European Commission

European Construction Sector Observatory

Policy fact sheet

Germany

BIM in Infrastructure Construction

(BIM4INFRA2020)

Thematic objectives 2, 3, 4 & 5

January 2021

In a nutshell

Implementing body	Planen-Bauen 4.0 GmbH and consortium partners. Supported by the Federal Ministry of Transport and Digital Infrastructure (Bundesministerium für Verkehr und digitale Infrastruktur – BMVI)
Key features & objectives	BIM Roadmap implementation initiative to establish digital planning and construction as standard practice in all federal infrastructure construction projects from 2020.
Implementation date	October 2016 – ongoing
Targeted beneficiaries	Project owners, architects, builders, planners, engineers, structural engineers, operators and building suppliers.
Targeted sub-sectors	Infrastructure construction (pilot phase)
Budget (EUR)	Not published.
Good practice	★ ★ ★ ★ ★
Transferability	★ ★ ★ ★ ★

Digitalisation is transforming how businesses, industries and value chains operate, collaborate and compete. Over the last decade, digitalisation has had a huge impact on large areas of the economy, delivering significant productivity gains. However, those gains have largely bypassed the construction industry[1].

Digital tools are used in the construction industry, from planning to construction and building operations; yet their use is more limited than in other industries. Information, and digital information in particular, is less exploited in construction than in other more technologically advanced industries[2].

Building Information Modelling (BIM) – otherwise known as **Building Information Management** – is a broad term that describes a digital model-based process for managing and sharing information throughout the lifecycle of a built asset.

To help BIM achieve a breakthrough in Germany, the Federal Ministry of Transport and Digital Infrastructure (BMVI) launched a BIM Roadmap in December 2015. It applies primarily to infrastructure construction and infrastructure-related building construction, but can also be used as a model in other areas[3].

The **BIM Roadmap** is based on seven key principles[4]:

1. A cooperative working methodology for the entire infrastructure construction value chain;
2. Accurate, consistent and clear client requirements in award procedures;
3. Use of digital models and data in digital form;
4. Sufficient time for value chain partners (public and private) to adapt to change;
5. An international standards-based approach;
6. Use of manufacturer-neutral, independent and open technology standards and processes;
7. Dependency aspects such as legal framework conditions to be addressed at a later stage.

The BIM4INFRA2020 working group and project were commissioned by BMVI in 2016 to implement the principles and objectives of the BIM Roadmap.

BIM4INFRA2020 is being implemented in three phases. Phases I (preparatory) and II (extended pilots) were completed successfully. Key results include BIM 2020 use cases and scenarios, ten BIM guideline documents, a database concept and six completed pilot projects. Phase III began in December 2020 with the aim of establishing BIM Performance Level 1 as standard practice in all new infrastructure projects.

1.

General description

BIM4INFRA2020 is a government-backed initiative that was launched by the Federal Ministry for Transport and Digital Infrastructure (BMVI) in 2016. It aimed to establish digital planning and construction as the standard for federal infrastructure projects in Germany by 2020.

The use of Building Information Modelling (BIM) in infrastructure projects is the core focus of the initiative. By applying BIM methods and tools, the goal is to use digital models and processes to record, exchange and process all of the lifecycle data associated with a built asset, from planning to construction and operation[5].

The **BIM Roadmap** (BIM-Stufenplan[6]) establishes a pathway for the gradual application of digital design, construction and operation in infrastructure projects in Germany.

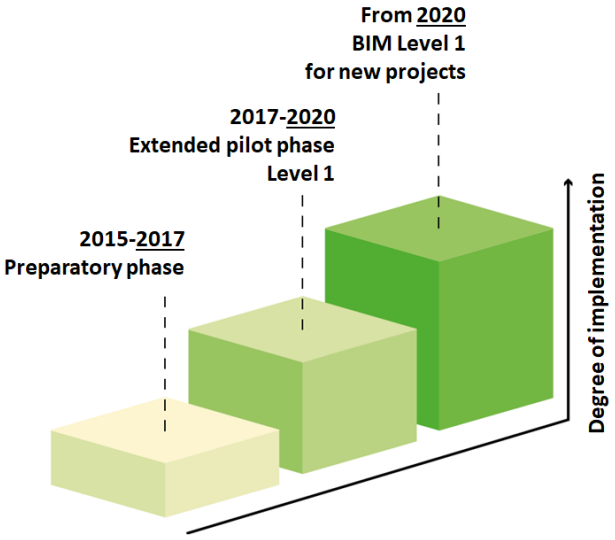
The BIM Roadmap[7] aims to deliver planning improvements and efficiencies:

