could be small when compared with the potential social and environmental benefits that could be delivered to the climate change and resource efficiency agenda.

The purpose of this handbook is to reach for this prize by encouraging the wider introduction of BIM by the European public sector as a strategic enabler; and to adopt an aligned framework for its introduction into the built environment and construction sector. This alignment brings clarity and repeatability to this digital innovation across Europe – reducing divergence, misunderstanding and waste. It will accelerate growth and encourage competitiveness of the construction sector, especially its SMEs.

Foot Notes

[1] BCG, Digital in Engineering and Construction, 2016; McKinsey, Construction Productivity, 2017
[2] WEF, Shaping the Future of Construction, 2016
[3] FIEC, Annual Report, 2017

Conclusions

This handbook concludes that there is a window of opportunity for harmonising a European wide common strategic approach for the introduction of BIM.

Government policy and public procurement methods are recommended as powerful tools to support this step-change in the sector. Without this top-down leadership, the sector's low and uneven adoption of information technology is likely to continue which would limit its opportunity to significantly improve productivity and value for money. This is especially true within its large and diverse SME sector.

Governments and public sector organisations can provide leadership to encourage the sector towards the untapped opportunity of digital, and in turn provide better public services and better value for public money. However, governments cannot do this alone: working together with industry at European and national levels is essential to achieve this digital transformation with due consideration given to commercial models, education, skills development, SMEs and changes to current practices.

The vision is to build together with the private sector a competitive and open digital construction market: one that sets the global standard. This handbook calls for coordinated public sector action across both European and national levels to drive towards this vision.

Finally, this handbook describes the first steps of a digital revolution for the sector that will, over time, require significant adjustment by construction clients and the supply chain. This cannot be achieved overnight and experience has shown that successful BIM adoption strategies recognise the need for a period of adjustment as BIM requirements are increased gradually. This handbook aims to provide the support to enable Governments and public sector clients to transition construction to the digital era.

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Introduction

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Background

The introduction of Building Information Modelling (BIM) represents the construction sector's moment of digitalisation

Digitalisation is the adoption or increase in the use of digital or computer technology by an entity such as an organisation, industry sector or country. The introduction of Building Information Modelling (BIM) represents the construction sector's moment of digitalisation. It is undisputed, that the wider use of technology, digital processes, automation and higher-skilled workers contribute greatly to our economic, social and environmental future.

The construction sector is strategically important to economies in terms of output, job creation and for the delivery and maintenance of the built environment. The European construction sector output of €1.3tn[4] (trillion) is approximately 9% of the region's GDP and it employs over 18 million people; 95% of which are employed by small and medium sized enterprises (SME)[5]. However, it is one of the least digitalised sectors with flat or falling productivity rates[6]. The sector's annual productivity rate has increased by only 1% over the past twenty years[7]. Several industry reports[8] identify systemic issues in the construction process relating to its levels of collaboration, under-investment in technology and R&D; and poor information management. These issues result in poor value for public money and higher financial risk due to unpredictable cost overruns, late delivery of public infrastructure and avoidable project changes.

Reports estimate the financial opportunity for digitalising engineering, construction and operations processes to be in the range of 10%–20% of capital project expenditure across vertical construction (buildings) and infrastructure projects[9]. Even using the lower threshold, a 10% productivity improvement of the European construction sector would generate savings of €130 billion. This is a prize worthy of Europe's investment and one that requires a coordinated and common approach. This will require leadership and the procurement leverage from Government and public sector clients across Europe who represent the construction industry's single biggest client.

Digitalisation of the construction sector represents a once in a generation opportunity to tackle these structural challenges by taking advantage of the general availability of best practices from other industrial sectors and of engineering methods and tools, digital workflows and technology skills to shift to a higher level of performance – and to become a digital construction sector.

Foot Notes

[4] FIEC, Annual Report, 2017 and European Commission
[5] European Co nstruction Forum, 2017
[6] Accenture, Demystifying Digitization, 2016
[7] McKinsey Global Institute, "Reinventing Construction: A Route to Higher Productivity", February 2017
[8] BCG, "Digital in Engineering and Construction", 2017; Economist Intelligence Unit, "Rethinking productivity across the construction industry", 2016; UK NAO, "Modernising Construction", 2001
[9] BCG, "Digital in Engineering and Construction: The Transformative Power of Building Information Modeling", 2017

Purpose of this handbook

This handbook provides a central reference point for the introduction of Building Information Modelling (BIM) by the European public sector and aims to equip Government and public sector construction clients with the knowledge to provide the necessary leadership to its industrial supply chain. It is produced by the EU BIM Task Group (EUBIMTG) which is comprised of public sector clients, infrastructure owners and policy makers from over 20 countries across Europe.

This group has a unique knowledge-base as its members are actively involved in delivering and operating public capital assets across Europe. It is not a technical guide to BIM technology, its applications or standards as this information can be found in a number of other informed sources. This document points to and encourages the use of these standards and applications to encourage wider benefits across the supply chain.

It is a co-funded European Commission project to support Europe's transition to a digital construction sector and in particular a consistent introduction of BIM by the European public sector clients and policy makers. It also contributes to a wider dialogue across the public sector and private industry about the transition to a European digitalised construction sector.

Who is this handbook aimed at?

Public Policy User

National Or Local Public Client/ Procurer User

Operator User

This handbook draws on the collective knowledge and experiences of those involved in the EUBIMTG and the results of a European survey of public sector BIM programs and existing and developing standards.

It is aimed towards European public stakeholders that develop policies relating to sectors, public clients that procure, own or operate built assets, such as, public infrastructure or buildings.

Broadly the users of this handbook fall into three groups:

- **Public policy user**
  Involved in the development of policy for infrastructure or construction sectors
- **National or local public client/procurer user**
  Primarily concerned with procurement of services
- **Operator user**
  Responsible for the on-going management and operation of the built asset or environment

For these users, the guide will provide a strategic overview of public sector BIM programs, the value proposition for a common European framework and the common principles and standards that can be adopted to inform national and local government BIM initiatives.

Why is this handbook required?

In order to fully realise the opportunity that digitalisation of the construction sector would deliver, we must address three challenges:

1. **Growing digital capacity across a diverse range of stakeholders**
2. **Defining consistent ways of working while maximising competition and innovation**
3. **Communicating and engaging the shared value to clients and the supply chain in order to change behaviours**

One-off pilot projects or successful mega infrastructure projects that adopt digital working practices are beneficial as exemplars, however, Europe's "prize" of €130 billion savings will only be achieved through the wide-spread adoption of digital processes on mainstream construction projects. Therefore, adoption needs to be at scale; with a skilled workforce equipped with the digital competences and capacity to operate across the value chain and across projects of differing size, complexity and type.

This capacity building is only possible through a consistent way of working that removes or reduces the transaction cost of re-learning from one project to the next. Therefore, this handbook aims to address the problem of misunderstanding, inconsistent requirements and national divergence.

The approach of this handbook is to create common guidance primarily for the demand side, i.e. public clients and policy makers and work towards alignment across European countries by creating common understanding, converging requirements and consistent terminology for digital working.

This handbook is produced in the context of three related strategic drivers:

- **A rapid increase of European public sector led BIM initiatives**
- **The EU Public Procurement Directive (2014) reference to the encouragement of BIM in public works**
- **The European Commission's call for funding to develop a common framework for the introduction of BIM to the European public works and construction sector**

Firstly, an increasing number of European governments and public sector organisations have introduced programmes to encourage the wider adoption of BIM at a national, regional or public estate level. The number of national public sector led BIM programmes has increased significantly since 2011 (to approximately 11 active programmes) which has created the opportunity for sharing common practices. At the same time, this increase in national programmes creates a risk of divergence across different European markets. Divergence in definitions and practices for BIM would likely create new barriers for working in different markets and add cost of compliance to the construction sector.

Secondly, in 2014 the European Union recognised the benefit of BIM to the public sector to generate greater value for money (in public works) and the encouraging of innovation. This directive has encouraged public procurers across Europe to consider the introduction of BIM, creating a need for information on BIM from the European public sector.

Finally, this handbook and the EU BIM Task Group is a direct result of the European Commission's call for funding for a two year programme to form a European public sector network sharing best practices on BIM and for the development of a handbook of recommendations.

One-off pilot projects or successful mega infrastructure projects that adopt digital working practices are beneficial as exemplars, however, Europe's "prize" of €130 billion savings will only be achieved through the wide-spread adoption of digital processes on mainstream construction projects

What is 'BIM' to the public sector stakeholder?

For public clients and governments, this translates to more being built and maintained for the same or less public money: a lower risk of cost overruns on public infrastructure projects, improved project understanding and transparency and greater stakeholder engagement

For the public sector, BIM can be thought of as 'digital construction'. It is similar to the technology and digital process revolution that entered the manufacturing sector in the 1980s and 1990s to improve productivity rates and output quality. It combines the use of 3D computer modelling with whole life asset and project information to improve collaboration, coordination and decision-making when delivering and operating public assets. It also addresses long over-due changes in processes from the analogue into the digital world that enable us to control and manage an unprecedented volume of digital data and information.

For public clients and governments, this translates to more being built and maintained for the same or less public money: a lower risk of cost overruns on public infrastructure projects, improved project understanding and transparency and greater stakeholder engagement.

In this handbook, the following central questions are addressed from the perspective of the European public sector stakeholder. To provide a progressive understanding of the common European framework, these questions are answered in two sections. Firstly, at a high level in the general guidance section and then in more detail in the action recommendations with examples and case studies section as follows:

General Guidance

- What is the value proposition of BIM to the public sector and public client?
- Why are public sector organisations providing leadership to encourage the wide adoption of BIM?
- What are the benefits to adopting a common European approach to the introduction of BIM?
- How are governments and public organisations introducing BIM at a strategic level?
- What are the common definitions of BIM when implemented at a project level that enable the consistent way of working?

Action Recommendations

- How would a common European strategic approach be introduced?
- How would a common European performance level be implemented at a project level?
- With reference to examples and case studies — How are public sector programmes introducing BIM at a strategic level and the implementation level?

Scope and use of this handbook

This handbook provides public stakeholders with policy, strategic and implementation level recommendations for the introduction of BIM as part of a wider change programme. Its authority and legitimacy is evidenced by a diverse range of contributors and consultations with public sector representatives within the EUBIMTG and a survey conducted by the group.

The recommendations contained do not form part of a European mandate though they are based upon current knowledge and European best practices. As experience grows in this area of digitalisation of the construction sector and improvements to standards and procurement practice, it is expected that this handbook will need to be revised periodically.

The scope of the handbook is to provide strategic recommendations to inform policy development or change management programmes at the national, regional or estate levels. In addition it provides implementation level recommendations to inform decisions at the project and procurement level.

The scope of the handbook is not to provide a technical introduction to BIM (which is covered widely in other literature), nor is it to develop standards or to 'compete' with standards bodies, academia and industry associations. It aims to signpost good practice and developed standards when introducing BIM; and to inform the decision making of public sector organisations to be consistent with each other, and the European construction sector.

This handbook's central aims are to:

- build common understanding and language
- share and promote the consistent introduction of BIM
- encourage wider use of developed standards and common principles

This handbook is designed to be read in sequence to gain an understanding of the general concepts before working towards a more detailed description of actions and recommendations, as follows:

- **Chapter 2**: General Guidance
- **Chapter 3**: Strategic and Implementation Recommendations
- **Chapter 4**: Case studies and examples

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Section 2

General Guidance

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The opportunity for leadership and alignment

It is predicted that BIM will become the standard for delivering the world's public infrastructure projects

BIM is becoming a global language for the infrastructure and construction sector, enabling greater collaboration and movement of capabilities across borders. It is predicted that BIM will become the standard for delivering the world's public infrastructure projects. It is, for example, already being used on many of the metro schemes currently in construction around the world.

The construction sector, including its clients, is highly fragmented in its process and learning. To a large extent it relies on ad-hoc improvements from one project to another. Therefore an industry-wide approach is needed to sustain long-term investment, capability and capacity development.

Government policy and public procurement methods are recommended as powerful tools to support this positive change in the sector. Without this top-down leadership, the sector is likely to continue its under-investment in information technology and to deliver low value for money and mediocre productivity levels This is especially true for its large and diverse SME sector. Governments and public sector organisations can provide leadership to encourage the sector towards the untapped opportunity of digital, and in turn provide better public services and better value for public money.

This guide proposes a proven approach based on universal principles, non-proprietary practices and open standards. This approach may be adopted by European public agencies in their own markets to deliver the following benefits to the public estate and private sector performance:

- Greater productivity of the sector – delivering more built assets for the same or less expenditure
- Improved output quality of public built assets
- Adapting to a sustainable built environment – one that supports the challenges of climate change and the need for a circular economy
- Increased transparency of construction performance
- New opportunities for sector growth, through exports and additional service offerings
- A stronger and digitally-skilled sector attracting talent and investment

We offer this guide as a contribution to the national and regional public sector collaborations emerging in Europe and welcome cooperation to extend its examples, case studies and recommendations.

The public sector – a driver for innovation

The need to get the best possible value from spending public money will always remain a constant for those entrusted with spending decisions. As a result of the financial crisis of 2008, the need to reduce overall spending has sharpened this requirement. The continuing downward pressure on the availability of public sector finance together with the ever-growing upward pressures of demand for public services will continue to further increase the need to make better use of the resources available[10]. The challenges are vast:

- Urbanisation and housing crisis
- Skilled workforce shortage
- Resource scarcity
- Climate change and circular economy
- Globalized markets
- Ageing infrastructure

Public procurers have substantial influence as a group to drive change as the construction industry's largest single client. As a non-competitive, transparent and non-discriminating client group, they can invest public money to secure better value for taxpayers and to encourage the market through procurement.

This guide is intended for a range of public sector stakeholders for the built environment in strategic or management roles. This section provides an overview to this audience and responds to the following questions:

- What is the value proposition of BIM to the public sector and public client?
- Why are public sector organisations providing leadership to encourage the wider adoption of BIM?
- What are the benefits of adopting a common European approach to the introduction of BIM?
- How are governments and public organisations introducing BIM at a strategic level?
- What are the common definitions of BIM when implemented at a project level?

Foot Notes

[10] HM Treasury Green Book: Appraisal and Evaluation in Central Government, Treasury Guidance. Green book supplementary guidance on delivering public value from spending proposals. (London: TSO). See www.greenbook.treasury.gov.uk.

Value proposition of BIM

BIM offers economic, environmental and social benefits across a range of different public stakeholders

The public sector can benefit from the adoption of BIM in three distinct stakeholder roles:

- **Public procurer or an infrastructure and estate owner concerned with the project phase (i.e. delivery of built assets)**
- **Public infrastructure and estate owner concerned with the operations and maintenance phase (i.e. use of public built assets)**
- **Public policy officer concerned with the development of legislation, policy, regulation or standards to improve performance of the sector or built environment (i.e. sector focus)**

For those in the private sector that have already exploited its digital process and technology, the benefits of BIM are well understood. These benefits include better coordination, and the faster production of accurate and reliable information to improve decision making and the quality of outputs. For the public sector, these benefits translate to economic benefits, such as better value for public money during the delivery phase and improved quality of public goods and services during the use of the built asset. For a policy maker concerned with construction sector performance, these economic benefits can be aggregated to a national level to support increased levels of productivity (e.g. measured as GDP) and potential for growth (e.g. measured as exports).

In addition to these economic benefits, BIM can support environmental benefits, such as more accurate material ordering leading to less waste to landfill and optimised simulation of energy analysis leading to lower energy demands from the built environment.

Social benefits can be delivered to the public infrastructure owner by utilising BIM effectively in public planning and consultation to build support for new or updated public infrastructure, such as highway placement, water containment features or public building refurbishment. This public engagement can support public infrastructure that is well designed and aligned with the needs of the local community resulting in improved social outcomes such as better resource planning, greater use of public facilities or mapping and protection of architectural historic heritage. Therefore, we can say that BIM offers economic, environmental and social benefits across a range of different public stakeholders.

The table opposite combines these benefits and different public stakeholders in a single grid. The yellow dots indicate the targeted benefits from a survey conducted by the EUBIMTG of the currently active BIM programmes across Europe (surveyed in June 2016).

The survey indicates that for public estate owners most of the benefits are economic, i.e. delivering savings to the delivery phase or to the use phase. In addition, for policy makers the benefits are mostly economic related (e.g. higher rates of productivity and competitiveness in global markets).

The survey indicates that there are a small number of active BIM programmes that are benefitting from the environmental and social agenda for both policy stakeholders and public estate owners and are pursuing a longer-term vision

	BUILT ASSETS		SECTORS	
	Delivery Phase	Use Phase	Construction	Digital
ECONOMIC	10% savings on time delivery ●●●●	Lower maintenance costs Lower operations costs ●●●●	Improve sector competitiveness Grow export capability ●●	Grow digital services industry Digital single market
ENVIRONMENTAL	Less site waste	Optimise operational energy use Assess whole life-cycle analysis ●	Resource efficiency Circular economy ●	Data infrastructure resource efficiency
SOCIAL	Higher standard of health and safety Improved public consultation and engagement	Improce social outcomes (e.g. patient care, pupil learning) ●	Cleaner and safer jobs in construction Attract next generation to the sector	Data Security Attract digital talent to construction

KEY

● = Targeted benefit of the surveyed public sector BIM programmes

Why provide public leadership to encourage BIM?

The EUBIMTG consulted across Europe to identify the common reasons that public sector organisations had decided to provide leadership for the wider use of BIM.

Reason for leadership	Description of the driver
Better value for public money	The public sector procurer has responsibility to gain the most economically advantageous value for public money. The introduction of BIM can offer more accurate and lower construction costs, and the reduction of delays for project delivery of public built assets.
Public procurement as a motivator for innovation	Governments, as the single largest procurers of construction with public sector spending approximately 30% of construction total output, can influence and encourage innovation. This is one of the stated aims for the European Union Public Procurement Directive (2014).
Network effect of adoption: support for SMEs	As the construction industry is highly fragmented with 95% of the industry defined as Small to medium sized Enterprises (SMEs), it is not easily able to organise itself and align on one single direction. Only through the wider adoption of BIM across the value chain will full economic benefits be achieved.
Digitalisation agenda	Governments, policy makers and industry are recognising the benefits of encouraging the digitalisation of industrial sectors. This is an especially important agenda in Europe with the European Commission's Digital Single Market initiative.

Why are public organisations adopting a common approach to BIM?

The European Commission provided funding and support to the EU BIM Task Group to bring together national BIM programmes across Europe towards a common approach. The benefits of adopting a common European approach can be seen in the following table:

Benefit of a European approach	Description of the benefit
Accelerate national efforts	Through collaborative working and sharing of best practice, nations can accelerate their own BIM initiatives by learning from others.
Minimise costs	Wasted effort and investment can be minimised through the reuse of existing developments and knowledge.
Impactful and robust programmes	By drawing upon existing knowledge and practical experience of what makes programmes successful, individual nations can be informed to create and implement effective initiatives.
International critical mass	Taking a similar approach to neighbouring countries for the encouragement of BIM will increase the strength and effectiveness of each individual national programme.
Reducing trade barriers to growth	Alignment of a European approach will encourage trade and opportunity for growth across borders. Creating national specific approaches will likely confuse the construction sector, discourage cross border working and add a cost burden to the industry when complying with national different approaches.
Encourage international standards developments and software integration	Europe has the opportunity to collectively encourage the development of standards for use in international markets. This ensures open competition in the supply chain and the open sharing of information across software platforms.

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European common strategic framework and common performance definition of BIM

This handbook provides two central frameworks for the common introduction of BIM to the European public estate and public works:

- A strategic framework for public sector led BIM programmes
- A common performance definition of BIM

These two frameworks complement each other to provide public stakeholders with a holistic methodology for the introduction of BIM as a national, regional or public estate initiative; and an implementation level definition of BIM to provide consistency for industry at the organisation and project level.

Strategic framework for public sector BIM programmes

BIM programmes are change management initiatives that require: goals, resources, people, developments, momentum, successes and time. In order to align these elements, this section presents a strategic framework to deliver robust and effective BIM programmes. This strategic framework provides a common approach for the introduction of BIM by the European public sector. The framework identifies the following four strategic areas of action that are important when developing BIM initiatives:

- Establishing public leadership
- Communicating vision and foster communities
- Developing a collaborative framework
- Growing client and industry capability and capacity

Each of these four high level areas contains specific actions for the public stakeholder to consider. The framework provides a route map for those stakeholders starting the journey and offers a cross-check to those that have already begun.

Strategic framework for public sector BIM programmes

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This framework recommends that public sector led programmes are most effective and robust when these four strategic areas are well defined and developed equally and concurrently. The following high level description of the strategic framework provides structure for the detailed description of the recommended actions in the Recommendations Chapter.

Strategic Recommendations
Page 30

Strategic Area	Action high level description
Public leadership	■ Define compelling drivers, a clear vision and goals ■ Describe the value of BIM to the public and private sector ■ Document the general approach for moving the industry towards the defined vision and goals ■ Identify a public sector champion to sponsor the initiative ■ Establish an implementation team to drive the programme. The value proposition and sponsor can unlock the required funding and resources
Communication and communities	■ Early and frequent engagement with industry stakeholders is essential to support the industry change process ■ Participate in and provide encouragement for regional and special interest networks to disseminate best practice ■ Use mass communication tools, such as online media, events, web and social media to reach audiences
Collaborative framework	■ Assess and address legal, regulatory, procurement and policy barriers in order to facilitate collaborative working and sharing of data. ■ Develop or use international standards for data requirements ■ Reference international standards for encouraging collaborative processes and sharing of data ■ Produce guidance and tools to support the upskilling of industry and development of academic curricula
Capability and capacity development	■ Run pilot projects and promote training to encourage early successes. ■ Increase the use of public procurement as a driver for industry capacity development ■ Measure progress, produce case studies to increase industry awareness and support

This framework describes the common strategic levers for a public sector led BIM programme. This high level approach is supported by the common performance level for the specification of BIM at the project, organisation or national level.

The framework describes how BIM can be encouraged strategically and the common performance level describes what BIM is when introduced to projects and the public estate.

Common performance level for the implementation of BIM

Despite a common definition, we often observe that BIM means many things to different people

There are several definitions of BIM available from Wikipedia to the International Standardisation Organisation (ISO), more or less consistently describing BIM as follows: a process or method of managing information related to facilities and projects in order to coordinate multiple inputs and outputs, using shared digital representations of physical and functional characteristics of any built object, including buildings, bridges, roads, process plant[11].

However, when BIM is introduced or specified at a project, organisational or national level, there is often a lack of clarity and common understanding of where to start, what to do and what defines a "BIM project" versus a "traditional project". Despite a common definition, we often observe that BIM means many things to different people. There is no single international standard or definition of the activities that should be procured and performed on a project for it to be considered a BIM project. Very often we encounter the view that BIM is software, a 3D model or a system. This inconsistency causes confusion and divergence for public procurers and private sector suppliers, leading to barriers for successful implementation.

Experience from the EUBIMTG recommends that a clear and specific definition of activities and characteristics combined with the phased implementation of the strategic framework in a realistic time frame seems to be the most promising approach to a successful transformation of the construction sector.

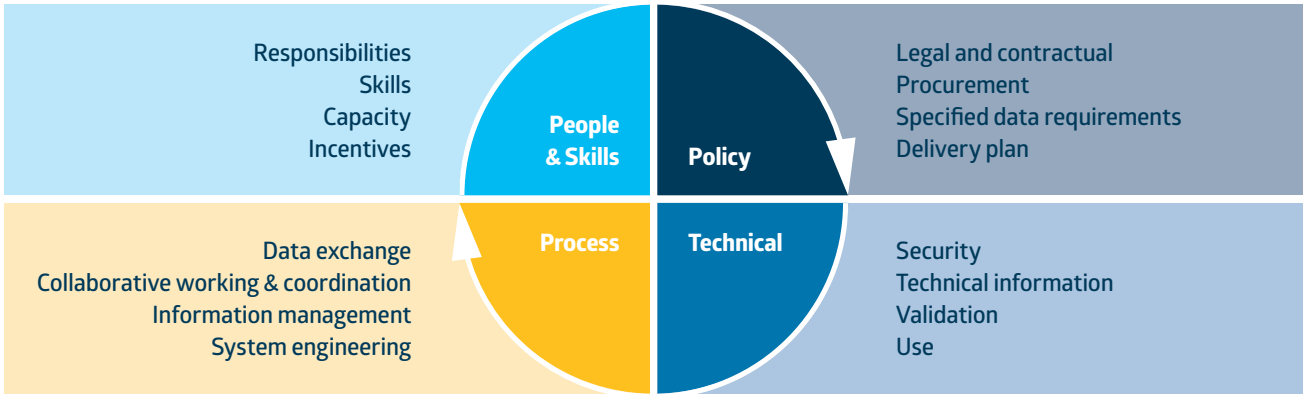
The following characteristics of a "Common EU performance level" describe the activities that should be consistently performed on a project for it to be considered an EU BIM project. They should be seen as minimum criteria for procuring and delivering construction projects in a consistent way across Europe. This is intended to be a stretch target, but one that is realistic for all European nations at the same time. The characteristics are closely aligned with existing and emerging international and European standards as well as best practice examples from the EUBIMTG.

The "Common EU performance level" was intentionally designed to not require any changes to legal frameworks or rules in any of the member states. The recommended activities can be performed under any procurement strategy or form or contract. Some of the recommendations have been specifically developed to support growth of SMEs; and to ensure open, fair and competitive markets across the professional service providers, trades and technology providers of all scales. The recommendations protect against over-specified requirements that may incur additional costs and introduce waste to the process. The characteristics cover four core definition areas as shown and explained opposite:

Foot Notes

[11] ISO/TS 12911:2012(en) Framework for building information modelling (BIM) guidance (https://www.iso.org/obp/ui/#iso:std:iso:ts:12911:ed-1:v1:en)

Common EU performance level for the implementation of BIM



The minimum characteristics described here transition the handbook from the strategic level to the operational use and definition of BIM at the organisation and project levels. The common EU BIM performance level provides a signpost to existing and developing standards. It will be most effective when these four areas are well defined and developed equally. The following high level description of the minimum characteristics is the foundation of the actions recommended in the "Implementation Level Recommendations" Chapter.

Implementation Level Recommendations
Page 59

Definition Area	Characteristics high level description
Policy	■ Commercial, legal and contractual matters are agreed and documented in an appropriate format and become part of the contractual arrangements between the parties involved. ■ The tender process includes an appropriate assessment of the supplier's capability, capacity and willingness to deliver the BIM requirements. ■ Information requirements associated with a construction project are specified and expressed in terms of the project stages that the project client or the supply chain intends to use. The fundamental principle of avoiding over-generation and over-processing of data should be applied through the specified information requirements. ■ Details on how the information requirements will be met and delivered are agreed and documented in an appropriate format.
Technical	■ The information requirements specify data to be provided in vendor-neutral, non-proprietary formats. ■ An object-oriented approach forms the basic principle of specifying, modelling and organising data
Process	■ The information planning and delivery processes require container-based and collaborative working principles. ■ A Common Data Environment (CDE) is required as a means of providing a secure and collaborative environment for sharing work. ■ System engineering tools and methods are required to encompass holistically all needs and requirements of all stakeholders in a comprehensive manner covering all architectural visions – operational, functional, organic – for all states of the built assets along its lifecycle, and to structure properly all information.
People	■ Responsibility for data and information management is assigned in accordance with the complexity of the project.

The minimum characteristics described here transition the handbook from the strategic level to the operational use and definition of BIM at the organisation and project levels

EUBIM
TASKGROUP

Section 3

Action Recomendations

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Strategic recommendations

Refer to the Strategic Framework For Public Sector BIM Programmes
Page 24

Section 3.1 describes the programme level recommendations for the introduction of BIM as part of a national strategy or policy or as part of a public estate programme. The principle audience for this strategic section includes:

- Strategic leaders and change managers of public client organisations
- Central government policy officers

It describes the important steps to develop robust and impactful programmes using a common and consistent approach across Europe. Section 3.2 describes the recommendations for the definition of BIM at the industry, organisation and project levels. The principle audience for this implementation level definition includes:

- Public procurers and technical managers within public client organisations
- Technical policy officers, public sector legal specialists
- Building and infrastructure regulatory officers
- Industry suppliers (e.g. manufacturers, architects, engineers and contractors)

Strategic Recommendations

There are four strategic areas for public estate owners and policy makers to concentrate their efforts towards (see diagram on page 24):

- Establishing public leadership
- Communicating vision and building industry engagement
- Building a collaborative framework
- Growing industry adoption and capacity

The following recommendations have been collated and classified from a survey of current European public sector best practice and through consulting with the EUBIMTG. The recommendations provide general guidance and therefore specific national and cultural differences should be taken into consideration.