- More accurate planning and reduced cost overruns:
  - Visualisation of planning alternatives;
  - Fewer design errors by collision detection and enforced stakeholder collaboration;
  - Accurate assessments of cost increases caused by change requests from the owner;
  - More reliable construction processes by simulating construction sequences;
- Improved communication with the public:
  - Clear visualisation of construction projects for maximum transparency;
- Optimisation of lifecycle costs:
  - Simulation of lifecycle costs (including operation and maintenance costs);
  - Supply the digital model to the owner to improve facility management[8].

To achieve the objectives outlined in the roadmap, BIM Performance Level 1 will be gradually introduced over time to specific projects. The aim is to ensure that all parties involved have sufficient time to adapt to the required changes.

BIM Performance Level 1 describes the minimum BIM-related requirements to be met. They apply to the extended pilot phase from mid-2017 onwards and to all new infrastructure project procurement procedures by BMVI from 2020. This includes decisions on where responsibility for BIM activity coordination lies, i.e. with the client or the supply chain. Supply chain members will need to acquire the necessary skills to offer their services in compliance with client requirements[9]. Figure 1 illustrates the BIM implementation phases.

Figure 1: BIM Roadmap implementation phases



Source: BMVI[10]

Phase I[11] is the preparatory phase. It involves initial pilot projects and standardisation measures, early stage and ongoing training, resolving potential legal issues and preparing BIM guidelines on effective approaches (processes) to BIM design, construction and operation.

Phase II[12] scales up the application of BIM Performance Level 1 in a larger number of pilot projects.

Phase III[13] targets the broad application of BIM Performance Level 1 as standard practice in all new procurement procedures and projects from 2020 onwards.

BIM Performance Level 1

Level 1 BIM requires all new projects to meet minimum criteria related to data, framework conditions, processes, technology and people. These criteria are fully aligned with the BMVI BIM Roadmap.

The key features[14] include:

- Project procurement and delivery based on ISO 19650;
- Employer Information Requirements (EIR) defined in each project specifying use cases, model scope, object and attribute catalogues;
- Supplier creates BIM Implementation Plan (BIP) aligned with the EIR;
- Implementation of the principle of federated BIM model management according to ISO 19650;
- Use of a common data environment according to ISO 19650;
- Use of open data exchange standards (mainly IFC, but also OKSTRA and GAEB);
- Formal checking of BIM models for EIR compliance.

The BIM4INFRA2020 project was commissioned by BMVI in 2016 to implement the vision and objectives of the BIM Roadmap, adhering to the implementation timeframe (Figure 1).

The BIM4INFRA2020 initiative is being implemented by a **consortium**[15] **led by Planen-Bauen 4.0 GmbH**. The other partners include:

- AEC3 Deutschland GmbH;
- Ruhr-Universität Bochum - Lehrstuhl für Informatik im Bauwese;
- Kapellmann und Partner Rechtsanwälte mbB;
- OBERMEYER Planen + Beraten GmbH;
- Technische Universität München – Lehrstuhl für Computergestützte Modellierung und Simulation (CMS);
- WTM Engineers GmbH;
- Max Bögl Bauservice GmbH und Co. KG;
- interactive instruments Gesellschaft für Software-Entwicklung mbH;
- HOCHTIEF ViCon GmbH;
- SUB Erste Lesung GmbH.

BIM4INFRA2020's **project goals**[16] are to:

- develop an achievable level of performance for the introduction of BIM;
- support pilot projects and expand the pilot phase;
- examine relevant legal issues and develop recommendations for future contract drafting;
- provide appropriate guidelines and templates for the allocation and processing of BIM services, and BIM use cases in particular;
- identify requirements for uniform data structures for the infrastructure area;
- develop a uniform database concept and BIM library;
- develop and launch information and public relations activities.