The recommendation section explains the actions to be taken by public stakeholders to introduce BIM. For each recommendation this section will explain:

- What is the action?
- Why is the action important?
- What is the implementation recommendation?
- How has the recommended action been implemented?

Establish public leadership

The public sector BIM programme is not usually a standalone action isolated from other organisational activities. It would normally connect and support other goals and strategies. To ensure the programme has a strong foundation it starts by clearly defining:

- why BIM is relevant to the organisation or to the sector
- the scope of the programme and how it relates to other initiatives
- objectives and a strategy for achieving the stated goals
- a long-term commitment to encouraging the shift to a digital construction sector

PUBLIC LEADERSHIP ACTION 1
DEFINE COMPELLING DRIVERS, A VISION AND GOALS

What is the action?

Establish public leadership by first defining compelling drivers, a clear vision and specific goals. These are often the first steps taken by public sector organisations to establish a basis for the concerted action of a BIM programme, in order to:

- define what is motivating the public organisation to taking public leadership for the encouragement of BIM to its public estate
- describe what the future will look like by taking the action
- specify the measures and targets that will be improved by the programme
- make a public statement of intent to provide leadership and encouragement to industry
- increase the competences of the public owner/procurer/manager acting as the client organisation

Why is the action important?

The combined effect of this action is important and needed for:

- building support within the public sector organisation to allow funding and the necessary resources to be committed
- building alignment for a common direction between stakeholders across the public and private sector
- creating focus on the outcomes expected by taking action

What are the recommendations?

	Highly recommended	Recommended	Encouraged
Vision, Drivers & Goals	Ensure clear public drivers and goals are defined and documented. Make a public statement of intent.	During the BIM adoption process, change management strategies should be implemented to support and monitor commitment, to detect problems or inefficiencies, and where needed to take corrective actions.	Define organisational level metrics that address the drivers and describe progress towards the goals. Benchmark the starting point and measure progress throughout.

Estonian AEC industry

Framework / Performance Criteria: Strategic Framework Recommendations
Topic: Vision, Drivers & Goals
Recommendation: It is highly recommended that owners of BIM programs proactively communicate the public vision, drivers and goals for the introduction and the implementation of the road map of BIM.

CONTEXT

BIM adoption in the Estonian AEC Industry has increased rapidly during the last decade. One public procurer, several large construction companies and some forward-looking designers developed their in-house standards and skills to boost internal productivity and efficiency. In the case of the private sector actors this gained a competitive edge in the marketplace. The companies developed their individual approaches and standards which best suited their internal business processes and goals.

During this period, it was recognised that further productivity improvements were constrained by this non-standardised approach in a fragmented, high volume market.

In order to standardise the BIM implementation definition, a cluster of private companies formed to develop BIM collectively (http://e-difice.com/en/). This private industry effort to standardise BIM was viewed as an important step and precondition towards a general national BIM introduction.

Making a public commitment to BIM and defining a vision statement

The Ministry of Economic Affairs and Communications announced a joint initiative with industry to encourage BIM in the sector with defined workflows and standards. The Ministry publicly communicated its vision to "digitalize the entire industry so that all the value chain stakeholders benefit; and to drive a performance improvement for the whole industry".

The change management process

In Estonia, the first phase was to form a small group of public stakeholders (under the leading Ministry of Economy and Communications) who were ready to commit to the introduction of BIM requirements in their tenders.

Secondly, after securing the commitment of this core group of public stakeholders, other public procurers were convinced to join the initiative. This resulted in a formation of a large group of public clients, which contained the majority of the public purchasing power in the Estonian construction sector. This established a compelling and credible voice for the stated vision of digitalizing the entire sector and public estate.

Thirdly, this group publicly announced step by step BIM adoption requirements for the years ahead. Importantly, as the Ministry provided a long-term assurance for its commitment to introducing BIM to public construction projects, the industry gained confidence to invest in training, skills development, new workflows and technology.

Finally, BIM adoption requires dedication and involvement of the public and private stakeholders. Therefore care was taken to identify and include key stakeholders to be involved throughout the term of the programme. Engaging prominent people also helped to maintain the programme schedule and ensured that the vision, shared goals and planned activities were communicated early and often to industry and public clients.

WHY WAS IT DONE AS DESCRIBED?

The strategy has several fundamental principles which were considered.

- BIM adoption is a change management process which requires a focus on people and their attitude to change. A natural instinct to resist change can be overcome by engaging senior stakeholders across the industry, especially during the early phases of the development – this is essential for success.
- A progressive and slow paced change is essential in order to provide the necessary time for industry and public sector to adapt to the new ways of working, processes and tools.
- The involvement of industry stakeholders was critical when defining information and process standards. The public sector clients can provide the impetus in the form of project requirements and outcomes; however the industry actors have the insight, experience and capabilities to develop common processes to unlock the benefits offered by collaborative use of BIM.

WHAT LESSONS CAN BE LEARNED?

The main lesson learned was the need to provide a clear vision, long-term commitment and public leadership from the Ministry (Economic Affairs). This combined leadership made it possible to initiate a wider digital transformation in the industry. Based on the experience of Estonia it is suggested that:

- the first vision and approach are developed with a small number of strategic stakeholders. After the core of the strategy is formed, it is ready to be discussed with a larger audience and adapted with minor changes.
- the leadership needs to be provided by a public sector organisation (e.g. a Ministry). This allowed decisions to be taken in the interest of the whole industry, for the common benefit, including support for Small to Medium Sized Enterprises (SMEs).
- communication of the vision, goals and activities periodically to the target audiences is an important observation from the Estonian experience. It creates engagement with industry and was used to identify clear goals for industry and provided the messages and time for industry to adapt to the changes.

PUBLIC LEADERSHIP ACTION 2
DOCUMENT THE VALUE PROPOSITION AND STRATEGY

What are the actions?

Firstly, define the expected benefit of BIM in relation to the objectives of the public sector organisation. Secondly, document the proposed strategy to be implemented by the public sector organisation to introduce BIM to the public estate and/or across the construction sector.

Why are the actions important?

The value proposition is important to clearly explain why the public sector should provide its resources to support the wider adoption of BIM across private industry. It provides the required support for an investment request, i.e. a business case for funding.

Documenting the strategy of the programme is required to gain the support and buy-in from key industry and public sector stakeholders to ensure people pull together in the same direction rather than taking different actions that could weaken the overall programme. A well described and approved strategy is a standard component of any successful change programme.

What are the recommendations?

	Highly recommended	Recommended
Value proposition & Strategy	Define clear value proposition and strategy for introduction of BIM. Use public sector procurement as a lever for the introduction of the programme. Adopt the strategic framework and performance level introduced in this document.	Should consider phased roadmap development for progressive introduction of BIM to public works. Should provide a definition for BIM. Ideally refer to a set of levels or modules that require a level of performance.

Digital Road Map for Design & Construction, Germany

Framework / Performance Criteria: Strategic Framework Recommendations
Topic: Document the value proposition and strategy
Recommendation: Define a clear value proposition and strategy for the introduction of BIM. Use public sector procurement as a lever for the introduction of the programme.

CONTEXT

Awareness is growing across the industry that a step change is required in both pace and behaviour, if Germany wants to avoid falling even further behind other nations in Europe and international markets. Recent spectacular major project failures, such as Berlin Airport or Stuttgart's central train station, have fuelled that debate and triggered strategic action.

Strategy

In December 2015, the Federal Ministry of Transport and Digital Infrastructure (BMVI) launched its strategic Road Map for BIM for the transport infrastructure sector in Germany. This internationally aligned plan, a joint project of government and industry was largely developed by an industry-led initiative "planen-bauen 4.0" in 2015. It has been designed to facilitate the target that BIM is to be applied on all new public projects procured in Germany from the end of 2020 onwards. A phased mobilization period prior to 2020 is intended to provide a progressive roadmap for the development of capability and capacity in the market.

At a strategic level, the Road Map comprises a guiding principle, a hypothesis that describes the value proposed for Germany and a vision for the German construction industry in the digital age.

The plan defines a common definition of BIM that can be understood across the entire industry, and used within organisations and on construction projects. This common definition for BIM, known as "Performance Level 1", includes a reference process for creating, managing and sharing digital data. The consistent application of this process can unlock the benefits of BIM, such as increased planning confidence for on-time delivery, transparency and productivity efficiencies, in a proven, low-risk and cost-efficient manner.

Performance Level 1 is the first step on a progressive journey of the digital maturity of the market. Three levels of maturity are envisaged for Germany. This first step provides the foundation of a lossless and secure data exchange between all the parties involved in the project and asset lifecycle.
In addition to the processes required to achieve this, vendor-neutral data exchange formats have been defined as Performance Level 1 criteria. The aim is to support neutrality towards software products and tools; and to encourage innovation in processes, tools and workflows.

Value Proposition for Germany

The strategy supports the wide use of BIM at "Performance Level 1". The value proposition to Germany and its construction value chain is to lay the foundations for an even more integrated way of working in an open and collaborative data environment. It is intentionally designed to deliver better products, services and data with the software and tools available today and particularly under the currently existing policy, procurement and legal framework in Germany

WHY WAS IT DONE AS DESCRIBED?

Progressive roadmap to support and grow SMEs

The small and medium enterprises (SME) – the "Mittelstand" form the engine room of Germany's strong and successful economy. There has been a huge concern that the change introduced through BIM might overburden SMEs and lead to monopoly positions and dependencies.

Germany's strategic plan, similar to the UK Government's Construction Strategy 2011, sets out clear targets and objectives in a five year programme as intended to protect and grow the SMEs and to support the wider industry transformation. This included procuring on public projects the delivery and sharing of neutral open format data and not specifying vendor-specific solutions.

Documenting the strategy, essential support for the industry change

The challenges of introducing change to an entire industry sector are vast. A clearly documented strategy, that can be published, communicated, discussed and explained in all means of communication is an essential milestone and enabler to the change process.

Developing the strategy, building buy-in

The development of the road map took five months. The process involved three workshops with over 40 participants from client organisations, designers, architects, contractors, lawyers, software vendors and operators. The workshops were crucial in building maximum buy-in and support from all members of the construction value chain. The plan was published by the German Transport Minister Alexander Dobrindt at a high profile launch event in December 2015. This event attracted significant media interest and facilitated the industry change process.

WHAT LESSONS CAN BE LEARNED?

What worked?

The strategic roadmap provides essential clarity and consistency at a high level. It also helped to identify and prioritise activities and funding requirements. Client and supply chain organisations use the plan as a guide for procuring projects with a consistent understanding and common implementation activities.

What we learned

What the year 2016 has shown is how hard it is to communicate a strategic plan to an industry that employs over 6 million people and to make people feel that the plan is relevant to them. It has also revealed that with a top-down implementation in the public sector it can be difficult to overcome special stakeholder interests preventing change in some areas.

However, there is no doubt that the plan is being adopted by the industry on both sides, client and supply chain, and that it contributes to an accelerated adoption of BIM in Germany.

FURTHER INFORMATION

The "German Road Map for Digitalisation in Construction" can be found on the website of the German Ministry for Transport and digital infrastructure (German and English version):

- http://www.bmvi.de/SharedDocs/EN/publications/road-map-for-digital-design-and-construction.html?nn=212250

PUBLIC LEADERSHIP ACTION 3
IDENTIFY SPONSOR, FUNDING AND STEWARDSHIP TEAM

What are the actions?

The last component in establishing public leadership highlights the value of a public sector representative to be a sponsor or champion for the programme, and for the necessary funding and resources to drive the programme forward.

A public sector sponsor or champion is an individual or group of stakeholders (e.g. a Minister, Director or Construction Client Group) that have the appropriate level of seniority and responsibility to inform and influence others within the public sector organisation(s). For example, the sponsor might support the funding request decision-making process, or speak publicly at an industry conference about the programme.

Funding for the programme would likely include a modest investment to fund a small team of people to lead the programme, for developments and for communications and skills development activities.

Why are the actions important?

This is the last step in establishing public leadership, enabling funding to be provided and practical action to be taken. Gaining the support of a senior public sector advocate increases the visibility and authority of the programme both within government and with industry stakeholders. It also unlocks access to funding and acquires resources that allow the programme plans to be executed.

What are the recommendations?

	Highly recommended	Recommended	Encouraged
Sponsor, funding and stewardship team.	The introduction of BIM to the public estate or as a policy requires resources and a plan. Therefore there must be funding for a defined program and an executive team with sufficient experience to implement the program.	Should provide a visible public sponsor (i.e. the individuals that are ultimately responsible for the program). Ensure that all parts of the industry are engaged in the program.	Could consider a public and private initiative for funding and a joint program. Encourage alignment with EU funded programmes and make use of available funding

UK Government's Construction Strategy 2011 & BIM Programme

Framework / Performance Criteria: Strategic Framework Recommendations
Topic: Sponsor, funding and stewardship team
Recommendation: The introduction of BIM to the public estate or as a policy requires resources and a plan.

CONTEXT

The UK's BIM Strategy was issued as part of the UK Government's Construction Strategy 2011. The strategy set a mandate for the use of "collaborative BIM" on all centrally procured built assets across all government departments by 2016. The UK defined "collaborative BIM" as Level 2 BIM. The levels indicate the progressive digital maturity of the market.

This mandate was later supported across parliamentary terms by the Construction 2025 policy and the Construction Strategy 2016–2020.

SPONSOR

The UK Government's Cabinet Office are responsible for co-ordinating the Government's drive to the development of standards enabling all members of the supply chain to work collaboratively through Building Information Modelling (BIM). The Construction Strategy and the BIM programme were launched by the Minister for UK Government's Cabinet Office, Lord Francis Maude in May 2011 at a high profile industry event.

Funding, with a plan and implementation team

The BIM strategy set out a clear progressive plan of activities over a five year period. The plan defined strategic areas of work:

- communications with industry and academia
- development of tools and standards
- increasing the capability of public clients and increasing the introduction of BIM on public projects

The plan defined a budget and resources to deliver the strategy. £5m was granted to industry and provided to the Construction Industry Council (CIC) to establish the UK BIM Task Group. This group would work with industry to define the new ways of working, standards and support Government Departments in adopting the new ways of working and disseminate knowledge to industry. http://www.bimtaskgroup.org/

WHY WAS IT DONE AS DESCRIBED?

Strategic fit with existing economic and environmental drivers

With increasing demands on Government investment in a period of reduced tax receipts, the UK Government Level 2 BIM programme supports the achievement of the following targets set in the Construction 2025 policy:

- 33% cost reduction in the initial costs of construction and whole life cost of built assets
- 50% reduction in the overall time from inception to completion for new build and refurbished assets
- 50% reduction in greenhouse emissions in the built environment
- 50% reduction in the trade gap for construction products and materials

The programme underpins and enables the realisation of the Government's policy objectives.

Funding and an implementation team

The digital transformation of the public estate and the construction industry of approximately 3 million people is a large change programme requiring resources, a clear plan and a dedicated team to drive forward.

The strategy identified a clear value to the UK in terms of public savings on construction; and a clear benefit to the industry sector – in terms of higher levels of productivity and competitiveness. This value proposition unlocked a modest sum of funding to support the activities of the programme team.

WHAT LESSONS CAN BE LEARNED?

Progressive roadmap

The UK Government's BIM mandate required the supply chain to progressively develop their BIM capability. By setting a long term target (of five years) this provided sufficient time for the industry to adapt its processes and increase training and skills.

Freely available standards and tools

The UK BIM Task Group also made freely available the British Standards and the Publically Available Specifications along with the legal addendum (called the "BIM Protocol").

Challenges

The largest challenge has been the up-skilling of Tier 2, Tier 3 etc suppliers. However, recent efforts are making progress in this area, for example, the Construction Products Association and Lexicon is helping manufactures to respond to the BIM opportunity.

FURTHER INFORMATION

The UK Government's Construction 2011 and 2025 policy documents and the Government Construction Strategy 2016-2020 can be found using the following links:

- http://bim-level2.org/en/
- https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/61152/Government-ConstructionStrategy_0.pdf
- https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/210099/bis-13-955-construction-2025-industrial-strategy.pdf
- https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/510354/Government_Construction_Strategy_2016-20.pdf

Outputs achieved from implementing the UK Government's Construction 2011 policy are published on the Cabinet Office website and can be accessed using the following link:

- https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/466952/20150825_Annex_A_Departmental_Cost_Benchmarks_Cost_Reduction_Trajectories_and_Cost_Reductions_2015_Final_Draft.pdf

Communicate vision and foster communities

At the centre of any change programme is the need to communicate with people about the intended change. It is important that communication is started early and reaches across the target audience with a clear message that defines:

- Why the change is needed
- What the future will look like
- How to get where we are going
- What are the expected barriers and how these will be addressed

This set of communication actions is recommended to start during the establishing of public leadership and will continue through the development of the collaborative framework, and throughout the period of increasing industry capacity.

COMMUNICATION AND COMMUNITIES ACTION 1
ENGAGE EARLY WITH INDUSTRY

What is the action?

While public leadership is being established during the definition of vision and strategy, it is highly recommended that the public sector organisation communicates its vision, goals and action plan for the introduction of BIM to the wider industry.

The motto for this action is to communicate "early and often". This action is specifically related to communication and engagement with the formal institutes and associations, such as Chambers of Architects, Engineering Colleges or Construction Associations.

Why is the action important?

Committing time early during the process to consult with industry bodies helps to remove concerns and build support for the programme among key industry stakeholders. Early and sustained communication with industry will help to:

- foster buy-in for the BIM programme
- signal to industry that change is expected
- dentify champions in industry that can help to lead the change

What are the recommendations?

	Highly recommended
Engage early with industry (formal networks and institutes)	It is highly recommended that owners of BIM programs proactively communicate the public vision, drivers and goals for the introduction and the implementation of the road map of BIM.

Swedish Transport Administration (STA)

Framework / Performance Criteria: Communicate Visions and Foster Communities
Topic: Engage early with industry (formal networks and institutes)
Recommendation: It is highly recommended that owners of BIM programs proactively communicate the public vision, drivers and goals for the introduction and the implementation of the road map of BIM

CONTEXT

In 2012, the Swedish government, through a productivity committee, recommended that the STA should introduce and demand BIM be widely used by the construction industry to create efficiency in the investment projects and in the management of assets. At this stage, the STA was also using BIM to create efficiency in several of its investment projects and for the management of assets. In order to drive a successful implementation the Director-General of STA decided to implement BIM as a strategic and structured initiative across STA. A change project was initiated for the purpose of delivering this coordinated and structured approach. Subsequently, this change became 'business as usual' for the STA.

Early communication to signal direction

The STA communicated the aim of implementing BIM from the beginning of its project development. In the early stages, the communications signalled general intent to the industry that they would need to start developing their capabilities in order to be able to meet the upcoming requirements for the use of BIM in public projects. Much time and effort was put into meeting with formal industry stakeholder groups, describing what BIM meant for the STA. Importantly, the early communications focused on the role of STA, its mission, and the goals and vision set for the programme.

Changing the communication over time

As the work within the STA progressed, the external communications became increasingly refined towards the specific requirements that would be expected of the supply chain (for example, the delivery of key datasets at specific stages).

Using the strategy document as a communications tool

The STA developed a BIM strategy document which was approved by the Director-General. The strategy document itself became a useful communications tools used to formally communicate the BIM mission to the industry, and internally to the STA itself.

The strategy defined a short term goal (2015) and a long term goal (2025) together with strategies on how to achieve the goals. The strategy created a clear signal to the industry that the administration was doing this and that they themselves would need to get on-board.

Continuous communications

One-day BIM conferences have been used to provide the industry and internal STA teams continuous updates. This external and internal STA communications has been an on-going activity that will continue during the programme.

WHY WAS IT DONE AS DESCRIBED?

Importance of a sponsor in communications

It was strategically important for the Director-General to approve the decision to implement BIM and the BIM strategy of the STA. This internal sponsor provided credibility to the work and added authority particularly in the communication with industry.

Signalling long-term direction to the industry

It was crucial that the communications strategy delivered the long-term message to the industry. The message described what would be coming, why change was required, and the need for them to start work in a BIM process. The programme recognized its impact on the industry and that change would be necessary within the supplier organizations (e.g. designers, engineers and contractors).

WHAT LESSONS CAN BE LEARNED?

Communication is one of the keys to succeeding in change management. One cannot wait to have all the answers or solutions. But when solutions are being progressed, one needs to communicate that this is the current situation and that the issues are being worked on. An open and honest dialogue between the public client and industry stakeholder groups was of paramount importance.

Even though the project team in the STA spent many hours on communicating the aim and uses of the implementation of BIM at different levels of the organisation, it is sometimes difficult to get acceptance at all the levels needed. Still today, in discussions on why we are implementing BIM, questions arise in meetings or presentations given on other BIM related topics. We expect this is part of the natural change process happening over a long-term period.

Looking back, the decision to have a successive implementation was wise. However, the communication of the reasons for that decision may have not always been sufficient.

FURTHER INFORMATION

Governmental report on improved productivity and innovation in the civil engineering industry:

- http://www.regeringen.se/rattsdokument/statens-offentliga-utredningar/2012/06/sou-2012-39/

COMMUNICATION AND COMMUNITIES ACTION 2
CREATE NETWORKS

What are the actions?

Public sector BIM programmes are encouraged to participate in and, if necessary, take action to promote the formation of groups of industry stakeholders to share best practices and lessons learned. It is recommended to collaborate with other countries and encourage alignment and accelerate learning. Similarly, it is highly recommended to join established international and national networks to facilitate the transfer of knowledge.

These best practice networks can efficiently disseminate information about the BIM programme across the geographic areas of the country and across the industry's different disciplines and types of organisations. Regional or national observatories or facilities may be used to collect and share project experiences to improve capability development.

Why are the actions important?

The use of networks to disseminate information and learning across the industry can accelerate the change process and remove barriers of adoption for supply chain members. Networks are especially useful to allow different organisations to interpret the BIM programme to their specific context. For example, an architect's network will discuss what the BIM programme means to them; as will a large contractor network consider the issues relevant to them. This is an especially useful tool to engage SMEs in the change programme.

The dissemination effect of networks is useful for public stakeholders within country and for the spread of good practice with other countries.

What are the recommendations?

	Highly recommended	Recommended	Encouraged
Create networks (cross-country and cross-discipline)	It is highly recommended to join established international and national networks both to contribute in the development of BIM, and for transfer of know-how. It is also highly recommended to create networks between public stakeholders/clients, if lacking, to align strategies, goals and the legal and regulatory framework.	Should identify potential collaboration with other countries to support and encourage alignment of common practices.	The public sector program could create, encourage or participate in networks of industry supply chain members, including technology providers, clients and academia. This facilitates best practice sharing across the country and across disciplines. These special interest groups may be small in size, e.g. 20–30 stakeholders. However they are vital for disseminating good practice across the value chain, and especially SMEs.

Swedish Transport Administration (STA)

Framework / Performance Criteria: Communication and Communities
Topic: Join and create networks
Recommendation: It is highly recommended to join established international and national networks both to contribute in the development of BIM, and for transfer of know-how.

CONTEXT

Whole value chain engagement

BIM Alliance Sweden is a non-profit association gathering parties from the industry such as technical consultants, contractors, software companies, architects, building material suppliers and public stakeholders within real estate and facility management.

The BIM Alliance was formed in 2014 through the merger of the former organizations OpenBIM, fi2 Facility management information and buildingSmart Sweden. Approximately 170 companies and organizations are members of BIM Alliance. It promotes the implementation, management and development of common open standards, processes, methods and tools, aiming towards the best possible IT tools and open standards that are utilized to stimulate effective processes within the built environment.

Disseminating knowledge across areas of specialism

Within the association a number of stakeholder groups have been formed for exchanging BIM-experience and BIM-knowledge within and between the different communities of the industry.

Creating a dialogue with industry

The Swedish Transport Administration joined the BIM Alliance in order to open a dialogue with industry about the Administration's aspiration for its BIM program.

WHY WAS IT DONE AS DESCRIBED?

The merging of three associations into one was a decision based on the belief that a joint association would provide a more powerful engine and driving force for change and would work more effectively towards the common goals and vision for the industry.
In Sweden, the BIM Alliance is the leading association form BIM with approximately 170 members.

The Swedish Transport Administration decided to participate with the BIM Alliance as it represented a wide diversity of the industry. Participating in the stakeholder groups provides a great opportunity to hold an open dialogue with different stakeholders discussing the key issues which builds greater buy-in and ultimately delivers a more successful BIM implementation program.

WHAT LESSONS CAN BE LEARNED?

In 2017, a strategic program for innovation was initiated, Smart Built Environment (SBE), with the aim to do research and development. It integrates Geographic Information Systems (GIS), Building Information Modelling (BIM) and Industrialized Construction.
The long-term aim is to integrate the developments of the BIM program and BIM community with this wider SBE initiative. This will have the benefit of maximising Sweden's resources and critically to bring learning and experience in from professionals outside the established BIM-centric community.

FURTHER INFORMATION

- http://www.bimalliance.se/
- http://www.smartbuilt.se/

COMMUNICATION AND COMMUNITIES ACTION 3
USE MASS COMMUNICATION, EVENTS, MEDIA, WEB AND SOCIAL MEDIA

What are the actions?

It is recommended to include the development and implementation of a mass communication plan. This action would utilise multiple communication channels such as media publications, websites, conferences and social media. The aim is to communicate to the whole value chain.

Why are the actions important?

Given the scale and fragmentation of the industry it would be impossible to communicate with each and every person therefore mass communication is a strategically important tool to engage people and encourage change. It allows these important outcomes to occur cost effectively:

- clear messages to be understood by a wide and diverse audience;
- an engaged and participating target audience;
- clear signposted milestones of the programme;
- sharing of successes to build and maintain momentum of the programme.

What are the recommendations?

	Highly recommended
Mass mmunication via events, media, web and social media	Should leverage mass communication tools to raise awareness of the program to the maximum audience. Define, recognise and encourage best practice of BIM implementation.

French PTNB, mass communication using a website

Framework / Performance Criteria: Communication and Communities
Topic: Use mass communication to raise awareness with the maximum audience
Recommendation: Develop a mass communication plan which would use multiple communication channels such as media publications, websites, conferences and social media

CONTEXT

The PTNB developed a dedicated website to communicate its aims, work programme and to disseminate good practice across the French construction and operations sector.

The aim of this action was to convince the greatest number of building professionals to be active in the digital transition. This website highlights and promotes the actions carried out by the French digital plan PTNB.

It includes analysis of projects of new construction and renovation using digital tools and to draw the clearest possible lessons in terms of necessary investments and benefits (e.g. likely costs, timescales and quality considerations). It also collects and highlights good digital practices. Finally, it encourages the use of digital technology in new construction, renovation and facility management operations by proposing tools and methods that are appropriate (e.g. software tools, guides and protocols).

This portal also communication events and key actions of the PTNB, including conferences, animations, media interviews and shows.

WHY WAS IT DONE AS DESCRIBED?

The portal was designed to better understand the state of play of BIM in France. The PTNB is the central means to communicate its message to the industry. The portal presents interviews with building professionals on their current practices, this is a crucial aspect of encouraging good behaviours.

WHAT LESSONS CAN BE LEARNED?

The lessons learned from these surveys are published on the site via the “Digital Barometer”.

The structure of the website is designed to maximise ease of use for the professionals.

The first section presents the three axes of the PTNB National Plan (convince and create appetite, support the increase of skills and encouragement adaptation of tools, build confidence in the use of digital tools).

The second section describes the on-going actions

The third section “Territorial References” gives access to a national network based on the territorial entities of the professional organizations and on the most advanced local initiatives in the digital field.