2.

Achieved or expected results

In Phase I (Preparatory Phase), the BIM4INFRA2020 working group developed a BIM implementation framework to enable the German construction sector to prepare for the 2020 BIM performance level requirements.

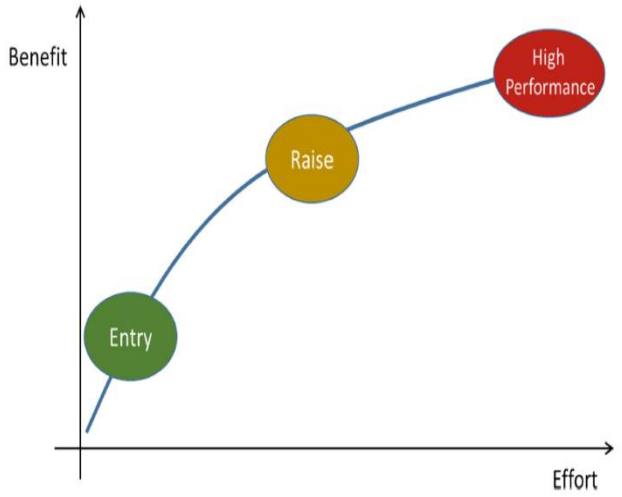
In Phase II (Extended Pilot Phase), six pilot projects were implemented to trial and validate the BIM implementation framework, in line with the BIM Roadmap vision and objectives.

Phase III is only recently launched and will be an ongoing activity. It is therefore too early to assess its progress and impact.

Phase I: Preparatory Phase

Three **BIM implementation scenarios – Entry, Raise and High Performance** – were defined to provide a phased pathway to BIM competency in projects. As shown in Figure 2, progression through the scenarios (implementation steps) implies an increase in effort that delivers greater performance and benefits.

Figure 2: BIM 2020 scenarios



Source: A. Borrmann et al[17]

The **BIM scenarios** are aligned with the BIM Performance Level 1 objectives. They are **shaped by** fixed **boundary conditions** (for all) and a selection of **use cases** (specific to each scenario).

The **boundary conditions**[18] are:

- use of a common data environment;
- supply of employer information requirements (EIR);
- supply of a BIM Implementation Plan (BIP);
- consistent use of classification systems;
- procurement and project delivery according to ISO 19650.

Table 1 lists the **20 standard use cases** defined by BIM4INFRA2020. They cover the design/planning, construction and operation phases, in line with the project implementation process.

Table 1: BIM4INFRA2020 use cases

• Initial state modelling	• Bill of quantities / tendering
• Design option analysis	• 4D implementation planning
• Visualisation	• Logistical planning
• Simulation & dimension	• Drawing generation: detailed design
• Coordination	• Construction progress monitoring
• Design process control	• Change management
• Drawing generation: preliminary design	• Billing
• Safety design	• Issue management
• Design approval	• As-built documentation
• Cost estimation	• Operation and maintenance

Source: A. Borrmann et al[19]

Phase II – Extended Pilot Phase

BIM4INFRA2020 implemented **six BIM pilot projects**. They targeted the construction of[20]:

- Three bridges:
  - Highway A99, Bridge 27/1;
  - Highway A1, Bridge 533;
  - Federal Road B31, Gauchachtalbrücke;
- One tunnel:
  - Highway A44: Eastern Tunnel Chain;
- One rest area:
  - Highway A7: rest area;
- One water-gate:
  - Watergate Wedtlenstedt.

The principal focus of all projects was to assess the interaction between public clients and contractors. BIM4INFRA2020 supported each project in key activities. Examples include the definition of Employer Information Requirements (EIR), assessment of BIM Implementation Plans and BIM model completeness and consistency checks[21].

To facilitate practical project-based learning about what works and what does not work, each pilot project applied the BIM methodology in different set-ups and in different phases of the building lifecycle[22].