FURTHER INFORMATION

- www.batiment-numerique.fr

Build a collaborative framework

This set of actions produces a common understanding and definition of BIM in context of the public sector programme. It creates the documents and tools necessary to support an industry-wide:

- common understanding
- common data exchange
- common ways of working
- basis for consistent up-skilling, training and education

The documents produced are typically standards, guides or tools (including online systems). For more detailed information about the development of a collaborative framework reference the material below in the section "Implementation Level Recommendations". The description immediately below provides a management overview of the issues and recommendations to be considered in the development of the programme.

COLLABORATIVE FRAMEWORK ACTION 1
DEVELOP THE LEGAL AND REGULATORY FRAMEWORK

What is the action?

It is highly recommended to assess and clarify the regulatory, procurement and legal contracting arrangements between clients and suppliers to facilitate the use of BIM and the exchange of digital information across the project and asset lifecycle. The action should consider the regulatory, procurement and legal aspects to clarify the terms relating to:

- intellectual property ownership
- obligations and liabilities of suppliers
- purpose of information exchanges
- roles and responsibilities for information management

It is recommended that the regulatory framework is reviewed and clarified if required to be consistent with EU policies and legislation. For example, specifying open data formats.

It is encouraged that a national BIM programme could inform and influence higher level regulations development, for example at the European level.

Why is the action important?

Concerns about the exchange of information can be a barrier for the collaborative use of BIM across the supply chain. Therefore action taken to clarify the procurement and contracting process and requirements can unlock new ways of working, stimulating innovation and encouraging the exchange of digital data.

What are the recommendations?

	Highly recommended	Recommended	Encouraged
Legal and regulatory framework	Assess the legal and regulatory support needed for the introduction of collaborative BIM. Identify gaps and remove barriers for the use of digital data in relation to liability, ownership and rights that constrain benefits resulting from the wider adoption of BIM. Ensure open access to trade.	Align legal and regulatory framework with EU policies and legislation.	Could influence policy and regulations development at a higher level, e.g. EU.

UK Government's BIM Task Group

Framework / Performance Criteria: Build a common collaborative framework
Topic: Develop a compatible legal and regulatory framework to encourage BIM
Recommendation: Review legal and regulatory support for the introduction of BIM. Identify gaps and remove barriers for the use of digital data in relation to liability, ownership and rights that prevent the adoption of BIM. Ensure open access to trade

CONTEXT

The UK BIM programme set a series of tests for implementing its 2016 requirement for BIM Level 2 across centrally funded construction projects. One of these tests stated that BIM working practices should operate within the existing construction contractual framework; and that any additions or changes should be minimal.

Level 2 BIM is a collaborative process. It depends upon the sharing of quality data in a defined and consistent process across the project lifecycle and between construction project participants (including the client). The UK BIM programme recognised that unclear roles, responsibilities and obligations would create barriers for this collaborative approach and would constrain the expected whole sector benefits.

Removing barriers and encouraging collaborative behaviours

The UK solution was to develop a supplementary legal agreement (the CIC BIM Protocol – link provided below) that could be simply added to professional services appointments and to construction contracts.

More details are provided on the BIM Protocol under the common performance recommendation (Policy, Legal x)

Process of developing an industry-wide legal solution

The UK BIM programme tendered a work package to the private sector for the development of this legal addendum which crucially included the requirement to consult with different industry stakeholders.

This BIM Protocol is made freely available for download (link provided right).

WHY WAS IT DONE AS DESCRIBED?

The UK programme recognised that the legal issues must be tackled in order for the wider benefits of collaborative BIM to be achieved across the sector and across projects.

Utilising industry expertise

The BIM Protocol was developed by industry experts (following a public tender and selection process) in order to gain 1) the buy-in and representation from across industry and 2) to acquire the specialist legal expertise.

WHAT LESSONS CAN BE LEARNED?

Remove barriers that may impede the adoption of BIM as a collaborative environment. Engage with industry to provide the expertise and optimal solution to the task of removing barriers.

FURTHER INFORMATION

- http://bim-level2.org/en/guidance/
- http://bim-level2.org/globalassets/pdfs/bim-level-2-introduction-to-commercial-documents.pdf

COLLABORATIVE FRAMEWORK ACTION 2
REFERENCE OR DEVELOP TECHNICAL AND PROCESS STANDARDS

What are the actions?

The programme should require the use of a standards based open data format for the exchange of information between the supply chain and the client. This format would be used in the tendering and contracting documentation to ensure a non-discriminatory definition for suppliers to comply to. This would also be consistent with European Union rules to ensure an open market to suppliers.

Where possible data classification systems and data exchange formats should use existing standards. It is recommended that national programmes do not "re-invent the wheel" by developing new data exchange formats.

It is recommended that the programme also specify a standard process to encourage collaborative working practices. The common process should include:

- guidance for collating, managing and sharing information
- managing different model versions in a file based workflow
- a security minded approach to BIM
- a central repository of BIM files for controlling access to information

The implementation level recommendations in the Section below "Implementation Level Recommendations" provide detailed information for a technical common performance level.

Why are the actions important?

The technical framework for data and process standards provides a consistent language and common understanding of the required outputs from the BIM process; and it provides a common agreement for the BIM process across the industry. This consistent approach standardises the interactions between the supply chain and client which leads to efficiencies and repeatability.

Without a standard data and process definition the supply chain and client will be re-creating a diverse range of proprietary approaches which will potentially add a cost burden for each project.

What are the recommendations?

	Highly recommended	Recommended	Encouraged
Technical: a and process standards	Require the use of a technical framework for data and process. Ensure that technical frameworks support open access to trade.	Should use ISO or CEN standards for data classification, exchange, security and processes. Don't invent own standards.	Participate in the development of national, European and international standards.

Rijkswaterstaat

Framework / Performance Criteria: Build a common collaborative framework
Topic: Technical: data and process standards
Recommendation: Require the use of a technical framework for data and process (preferably ISO or CEN standards) and participate in the development of these standards. Ensure that technical framework support open access to trade.

CONTEXT

Rijkswaterstaat provides in more than 20 infrastructure contracts an Information Delivery Specification (IDS) which is part of the contract. The IDS describes the process of the delivery of the data, the frequency of delivery, the responsibilities of the contractual partners, the use of open standards and how to exchange data.

WHY WAS IT DONE AS DESCRIBED?

The application of open standards provides all parties with a level playing field which is important to a public authority to ensure open competition and non-discrimination.

Contractual parties have to be clear about the process of data delivery, the frequency, etc. Hence a generic open framework was applied in combination with an open standard in order to record the decision and the decision making process followed.

WHAT LESSONS CAN BE LEARNED?

The contractual partners work along the same procedure, which clarifies the process right from the beginning. Although some IT companies build in this kind of open standards in their software products more companies need to do this in order to make use of software functionality available on the market.

FURTHER INFORMATION:

- http://www.iso.org/iso/catalogue_detail.htm?csnumber=55691

France PTNB

Framework / Performance Criteria: Build a common collaborative framework
Topic: Technical: data and process standards
Recommendation: Participate in the development of national, European and international standards.

CONTEXT

PTNB is the French governmental plan related to digitalisation of the construction sector and the use of BIM. In its roadmap, PTNB identified the use and promotion of standards as a topic of high importance. Standards have a big impact on professional processes.

There is a need to ensure that emerging standards are aligned with processes used by French stakeholders including SMEs who often don't have sufficient resources to adopt these activities on their own initiative. They require encouragement and a stimulus.

To address these issues, PTNB conducted a study to identify the standardization work in progress and to define for each of these topics the position of the French stakeholders. This led to the development of a specific roadmap.

Once this strategy was established, the work on standardization activities at European (CEN) and international (ISO and buildingSmart International) levels were closely followed. A steering committee (SC) was put in place to follow the execution of the work and validate the decisions to ensure national alignment. This SC was composed of professional organizations representing all stakeholders of the French construction sector, including SMEs.

The work identified thirteen topics of standardization work in connection with BIM and on which French players are invited to position themselves. To offer an integrated vision, four main families of subjects were defined:

1. BIM management or the sharing of information between actors (Information Delivery Manual, BIM Execution Plan, ISO 19-650).
2. BIM modelling or the machine to machine communication (Industrial Foundation Classes [IFC], BIM Collaboration Format [BCF], Model View Definition [MVD]).
3. BIM Model with dictionaries, classifications and BIM objects (Product life cycle support [PLCS], experimental standard XP P07–150).
4. Cross-cutting topics, such as data containers (which allows structured delivery of heterogeneous information) or "Linked data" (which links all documents associated with a known project).
5. All these standards are to be linked to other environment related topics, such as Smart City and Transport Infrastructures.

WHY WAS IT DONE AS DESCRIBED?

The key aspect was to avoid stakeholders defending their positions related to their own interest and ensure that they contributed to a global strategy – one that is defined and realistic.

WHAT LESSONS CAN BE LEARNED?

Importantly the contribution of PTNB, representing the French government, allowed the various French stakeholders to align to a common vision and to build consensus. This not only related to financial issues but is also to the process of exchanging information; and raising awareness about the importance of standardisation work. An aligned BIM strategy allows the industry to contribute efficiently to European and international standardisation work.

FURTHER INFORMATION

- http://www.batiment-numerique.fr/uploads/DOC/PTNB%20-%20FdR%20Normalisation%202017.pdf

COLLABORATIVE FRAMEWORK ACTION 3
BUILD SKILLS, TOOLS AND GUIDANCE

What are the actions?

Action should be taken to encourage industry skills development and learning relevant to the BIM programme. A skills framework is a recommended development for describing the learning outcomes expected by the BIM programme.

It is encouraged that guidance material is developed by the programme to explain the technical framework of the programme; along with the necessary tools to support the project level implementation.

Why are the actions important?

In order to create capacity in the effective and consistent use of BIM, training providers and academia need to be equipped with a common definition of the target behaviours expected by the BIM programme. Without a consistent definition of the required skills it is likely that training providers and academia will not be able to develop the sufficient capacity of capable skilled professionals.

In most countries it would be inefficient and cost prohibitive for the central BIM group to develop BIM training courses and training materials. Therefore, the development of a skills framework defines the expected learning outcomes which industry and academia can then respond to by developing courses and materials which meet this requirement.

The development of a skills framework could identify new skills to be developed by both the public procurer's organisation and in the supply chain.

What are the recommendations?

	Recommended	Encouraged
Skills development and guidance	Should provide framework for skills development.	Provide guidance for the understanding of the framework implementation.

UK Learning Outcomes Framework

Framework / Performance Criteria: Build a common collaborative framework
Topic: Skills development and guidance
Recommendation: Should provide framework for skills development

CONTEXT
The UK BIM Programme developed a Learning Outcomes Framework (LOF) for BIM. The LOF provides consistent information on BIM Level 2 to institutions, academia, training providers and private educators developing and delivering training courses to professionals in the sector. This aims to build capacity development in the industry.

WHY WAS IT DONE AS DESCRIBED?
To provide an outcome based requirement for up-skilling and educating the construction industry.

WHAT LESSONS CAN BE LEARNED?
The UK BIM Task Group learnt that it did not have the capacity to develop training courses itself. Therefore it decided to focus its resources working collaboratively with academia and industry to determine what good learning outcomes look like. This encourages suppliers to develop and deliver training that meets the skills requirement for the UK BIM performance level.

Engaging with industry and academia to support the development of an industry wide education template was crucial to its wider adoption by universities and industry associations.

FURTHER INFORMATION:
- http://bim-level2.org/globalassets/pdfs/learning-outcomes-framework.pdf

Increase Industry Capacity

This final set of actions support the development of the required capabilities and skills across industry and including public clients. These actions act as the engine that drives the digitalisation of the whole sector.

The focus is on introducing BIM to projects and showcasing successes in the real-world; delivering industry training and academic education; and embedding the shift to 'digital' across the industry as business as usual. This action area:

- builds momentum and encourages examples of best practice
- shares lessons learned to accelerate skills development
- ensures the BIM programme drivers and goals are being addressed

INDUSTRY CAPACITY ACTION 1
PROMOTE INDUSTRY PILOT PROJECTS

What is the action?

It is recommended that pilot projects are a useful way to test the collaborative framework (legal, data and process standards) and to provide a practical demonstration of how BIM is to be implemented under the BIM programme.

The programme could consider awards events or case studies as a means of highlighting best practice to the industry.

Why is the action important?

Providing examples of practical projects using BIM as described by the programme is an important early step for the programme in order to:

- build industry's confidence in the BIM programme
- learn from implementation so that the collaborative framework can be improved based on feedback
- provide examples of best practice for industry to adopt

What are the recommendations?

	Highly recommended	Recommended	Encouraged
Promote industry pilot projects	Organisations and companies should encourage adoption of the BIM methodology as a global cross-departmental strategy, establishing policies that set goals and plans for providing required training. Organisations should also encourage staff to share best practices and lessons learnt from their practical experience, to allow continuous improvement on the BIM methodologies and to correct deviations.	Start building practical experience and capability across the entire construction value chain.	Could highlight industry successes to encourage others to invest in capability development. Keep number of pilot projects in balance with client and market capacity.

Spain Es.BIM Initiative

Framework / Performance Criteria: Strategic Framework
Topic: Promote industry pilot projects
Recommendation: Organisations and companies should encourage adoption of BIM methodology as a global cross-departmental strategy, establishing policies that help setting staggered goals and planning required training. They should also encourage staff to share best practices and lessons learnt from their practical experience, to allow continuous improvement on BIM methodologies and to correct eventual deviations

CONTEXT

The Es.BIM initiative is sponsored by the Spanish Ministry of Civil Works. It has engaged companies and professionals from different areas of the AEC industry, in order to ensure the process covers the entire value chain.

Some of the companies that have practical experience of BIM processes used in projects (mostly construction companies) have shared their lessons learned in the Es.BIM online portal.
For each project, the following information is covered:

- Name of the company that has carried out the project.
- Date
- Images of the project.
- Specific data (size of the area, level of detail, client, budget, time period, etc). Not all of these data have been provided for all the projects.
- Purpose or use of BIM in the project.
- Benefits gained by the stakeholders.

WHY WAS IT DONE AS DESCRIBED?

Since one of the goals of the Es.BIM platform is to promote BIM initiatives all along the whole chain, and for different type of projects, examples that cover different areas have been included (buildings, highways, railways, airports, seaports, etc), from both public and private initiatives. The project examples include private clients as these can have less inertia than public institutions to change project methods, and have more flexibility to adapt their requirements to the possibilities that new technologies offer. Therefore, private initiatives are encouraged as they have clear impact on the speed at which BIM projects are diffused in the industry.

The initial home page (see link below) provides the opportunity to filter examples depending on the stage (design, construction, operation) or by selecting specific BIM Uses, to give a wide perspective of how different companies can use this approach to get tangible benefits.

It promotes the capabilities of BIM to the AEC companies that are embracing BIM methodologies, this in turn improves their image to potential clients and owners of public assets; and is useful for attracting talent in the form of new potential employees.

WHAT LESSONS CAN BE LEARNED?

At this stage, only a few of the cases highlighted in the platform are the direct result of the Spanish public initiatives. Once the pilot projects sponsored by the Spanish Government are in progress, their findings and benefits will be published on the platform (or by other means, according to the Communication Plan being developed by Group 2 of the Es.BIM initiative).

FURTHER INFORMATION

- The examples of successful BIM projects can be found at http://www.esbim.es/menu-casos-de-exito/.

It is important that the use of public procurement is increased progressively over time in order to provide industry time to up-skill and adjust its workflows

INDUSTRY CAPACITY ACTION 2
INCREASING THE USE OF THE STRATEGIC LEVER TO GROW CAPACITY

What is the action?

A strategic lever is a tool such as public procurement or regulation that can be used to drive a change or desired outcome. In the BIM programme the strategic lever would be defined by the strategy. As this handbook is written for the European public stakeholder and responds to the European Public Procurement Directive, it is recommended that public procurement or public policy be considered as the tools to drive the use of BIM in order to deliver public and private sector benefits.

Why is the action important?

The use of a public policy driver (such as public procurement or regulation) provides industry certainty and confidence to begin the transition towards digital construction; and provides the necessary motivation to invest in re-tooling and re-skilling its workforce.

Without the impetus or drive to use the collaborative BIM framework (referenced in Section 3.1.3) it is unlikely that the whole sector would transition to digital. The leading organisations and early adopters would take the opportunity but given the large size and high fragmentation of the industry this approach could leave many organisations behind the digital transition.

It is important that the use of public procurement is increased progressively over time in order to provide industry time to up-skill and adjust its workflows.

What are the recommendations?

	Recommended
Increasing use of strategic lever to grow capacity	The public sector programme should provide consistent and long term encouragement or requirements to progressively grow industry wide capacity for digital methods. It is recommended, that public procurement be used to progressively introduce BIM to public project tenders and contracts.

UK Public Procurement

Framework / Performance Criteria: Strategic Framework
Topic: Increasing use of a strategic measure to grow capacity of workforce
Recommendation: Provide consistent and long term encouragement or requirements to progressively grow industry wide capacity for BIM

CONTEXT

One of the most important decisions taken by the UK BIM programme was the recognition that project requirements must change first if industry as a whole were to change.

A standards framework development alone was insufficient to drive a whole sector transformation. Communications actions created crucial engagement with industry, however use of public procurement was the strategic force at the centre of the UK BIM programme.

In 2011, the UK BIM programme communicated a target that all centrally funded public construction projects would require the use of BIM by 2016. During 2012 to 2015 the pipeline of publicly funded projects adopting BIM Level 2 requirements increased significantly from approx. £100m to over £9bn.

WHY WAS IT DONE AS DESCRIBED?

This progressive increase in the number of public projects requiring BIM Level 2 was essential to steadily build capability of the supply chain and for the public client. It allowed time for skills development and learning to occur within the UK BIM Task Group, the public clients and within industry.

WHAT LESSONS CAN BE LEARNED?

The progressive and increasing use of public procurement was an effective measure to encourage the digital behaviour shift in the industry. A minimum level threshold for projects to require BIM was not set – which was viewed as a positive to encourage SMEs and whole sector engagement.

A diverse set of asset types were used during the early stages to ensure that learning could occur across the built environment.

FURTHER INFORMATION

The increase in projects introducing BIM Level 2, under the UK Government's Construction Strategy 2011, are published on the UK Government's Cabinet Office website and can be accessed using the following link:

- https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/466952/20150825_Annex_A_Departmental_Cost_Benchmarks_Cost_Reduction_Trajectories_and_Cost_Reductions_2015_Final_Draft.pdf

INDUSTRY CAPACITY ACTION 3
MEASURE AND MONITOR PROGRESS AND EMBED CHANGE

What is the action?

The aim of the programme is to improve certain important public sector indicators, such as value for public money or the timely delivery of public construction projects. This action is to measure the impact on these high level goals and monitor progress of the BIM programme.

It is encouraged that measurements of pilot projects are used to demonstrate improvements and support for the higher level goals.

Industry surveys of adoption levels could be used as indicators of success for the BIM programme.

Why is the action important?

Measurements of projects and of the programme are helpful to inspire and continue building the support of industry for its digital transition. Key performance indicators for the public sector are also useful to gain the support of public clients that are potentially introducing BIM to their public estate.

What are the recommendations?

	Recommended	Encouraged
Measure and monitor progress against goals, embed change	It is recommended to assess work practices and digital maturity levels from the beginning. This provides a basis for targets and common ways of working across industry. On a European (and international) level it is recommended to establish and participate in a common set of metrics (KPIs) to measure and monitor the uptake and effects of BIM in practice. Should produce surveys and lessons learned reports which identifies areas for improvement and thereby creates focus for skills and capacity development of the industry.	Could produce measurements and reports of pilot projects and industry adoption levels to encourage the long term industry wide transition to digital methods.

Swedish Transport Administration

Framework / Performance Criteria: Industry capacity
Topic: Measure and monitor progress and embed change
Recommendation: It is highly recommended to measure conditions, work processes and effects from the very start introducing BIM. That gives the basis for analysing correlations and critical success factors with the aim of providing foundation for fact-based improvement work in projects, organisations and industry as a whole

CONTEXT

The Swedish Transport Administration measure the use of BIM. The Administration developed a model of measuring, based on questionnaires, with the aim of understanding how the project members experience the use of digital models, to what degree digital models are actually being used and lastly what effect BIM creates in the projects. The questionnaire survey will be complemented with quantitative data for the projects concerning time, cost, quality and security.

WHY WAS IT DONE AS DESCRIBED?

The Swedish Transport Administration is convinced that major industry actors need to take increased responsibility to create pressure for change within the industry. By analysing differences between projects using BIM and projects not using BIM and making these results public the industry are motivated to increase their use of collaborative digital models. Publishing the results also reveals areas of improvement and provides the foundation for fact-based improvement in projects, organisations and the industry as a whole.

WHAT LESSONS CAN BE LEARNED?

The surveys using questionnaires have been a positive experience. The quantitative results indicate significant differences, in various areas, between projects using BIM and projects not using BIM. To create greater understanding of the results a complementary survey using quantitative methods and exhaustive statistical correlation analysis, would need to be performed.

Performing surveys is by itself not enough to drive change. The surveys will need to be set into context, in a structured model of improvements, where the results are used as foundation for fact-based improvement work. This exercise has not been implemented as yet.

Implementation level recommendations

This implementation recommendation section explains the actions by public procurers to introduce the common performance level as outlined in the previous section. For each criteria this section will explain

- What is the action?
- Why is the action important?
- What is the implementation recommendation?
- How has the recommended action been implemented?

The principle audience for this implementation level definition includes:

- Public procurers and technical managers within public client organisations
- Technical policy officers, public sector legal specialists
- Building and infrastructure regulatory officers
- Industry suppliers (e.g. manufacturers, architects, engineers, contractors and asset operators)

Policy

POLICY CRITERIA 1
CONTRACTUAL ARRANGEMENTS

What is the action?

The primary objective of the contractual arrangements is to enable the production of Building Information Models at defined stages of a project. The contractual arrangements for the use of BIM models and derived data are agreed between the contracting parties in a protocol, contract appendix or separate contract. The contractual arrangements cover specific obligations, liabilities and associated limitations, for example permitted purposes for the use of models, treatment of Intellectual Property, liability for use of models and data, electronic data exchange and change management.

Why is it important?

The contractual arrangements will support the adoption of effective collaborative working practices in Project Teams. They will ensure that all parties producing and delivering models and data adopt the common standards or ways of working described in the contractual arrangements and that all parties using the Models have a clear right to do so. They will also support the protection of IPR, which is a key concern for many information providers in the data-rich and collaborative BIM environment.

What are the recommendations?

	Highly Recommended	Recommended
Contractual arrangements	Obligations, liabilities and associated limitations for BIM are incorporated into the contract, for example as a BIM specific appendix or protocol.	Provide templates for BIM specific arrangements for different procurement strategies.

Swedish Transport Administration

Framework / Performance Criteria: Industry capacity
Topic: Contractual arrangements
Recommendation: Obligations, liabilities and associated limitations for BIM are incorporated into the contract, for example as a BIM specific appendix or protocol

CONTEXT

Templates for contract documents in the Swedish Transport Administration have been updated with amendments and supplements concerning BIM. In Sweden, a set of standard contract documents have been developed and provided by an industry organisation (Construction Contracts Committee, BKK, Byggandets kontraktskommitté) to the design and construction industry. The current standard contract documents do not regulate the use of digital information to a sufficient level and have therefore been amended by the Swedish Transport Administration. These amendments cover the areas of intellectual property rights, obligations and liabilities of both client and supplier, purpose of the information to be supplied as well as changes in deliverables. In implementing BIM, the Swedish Transport Administration have decided that the contractually agreed deliverable is the 3D model, not the 2D plan.

The supplements are incorporated in the main body of the contract templates, not in a separate BIM Protocol or appendix.

WHY WAS IT DONE AS DESCRIBED?

To stipulate the use of digital information in the contract, there are certain legal aspects that are required to be taken into consideration, such as intellectual property rights, deliverables and liability for example.

Regarding ownership of data, the Swedish Transport Administration currently advocates the "right of use" before ownership. They take the view that ownership should lie with the party that can best utilize the content commercially and otherwise. With the planned change in information management in the administration this issue will have to be investigated.

The decision to incorporate BIM into the contract templates was made with the aim to make BIM the standard way of working and of handling information about the asset throughout its lifecycle.

It was decided to not use the term BIM in the contractual templates and instead to use the phrase "object-oriented information model". It was considered that the term 'BIM' was too general and non-specific.

WHAT LESSONS CAN BE LEARNED?

The supplements of legal aspects concerning digital information in the contract need to be complemented with a set of other changes in processes and work instructions. It is critical to have a holistic view of the implementation of BIM, to acknowledge the need for processes and work instruction to support the technical requirements and legal aspects. It is important to educate the users, such as project managers and procurers, why the aspects related to the exchange of digital information need to be addressed in the contract. Another lesson learned is the importance of intuitive, consistent and widely accepted terms for describing the various parts of the process and models.

POLICY CRITERIA 2
EXCHANGE INFORMATION REQUIREMENTS (EIR)

What is it?

There are different types of information requirements related to the delivery or operational phase of an asset, spanning from organizational information requirements, asset information requirements and project information requirements.

All asset and project information that is to be supplied as part of asset management or project delivery should be specified by the appointing party through sets of exchange information requirements (EIR). They should be expressed in such a way that they can be incorporated into project-related appointments or instructions[12] and passed along the supply chain.

The content of the EIR basically covers three areas:

- **Technical:** Details of software platforms, definitions of levels of detail etc
- **Management:** Details of management processes to be adopted in connection with BIM on a project
- **Commercial:** Details of BIM Model deliverables, timing of data exchange and definitions of information purposes

This asset and project information to be supplied collectively by the solution providers (i.e. the Engineer and the Contractor and the Suppliers) can be supplied only if the Building Owners and the Operators have themselves at an earlier stage clearly spelled out their needs and requirements as these will be the base for any future validation and commissioning or acceptance of the to be built facility. This covers the project itself and its BIM objectives.

Why is it important?

Digitalisation brings an unprecedented amount of data and information. Organisations and projects alike are often overflooded with too much data and information. Over-production and over-processing of data, just because technology can and data storage has become cheap, increases waste, costs and risks significantly.

EIRs are an important element of project BIM implementation as they are used to set out clearly to the bidder what models and data are required and what the purposes of the data will be. Their intention is to limit the production and provision of information to what is really required at a certain point in time and make the production of information a truly lean process. The EIR allow the contracting parties to plan for the delivery of the required information. Where a supply chain exists the information requirements should descend the supply chain to the level at which the information can be most easily provided.

A helpful methodology for specifying information requirements by the appointing party is to address the questions that need to be answered to make asset or project related decisions or to assess a risk at different points during the delivery and operation of the asset.

Foot Notes

[12] (ISO/DIS 19650-1:2017(E) (, p. 11) (not published at the time of writing)

What are the recommendations?

	Highly Recommended	Recommended
Exchange Information Requirements	Data and information required by the appointing party should be specified as part of the tender documents. Over-specification should be avoided and a best practice methodology should be adopted. Building Owners and Operators shall spell out clearly, their own operational needs and requirements for the project itself and for the BIM project strategy at the appropriate point in time.	Provide templates and tools for EIR documents for different types of projects.

Development of EIR on University College London Hospitals Proton Beam Therapy Project, UK

Framework / Performance Criteria: Performance Criteria
Topic: Employer's Information Requirements
Recommendation: Provide templates and tools for EIR documents for different types of projects

CONTEXT

Development of the EIR on University College London Hospitals Proton Beam Therapy Project as an exemplar project to develop EIR templates and tools that UCLH can use across their capital programme and share learning with other UK National Health Service Trusts. UCLH is a provider of acute and specialist healthcare services for people from all across the UK and overseas. The new building, developed with funding from UCLH and the British Department of Health, will be built in close proximity to UCLH's Cancer Centre and radiotherapy services, creating a leading hub for cancer treatment in central London.

The proton beam therapy facility will be located underground, and there will be five additional floors above ground offering care and treatment of blood cancer and short stay surgery. The installation of the latest proton beam therapy equipment has specific logistics challenges with each unit each weighing around 120 tonnes.