The construction of the **highway A99 bridge** (27/1) provided the **most comprehensive test case**. The project scope covered various project phases, from **initial to detailed design and construction**. BIM models were created and handed over to the client in all phases[23].

The highway A99 bridge pilot project posed a range of challenges to the parties involved. The main challenge was the fragmented nature of the project. Each phase involved different companies using different BIM authoring tools. To resolve this issue, vendor-neutral format Industry Foundation Classes (IFC) had to be used extensively to handover the models during the design phases[24].

The **main conclusions**[25] drawn from the pilot projects include:

- No major problems with BIM implementation were experienced by any of the six pilot projects;
- Limited knowledge and experience of BIM at the client and supplier side demanded a very high level of effort;
- Clear and precise guidelines are essential to make use of BIM in federal projects less onerous (especially in terms of effort);
- Greater awareness of the need for a phased process to gradually help industry to incorporate BIM-based working practices;
- The BIM transition requires an investment commitment (organisational and financial) from all parties.

The pilot project findings highlight the improvements needed to unlock the power of BIM in construction and achieve significant efficiencies in project delivery.

BIM Guidelines[26]

To help the pilot projects to document the knowledge acquired during their BIM application experiment, BIM4INFRA2020 provided **ten guideline documents for BIM implementation**.

The BIM guideline documents were made **available online and are free of charge**. The target audience is AECO[27] professionals on the client and supplier/contractor side. The guides include:

- Basics and overall process;
- Employer Information Requirements (including templates and examples);
- BIM Implementation Plan (including templates and examples);
- BIM service specifications;
- Contract templates;
- BIM use cases;
- BIM discipline models and levels of development;
- Vendor-neutral data exchange;
- Data exchange using IFC;
- BIM Technology.

Database concept[28]

The design of the BIM4INFRA2020 database concept was motivated by the findings that emerged from the project implementation phases. It became apparent that technical support was needed to complement the BIM guideline documents and to support clients and suppliers.

Clients need the capacity and means to verify building information, which requires a standardised process that is easy to follow and is supported by appropriate tools. This efficiency would enable

them to set clear and consistent guidelines for contract information delivery, and define project-specific information requirements.

More standardised specifications and templates would make the bid and digital model creation process easier and more efficient. Greater standardisation and automation would also help to reduce errors in delivered models.

The BIM4INFRA2020 database concept covers three principal components to be developed in collaboration with stakeholders:

- **Classification and property database** to support the standardised description and classification of digital models and empower the seamless exchange and consistent reuse of digital building models;
- **Employer information requirements module** to make configurable templates available to public clients to enable them to create precise information requirements for project phases and use cases;
- **Object template database** to provide suitable and configurable BIM object templates to enable contractors to create models in line with project-specific requirements.

Phase II – BIM Performance Level I for new projects

This phase has only recently been launched. The launch date (2020) was delayed slightly until December 2020. It is therefore too early to assess its results.

BIM4INFRA2020 has produced important results, from 20 use cases to BIM 2020 scenarios, a range of BIM guidelines and the database concept. Pilot projects have also applied BIM4INFRA2020 methods and have identified areas for improvement needed for their wider roll-out.

BIM4INFRA2020 has also inspired the creation of the German Centre for the Digitalisation of the Construction Industry (BIM Germany). Set up in 2020 by BMVI, it will cover infrastructure and residential construction and will continue the work of BIM4INFRA2020 in the years ahead.

BIM Germany will also focus on BIM standards, harmonisation, training, and business support services for projects.

3.

Perspectives and lessons learned

Building Information Modelling is a game changer that is transforming the global construction industry. Leveraging its potential is key to the future success of the German construction sector.

The strategic approach to BIM introduction adopted by the Federal Ministry for Transport and Digital Infrastructure (BMVI) demonstrates the government's strong commitment to ensuring the German construction industry is future proofed. The Ministry contends that: *"The digital revolution is transformational for both the economy and society. It changes the prerequisites for growth, prosperity and the work of tomorrow, and is revolutionising industries and services, value chains and production processes, innovation and product lifecycles ..."*[29].