The works have already begun and the centre is expected to begin treating patients in 2019. The project will be Level 2 BIM compliant. It will also be targeting BREEAM® certification with "Excellent" status. UCLH have embarked on a digital transition within their Capital Investment and Facilities Directorate. A digital transition in this context is the shift from an 'analogue' way of working – where information about UCLH's built environment assets is procured and used based on paper and files – to a digital way of working – where the respective information is procured and used on the basis of reliable, readily available digital data that can be easily maintained and re-used in many ways. The basis of UCLH's digital transition is to procure data about developing built environment assets using BIM.

UCLH's Vision is that all capital development projects deliver structured data to support asset management decision making and streamlining, whilst making up to 20% savings in capital expenditure, by implementing a Level 2 BIM approach.

WHY WAS IT DONE AS DESCRIBED?

UCLH developed their own BIM strategy recognising the cost, time, risk reduction and quality benefits that Level 2 BIM delivers to capital programmes as well as the discipline required to define and articulate the employer's information requirements for each stage of the project. The Proton Beam therapy project had a number of technical and logistical challenges surrounding the proton beam therapy technology and the highly constrained central London site, making it the ideal project to develop their Level 2 BIM requirements and capability, which would be used disseminate best practice across UCLH's estate and other NHS trusts.

The Employer's information objectives for the project were to:

- Deliver defined open shareable asset information for use in operation and maintenance systems with the aim of supporting sustainable decision-making and process streamlining.
- Support the acceptance of Supplier's proposals using information modelling tools.
- Understand and confirm full programme, sequence and logistics implications using information modelling tools.
- Assess and address safety, security and sustainability issues using information modelling tools.
- Understand cost planning and estimation using information modelling tools.

WHAT LESSONS CAN BE LEARNED?

The developed EIR was issued to the Tier 1 design and build contractors as part of the invitation to tender. The EIR stipulated that supplier's Delivery Plan (BIM Execution Plan) [see Policy / Delivery Plan], should follow the order of the EIR. The supply chain's Delivery Plan's generally did not follow the order of the EIR. This meant that it took far longer to assess the level of each Delivery Plan against the EIR. UCLH therefore created and Delivery Plan template that exactly followed the EIR. The template enables UCLH to quickly assess compliance, identifying gaps in performance, along with assess where a supplier's proposal provides added value.

FURTHER INFORMATION

The following link provides back ground information on the project:

- http://www.uclh.nhs.uk/news/Pages/ProtonbeamtherapycomingtoUCLH.aspx

POLICY CRITERIA 3
BIM CAPABILITY CRITERIA

What is it?

In the tender process before contract award, the contracting party evaluates the suppliers' capabilities and capacity to the extent necessary for them to be considered appropriate to undertake work and deliver services for potential buyers. The assessment of BIM related capability and capacity in relation to BIM, industry standards and the contracting party's information requirements includes the commitment and the experience of the contracted party as a whole and of the proposed team, access to and experience of the information technology specified or envisaged as well as the quantity of experienced and suitably equipped personnel within the contracted party with availability to work on the proposed project.

Why is it important?

Assessing the BIM capability and capacity, but equally important the commitment and willingness of a bidder to comply with the BIM process and the information requirements set out by the contracting party, are crucial for the successful delivery of a BIM project. The capability criteria are also required in order to change the procurement process from a purely lowest price driven decision to one that provides robust and objective quality assessment criteria.

Importantly, the capability criteria is designed to be non-discriminatory and encourages the widest participation possible (for example, to be inclusive of SMEs).

What are the recommendations?

	Highly Recommended	Recommended	
BIM capability criteria	The assessment of contracted party capability and capacity should include assessment of the highly-recommended activities provided in this document and the bidders commitment to comply with the relevant standards, this guide and the contracting party's information requirements.	Whilst practical BIM experience is still limited in some regions and markets, the assessment criteria should not exclude a large proportion of suppliers, otherwise there might not be sufficient capacity in the market.	Apply BIM capability criteria that can be assessed objectively. Each question can have two parts – first a yes / no response, for example does the supply chain do something / have capacity. Second half is details of what the supply can do / how they do it.

E4 Stockholm Bypass, Sweden

Framework / Performance Criteria: Performance Criteria
Topic: BIM Capability Criteria
Recommendation: The assessment of contracted party capability and capacity should include assessment of the highly-recommended activities provided in this document and the bidders commitment to comply with the relevant standards, this guide and the contracting party's information requirements

CONTEXT

The E4 Stockholm Bypass project used BIM capability as qualification criteria. During the pre-qualification stage, the tenderer were required to present the technical and professional capability required to deliver the requested services. Several relevant capability criteria were provided and requested by the client.

WHY WAS IT DONE AS DESCRIBED?

In the Stockholm Bypass Project, the Swedish Transport Administration is implementing an initiative to streamline the construction sector by promoting the broad use of Building Information Modelling (BIM) for all disciplines. 3D models will replace traditional 2D drawings in the future. The envisaged benefits of a wider use of 3D models are fewer drawings, improved design coordination as well as better quality of construction and hand-over documents and processes.

The contractual deliverables on the Stockholm Bypass project will be 3D models supplemented by drawings. As-built documentation must be delivered by the contractors in the form of 3D models.

For the Stockholm Bypass to succeed in this initiative, the successful bidders need to demonstrate that they have the required capacity, capability and willingness to deliver to these requirements.

WHAT LESSONS CAN BE LEARNED?

All bidders demonstrated sufficient relevant experience to be accepted. It was clear that they had all understood the importance of BIM-capability to succeed on the project.

POLICY CRITERIA 4
DELIVERY PLAN

What is it?

Adopting a delivery or BIM Execution Plan is a requirement which should be put in place immediately upon the planning stage for a facility. It should then be updated – and enlarged in terms of stakeholder's coverage – as needed according to the project milestones and enable the seamless BIM based project execution.

The delivery plan or BIM Execution Plan can be split into two parts - a pre-contract execution plan outlining how the bidder will meet the EIR's should be used during the tender evaluation period to build confidence in the supply chain and ensure delivery of information at the right time, right format and appropriate level of development – and a post contract execution plan, providing all the details on what the project team agreed on regarding delivering the EIR.

As a minimum, the delivery plan covers the technical details on how the information provided will meet the requirements defined in the EIRs, when information is going to be delivered, what is going to be delivered and who is going to do it.

Why is it important?

Planning for information delivery is where the collaboration in the BIM methodology starts. Expanding the BIM Execution Plan to include the delivery of its own information is the responsibility of the contracted party, but it can't be done without involvement of the project client or the supply chain. All parties involved at that point in time need to agree on a single delivery plan for the project, so everyone knows what the responsibilities are and that the solutions outlined in the plan meet the different requirements and constraints.

What are the recommendations?

	Highly Recommended	Recommended	
BIM capability criteria	Develop a BEP template that aligns with the EIR template, as it is a very quick way to compare suppliers and identify gaps	Details about management and delivery of data, i.e. formats, level of detail, modelling conventions, processes, etc. are incorporated into the project plan or project handbook.	Clients should take an active role in the process to ensure that their information requirements will be met.

Estonia: Riigi Kinnisvara AS

Framework / Performance Criteria: Performance Criteria
Topic: Delivery Plan
Recommendation: An execution plan outlining how the bidder will meet the EIR's should be used during the tender evaluation period to build confidence in the supply chain and ensure delivery of information at the right time, right format and appropriate level of development. Details about management and delivery of data, i.e. formats, level of detail, modelling conventions, processes, etc. are incorporated into the project plan or project handbook.

CONTEXT

Estonian public real estate company Riigi Kinnisvara AS and the chosen supplier(s) agree on the development of a BIM execution plan for the next phase during the kick-off meeting. The execution plan includes workflows, processes and other BIM related details, for example:

- A brief description of the project and the BIM-specific objectives,
- Roles and responsibilities of the project partners,
- Processes and workflows regarding data management, design coordination, etc.,
- Modelling guidelines, including model structure, data exchange formats, levels of detail, naming conventions, etc.
- Delivery strategy for producing contractual deliverables,
- Hard- and software
- Relevant standards

The BIM execution plan is shared with the stakeholders within two weeks after the kick-off meeting and becomes the backbone of the delivery of the project. The plan is a living document, but changes need to be agreed and approved by the client.

WHY WAS IT DONE AS DESCRIBED?

A jointly developed and agreed BIM execution plan is a critical milestone for the success of a construction project. Since the rules and details are discussed and agreed between all project partners at the beginning of the project, the communication and understanding amongst the partners is more efficient. Misunderstandings, disappointments and wrong assumptions can be reduced significantly.

Additionally, the experienced client can evaluate whether the supplier and agreed processes have the potential to fulfil the EIR and client's expectations and consider possible countermeasures early in the project.

WHAT LESSONS CAN BE LEARNED?

The execution plan should be created and agreed upon at the beginning of the process (kick-off meeting). The project success rate and the quality of the project can be increased significantly, when all project partners are involved in the development of the execution plan. The joint effort of agreeing project-specific implementation and execution details enables a true collaborative working environment. In case of setbacks, it is recommended that the reasons are evaluated and improvements to the execution plan template are made for the next project.

BIM introduction is an on-going process for all partners and there is a learning curve to be considered. A continuous improvement approach can be helpful to build a focused list of "lessons learned".

FURTHER INFORMATION

All available materials Riigi Kinnisvara AS is using are available in Estonian on the official web-site http://www.rkas.ee/bim

Technical

TECHNICAL CRITERIA 1
VENDOR-NEUTRAL DATA EXCHANGE

What is it?

Data can be exchanged in platform neutral, open file formats that are not controlled by a single vendor or group of vendors. One commonly used collaboration format in Building information modeling (BIM) is IFC (Industry Foundation Class). The IFC model specification is open and available. It is registered by ISO and is an official International Standard[13].

Why is it important?

Vendor-neutral, non-proprietary data exchange formats increase interoperability and facilitate the exchange of data across the supply chain and with the client that has been produced with different software packages.

Additionally this supports diversity in the supplier chain and the software landscape, avoids monopolies and helps to encourage competition. Open standards are very important to public procurers, because they provide the possibility of stating requirements for data in a format and a data model that any member of the supply chain can deliver (such as SMEs), agnostic to the software they choose. There can be exceptions to this principle rule during the exploitation phase when the owner/manager has to use one editable file format only.

Open standards are crucial also for archiving project data. Models, drawings and documents can be unreadable in a just few years if they are not stored in open formats such as XML derivatives.

What are the recommendations?

	Highly Recommended	Recommended	Encouraged
Vendor-neutral data exchange	Require non-proprietary data exchange formats at specified milestones in order to facilitate the exchange of data between the employer and the supplier		In order to avoid data loss encourage the additional supply of native file formats

Foot Notes

[13] ISO 16739:2013

Rijkswaterstaat

Framework / Performance Criteria: Performance Criteria
Topic: Vendor-neutral data exchange
Recommendation: Require non-proprietary data exchange formats in contracts

CONTEXT

Rijkswaterstaat requires in their contracts to exchange information in accordance with the Dutch open standards. One standard describes the process of exchanging information. Another standard describes what kind of information in which data structure need to be exchanged. This works very well in combination with an object type library.

WHY WAS IT DONE AS DESCRIBED?

The open standard approach makes the data delivery and data exchange more efficient which result in better quality and a reduction in costs. This also provides a level playing field for all parties without excluding one, especially important for attracting SMEs. This is achieved via the use of open standards. In this way a vendor locked in situation can be avoided.

FURTHER INFORMATION

- http://www.coinsweb.nl/index_uk.html
- http://www.crow.nl/getmedia/991abf25-8088-4703-8445-de47788eb206/Flyer-What-is-VISI,-100617-rev0.aspx

TECHNICAL CRITERIA 2
OBJECT-ORIENTATED ORGANISATION OF INFORMATION

What is it?

The "object-oriented" approach describes the characteristics or properties of things. In the object-oriented approach, the object is central, thus acting as a container of characteristics or properties. Properties have values, optionally expressed in units. The set of properties associated with an object provide the formal definition of the object as well as its typical behaviour. The role that an object is intended to play can be designated through a model. Objects may be related to formal classification systems through the provision of references[14].

It is important to highlight in this context, that objects can be construction products like door handles, windows or parts that can be ordered or purchased from suppliers. But they can also be "virtual" objects, like an alignment, a space, corridor or boundary.

Why is it important?

The object-orientated approach provides the capability to define the context within which the object is used. It enables classification systems, information models, object models, semantic models and process models to be referenced from within a common framework.

What are the recommendations?

	Highly Recommended	Recommended	Encouraged
Object-orientated organisation of information	Apply an object-orientated approach where a set of properties is associated with an object to provide the formal definition of the object as well as its typical behaviour.	Classification systems, information models, object models and process models should be referenced from within a common framework of international standards.	

Foot Notes

[14] E DIN EN ISO 12006-3:2016-08

Rijkswaterstaat, OTL

Framework / Performance Criteria: Performance Criteria
Topic: Object-oriented organisation of information
Recommendation: Apply an object-oriented approach where a set of properties is associated with an object to provide the formal definition of the object as well as its typical behaviour

CONTEXT

Rijkswaterstaat (RWS), the Dutch national road and waterways authority, has designed its own object type library (OTL) and requires all data to be delivered in accordance to that OTL. In more than 20 contracts of Rijkswaterstaat's infrastructure (roads, waterways, locks) RWS requires contractors to deliver data according to the structure of the RWS OTL. The OTL is a taxonomy with objects which are related to each other. Each object contains a set of properties which may contain data of real physical objects (to be build or maintained).

WHY WAS IT DONE AS DESCRIBED?

RWS' asset management system is a historically grown collection of other systems, which overlap or do not relate to each other in certain areas. Hence it was impossible to require suppliers to deliver data according to one specific structure – it didn't exist! This was the reason to develop an object type library, which ensures that the relevant information is delivered in the required format and referring to the right objects. Furthermore the object data and structure can be used as backbone for the future modernisation of the asset management system.

WHAT LESSONS CAN BE LEARNED?

Providing one specific data structure to all stakeholders (designers, contractors and asset managers) helps to improve the data hand-over from the supply chain to the employer and from the employer to the asset manager and vice versa. It is not just a different technical solution, it has a significant impact on how people work and generate and deliver data, resulting in a better quality of data and better cost control.

FURTHER INFORMATION

- https://otl.rws.nl/publicatieomgeving/#/

Process

PROCESS CRITERIA 1
CONTAINER-BASED COLLABORATIVE WORKING

What is it?