"To leverage this potential in Germany, we need a new digital planning and building culture. Building Information Modelling is a key element. BIM digitalises the entire lifecycle of a construction project: from the design and planning of a building, through to construction, operation and eventual demolition. This innovation gives everyone involved access to virtual plans, process control, extensive databases and 3D to 5D building models. Architects, builders, planners, engineers, structural engineers, operators and building suppliers work hand in hand"[30].

Public sector leadership is essential to encourage the use of BIM as standard practice in the transport and infrastructure sectors.

The Federal Ministry for Transport and Digital Infrastructure emphasises the important role that the public sector must play to drive industry change: "*We want to make digital planning and construction the national standard. The public sector must lead the way as a major builder and drive cultural change. We have therefore set up a reform commission for the construction of major projects and formulated the clear principle: "First build digitally, then build for real". That is why we have started pilot projects to test BIM … and that is why the BMVI has developed a phased plan for future planning and building to make BIM the new standard for transport and infrastructure projects by 2020"*[31].

The pilot projects highlighted what needs improvement to ensure the successful implementation of BIM in all federal infrastructure projects.

The main improvements[32] required to support the use of BIM in federal project procurement and delivery include:

- Clear and precise guidelines to inform clients, projects and contractors on how best to use BIM in federal projects, giving consideration that the parties may need assistance with the tools;
- A phased BIM implementation process to enable industry to incorporate BIM-based working practices more effectively;
- Clarity on the need for all parties to invest appropriately, in both financial and organisational terms, to make a sustainable transition to BIM competency in infrastructure projects.

4.

Conclusion and recommendations

BIM4INFRA2020 is an important government-backed German initiative that is implementing the German BIM Roadmap vision for the infrastructure construction sector.

The key results are:

- **Defined BIM 2020 scenarios based on use cases;**
- **A comprehensive set of BIM guidelines;**
- **The BIM4INFRA2020 database concept.**

Another important result or knock-on effect of the BIM4INFRA2020 project is that it has led the BMVI to establish the German Centre for the Digitalisation of the Construction Industry (BIM Germany).

BIM Germany began operations in 2020. Its principal mandate is to drive the digitalisation of the German construction sector. Its scope is broader than the BIM4INFRA2020 project, as it covers the infrastructure and residential construction sectors.

Part of its remit is to continue the work of BIM4INFRA2020 by accelerating the development of standards, harmonisation, BIM training, and business support services for BIM projects and creating a vision for the future digitalisation of the German construction sector.

BIM4INFRA2020 pilot projects provided good coverage of all project phases and a range of project set-ups and requirements. Although they did not experience any major problems, they proved to be a valuable learning experience by identifying key areas for improvement. BIM4INFRA2020 has proactively engaged with the challenges identified during the course of the project. The newly founded BIM Germany is expected to continue the pursuit of BIM competency in infrastructure construction. The centre is also expected to play an important role in assessing the implementation of the final phase of the German BIM Roadmap. Phase III began in December 2020.

Looking forward, two recommendations are suggested to help improve the reach and impact of BIM4INFRA2020:

- Strong(er) focus on upskilling measures for client and supply side organisations and teams would help to address the knowledge gap revealed by the pilot projects. With training being part of their remit, the newly formed BIM Centre in Germany would be well placed to lead a coordinated response;
- Consideration should be given to implementing new or improved measures to incentivise and/or support contractors to invest and grow their BIM competencies.

Overall, BIM4INFRA2020 is rated a '5-star good practice measure' on a scale of 1 (low) to 5 (high).

This score is based on the ambitious nature and scope of the project, and the broad delivery of its objectives, to date. It has produced a clear pathway to digital planning and construction in the infrastructure sector. Key building blocks have been delivered. It also helped to inspire the creation of a national BIM Centre in Germany.

BIM4INFRA2020 is rated a '5-star transferable measure' on a scale of 1 (low) to 5 (high).

This score is based on a similar rationale to that given for good practice. BIM is by definition a global solution that is helping to drive efficiencies globally. Even if BIM4INFRA2020 is not readily transferable to another country in its entirety, it will at least provide a valuable example of a blueprint for digital transformation and policy learning.

Endnotes

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