The term "container-based collaborative working" has been adopted from the draft international standard ISO/DIS 19650-1:2017. A "container" can be a 3D model, a drawing, a document, table or schedule – also often called a "file". A database, containing multiple tables of structured data, are also containers. We can categorize them as document containers, graphical information containers and also non-graphical information containers.

Container-based collaborative working basically means two things:

1. The principle that the author or originator of a piece of information, for example a model or a drawing, is responsible and liable for the content and quality still applies, and
2. certain rules concerning the processes of information management are defined so that data and information can be exchanged in a secure and efficient way.

Why is it important?

Container-based collaborative working is part-way along the maturity journey from paper-based drawings and documentation to server-based working, where data is stored in centralised databases and multiple parties work simultaneously on one model.

Introducing the concept of container- or "file-based working" as a first step introduces sufficient change to have an impact and is close enough to the current practice to be implemented without requiring a fundamental change to legal and contractual frameworks. It is also designed to be realistic for SMEs to adopt this method

What are the recommendations?

	Highly Recommended	Recommended	Encouraged
Container-based collaborative working	Apply the fundamental principles of container-based collaborative working where originators produce working which the control, sourcing verified information from others where required by way of reference, federation or direct information exchange.	Should use appropriate tool support to enable a container-based collaborative working. Tools should support distributed work, version- and configuration management, access control and workflows.	Could make use of standardized methods like BCF (BIM Collaboration Format) to enable a formalized way of messaging between parties within the project workflow.

Albano Project, Sweden

Framework / Performance Criteria: Performance Criteria
Topic: Container-based collaborative working
Recommendation: Apply the fundamental principles of container-based collaborative working where originators produce working which the control, sourcing verified information from others where required by way of reference, federation or direct information exchange

CONTEXT

The design of the university campus Albano in Stockholm involves many designers from different design disciplines. This created a need for robust processes for sharing data and coordinating the design across the different contracts and disciplines. All parties involved were required to apply a method for the definition and verification of the iterative development of graphical and non-graphical information, based on National Standards and guidelines for classification and modelling. The method is defined in the strategic plan for BIM as part of the project plan and is aimed to ensure effective design management and minimize the risk for imbalances in the design progress of different design disciplines.

WHY WAS IT DONE AS DESCRIBED?

The project management of the Albano project had identified a risk of not being able to ensure efficient collaborative and integrated design work due to difficulties in managing the discipline specific information delivery in combination with the overall information delivery. In addition, the overall requirements for the design work were considered challenging due to constraints in terms of time, budget and environmental requirements.

In the concept of container-based working the liability and responsibility for models and design remains with the authoring discipline, unchanged from the traditional way of working. Moving into the exchange of digital data in a native file format, this concept was seen to securing sufficient control over quality and progress whilst enabling the benefits of coordinated digital models and associated data. The method was included in the contractual documents for each design discipline.

The design management was changed from document-based information exchange and deliveries to model-based deliveries in which a distinction was made between different types of deliveries such as recurring and specific deliveries. Each delivery was treated individually and a "level of development" specification, applying to graphical and non-graphical data, was made per discipline, system and object type including properties. All specifications were made available to the project by an information portal to allow for efficient use by all parties involved.

WHAT LESSONS CAN BE LEARNED?

The overall result was that designers worked according to strict and clear instructions regarding the detail, granularity, content and structure of the data they had to generate. The process contributed to a more reliable and coherent design delivery process.

The container-based or file-based approach is familiar to people and very similar to the traditional way of working. It does not require a fundamental change in legal and technical frameworks, which reduces the barriers for adoption significantly.

FURTHER INFORMATION

- https://www.albanobim.se/styrande-dokument/bim-strategi/ (In Swedish)
- https://www.albanobim.se/modellhantering/lodfardigstallandegrad/ (in Swedish)
- User name and password details are available upon request from Trafikverket.

PROCESS CRITERIA 2
COMMON DATA ENVIRONMENT

What is it?

A Common Data Environment (CDE) is a system for managing data and information. The CDE is not just a web- or cloud-based "data room". It comprises the required processes and rules to make sure that people are working on or using the current version of a file or a model and telling them what they can use it for. These processes were well defined and managed in a paper-based filing system, but with the adoption of new electronic technologies and the massive increase of data produced on a typical construction project, the need for good management has been overlooked and the old systems have not been replaced.

The CDE principles are well defined and described. They have been derived from mature project management methodologies and amended to meet the specific needs of construction projects. Many electronic data management systems have the standard workflow implemented, which enables an efficient set-up and administration of the process.

Why is it important?

Collaboration between the participants involved in construction projects and in asset management is pivotal to the efficient delivery and operation of facilities. Organizations are increasingly working in new collaborative environments in order to achieve higher standards of quality and greater re-use of existing knowledge and experience. A major constituent of these collaborative environments is the ability to communicate, re-use and share data efficiently without loss, contradiction or misinterpretation.

This approach does not require more work, as this information has always been required to be produced. However, true collaborative working requires mutual understanding and trust within the team and a deeper level of standardized process than has previously been experienced, if the information is to be produced and made available in a consistent timely manner. Information requirements have to descend down supply chains to the point where information can be most efficiently produced, and information has to be collated as it ascends up supply chains. At present, each year considerable resources are spent on making corrections to non-standard data, training new personnel in approved data creation techniques, coordinating the efforts of subcontractor teams and solving problems related to data reproduction. This is considered waste and can be reduced if the concepts and principles of the CDE are commonly adopted.

What are the recommendations?

	Highly Recommended	Recommended	Encouraged
Common Data Environment (CDE)	Apply the CDE principle as a means of allowing quality assured information to be managed and shared efficiently and accurately between all members of the project team – whether that information is geo-spatial, design, textual or numeric.		Security should be considered as part of the management process. Encourage the use of a managed environment to store shared asset data and information, with appropriate and secure availability to all individuals who are required to produce, use and maintain it.

Crossrail, UK

Framework / Performance Criteria: Performance Criteria
Topic: Common Data Environment
Recommendation: Apply the CDE principle as a means of allowing quality assured information to be managed and shared efficiently and accurately between all members of the project team – whether that information is geo-spatial, design, textual or numeric

CONTEXT

Crossrail, currently Europe's biggest civil engineering project, is being built under central London to link existing Network Rail lines to the east and west of the capital. When it opens in 2018 it will provide rail services from Maidenhead and Heathrow in the west to Shenfield and Abbey Wood in the east of London.

The large and increasing number of contractors and stakeholders on the project meant that an increased amount of information was being produced on the project. An information and data management strategy had been put in place to ensure best practice in 'Whole Lifecycle Information Management'; a combination of standards, methods and procedures, but also software, tools and hardware.

The role of lifecycle information management on the project was designed to:

- Reduce risk resulting from unmanaged or poorly controlled data
- Improve efficiency in workflows and data access through the implementation of spatial technology

Crossrail was already well underway when the Government-driven 'BIM revolution' started in the UK in 2010/2011. However, elements of the Level 2 BIM criteria had been written into Crossrail's 'Data and Information Strategy', the 'Data Management Guide' and the 'Requirements Strategy'. The BS1192-based workflow was fully implemented through the use of an engineering content management system (ECMS) for all design drawings and models, complemented by a document management system and a web-based Geographic Information System to name a few components of the entire CDE. With the deployment of the asset management database another step towards Whole Lifecycle Data Management was done.

The collaboration tool used as the ECMS formed the basis for a centralised management of design standards. It managed synchronisation of edits from multiple users. The BS1192-based workflow was implemented through the software. All parties involved were required to work within the CDE to ensure they meet the required standards, the BS1192-based workflow and file naming conventions.

Other places for storing data, such as USB drives or local C drives were disabled by IT. Automatic data quality checking procedures flagged non-conformities to the CAD support team. Licences and training for the system were provided by the client to all parties working on the project.

WHY WAS IT DONE AS DESCRIBED?

The Crossrail project aims for maximum integration of spatial data irrespective of its native format. The array of engineering disciplines involved in the project include structures, geotechnics, tunnelling, noise and vibration, commitments, interfaces, and heritage. These all generate and demand a huge amount of information every day on a project of this size. In addition to this there is a vast amount of historical information, surveys, reports and drawings from previous stages of the project, generated or collated by other consultants. Other disciplines within Crossrail that require or generate information in relation to the design are for example the property and legal team, health and safety, help desk, estates management and many more. It is vital to the success of the project that data and information is readily available to all staff working on the project, and that it is reviewed and updated where new or more accurate information is found. The number of people on the project and the risks of badly managed data made the business case for the comprehensive implementation of a CDE.

WHAT LESSONS CAN BE LEARNED?

The key principles can be summarised as:

- Treat data as a valuable resource! (owned by the Client)
- Establish your requirements (at business and project level)
- Structure data with the end-use in mind – from the start
- Good asset breakdown structure & classification – from the start
- Use relational databases – from the start
- Become data-centric (create a CDE)

Beware (or mindful of):

- Data interoperability (be prescriptive!)
- Being led by IT!
- People don't like change!

FURTHER INFORMATION

- http://www.atkinsglobal.com/~/media/Files/A/Atkins-Global/Attachments/sectors/rail/library-docs/technical-papers/gis-and-information-management-on-crossrail-c122-bored-tunnels-contract.pdf

People and Skills

PEOPLE AND SKILLS
ASSIGN RESPONSIBILITY FOR DATA AND INFORMATION MANAGEMENT

What is it?

Clarity of roles, responsibility, authority and the scope of any task are an essential aspect of effective information management. For smaller or less complex assets or projects, information management roles may be performed alongside other roles – asset manager, project manager, design team leader, principal contractor, etc. Key to the allocation of roles, responsibility and authority is the appropriateness and ability of the organization to be able to fulfil the requirements of the role[15].

Why is it important?

The importance and complexity of project and asset information management activities and responsibilities are often underestimated. Every single person working on a construction project requires and generates an enormous amount of data and information. This is not limited to models and drawings. It includes all types of project data, for example schedules, emails, photographs, specifications, etc. Choosing and implementing the most efficient and appropriate technical solution that best supports the processes, security and other requirements as well as the needs of the people with the data, is not a trivial task.

What are the recommendations?

	Highly Recommended	Recommended	Encouraged
Assign responsibility for data and information management	Responsibilities for data and information management should be assigned to competent and qualified individuals Information management roles should not refer to design responsibilities.	Resourcing of data and information management responsibilities should be proportionate to the size and complexity of the project	Task-based role definition: identifying the information needs, related tasks and required workflows form the basis to fill the roles needed for any contract appropriately

Foot Notes

[15] ISO/CD 19650-1, Date 2016-07-06

Es.BIM initiative

Framework / Performance Criteria: Performance Criteria
Topic: Assign responsibility for data and information management
Recommendation: Responsibilities for data and information management should be assigned to competent and qualified individuals. Information management roles should not refer to design responsibilities

CONTEXT

The Es.BIM initiative has been organized around specific tasks groups. One of them (Group 2.3) oversees the definition of specific roles in a BIM environment. Different project types and their corresponding delivery stages were identified and considered.

At the same time, a thorough review of existing international rules, standards and common practices was carried out to gather and summarize the current situation around BIM related roles and responsibilities in different countries. The international review was then compared with the current situation in the Spanish AEC Industry and recommendations for changes to the traditional roles as well as identification of new tasks were developed for different types of projects at different stages.

WHY WAS IT DONE AS DESCRIBED?

The BIM process puts a much higher attention on activities around data and information management than the traditional approach on construction projects. This change needs to be reflected in the relevant roles and responsibilities; relevant tasks must be defined and it must be clear which role they correspond to. In order to develop and provide a document that can consistently be used by owners, employers and suppliers alike, the Spanish initiative saw it as important to assess which roles or functions are necessary during the different stages of the building or infrastructure lifecycle.

There is currently no single international standard for roles and responsibilities on a "BIM project". By analyzing existing documentation and best practice from different countries and international standards, the Spanish initiative tried to benefit from the larger experience of BIM implementation in other places all over the world. At the same time, given the fact that some of the responsibilities and related liability in projects in Spain are regulated by law, it was necessary to adapt the findings to match the existing legal framework in Spain.

WHAT LESSONS CAN BE LEARNED?

The first version of the document developed by group 2.3 of the Spanish BIM initiative suggests several modifications of the existing roles and responsibilities on a construction project, aimed to:

- define more specific tasks related to data and information management, since some of them are far too general to serve as a guide
- revise some of the roles and describe the responsibilities more clearly. This will allow to identify interdependencies / overlaps, especially in cases where design quality responsibilities were mixed up with data quality tasks and responsibilities.
- link tasks more clearly to delivery stages,
- link roles more clearly to project types

It is envisaged that future versions of the document will include further details, especially when the ISO 19650 standard, which defines relevant roles and responsibilities, gets adopted at CEN to become a European standard.

FURTHER INFORMATION

- The following link provides further background information:
- http://www.esbim.es/descargas/

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List of abbreviations

AEC	Architecture, Engineering and Construction
BCF	BIM Collaboration Format
BEP	BIM Execution Plan
BIM	Building Information Modelling
BREEAM®	Building Research Establishment Environmental Assessment Method
bSI	buildingSmart International
CAD	Computer Aided Design
CDE	Common Data Environment
CEN	European Committee for Standardization
ECMS	Engineering Content Management System
EIR	Employers Information Requirement
EU	European Union
EUBIMTG	EU BIM Task Group
GDP	Gross Domestic Product
GIS	Geographic Information System
IDS	Information Delivery Specification
IFC	Industry Foundation Class
ISO	International Standardisation Organisation
IT	Information Technology
LOF	Learnings Outcomes Framework
MVD	Model View Definition
OGC	Open Geospatial Consortium
OTL	Object type library
PLCS	Product life cycle support
PTNB	Plan Transition Numérique dans le Bâtiment
R&D	Research and Development
SC	Steering Committee
SME	Small and Medium-Sized Enterprises
USB	Universal Serial Bus
XML	Extensible Markup Language

By 2025, “full-scale digitalization… will lead to annual global cost savings of 13% to 21% in the design, engineering and construction phases and 10% to 17% in the operations phase”

BCG (The Boston Consulting Group)
‘Digital in Engineering and Construction: The Transformative Power of Building Information Modeling’ 2016

EUBIM TASKGROUP

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