



Federal Ministry  
for Digital  
and Transport

# Federal Trunk Roads BIM Masterplan

**Digitalization of planning, construction, maintenance and operation in  
Federal trunk road construction using Building Information Modelling (BIM)**



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# Summary

With this Federal Trunk Roads BIM Masterplan, the Federal Ministry for Digital and Transport is following up on the recommendations of the Construction Reform Commission and the Road Map for Digital Design and Construction and providing a more in-depth implementation strategy for Autobahn GmbH and the federal state authorities with delegated powers. The Masterplan defines the common understanding of BIM as a **cooperative, digital working method** in federal trunk road construction and pursues five **strategic goals** with the full implementation of BIM:

- increase efficiency and on-time as well as in-budget delivery;
- plan projects sustainably;
- improve communication by enhanced linking of works;
- improve data continuity through centralized data management; and
- ensure nationwide harmonization and standardization of the BIM method.

In its **vision for the future**, the Ministry describes what it aims to achieve in the long term by using BIM in federal trunk road construction. The ‘Digital Twins for Federal Trunk Roads’, a vision for the future, focuses on digitalizing and optimizing the operational phase based on digital twins, digitally mapping the physical infrastructure. For example, the use of preventive maintenance and the integration of forward-looking technologies, such as the networking of real-time data (e.g. sensors) or the use of artificial intelligence, can harness the potential of maintenance to preserve the infrastructure’s structural fabric. This vision of the future is to be implemented on the basis of universal use of BIM.

The networked digital twins to be established will be built on the foundations of continuous and universal application of the BIM method over the entire infrastructure life cycle. In the **implementation strategy** of this Masterplan, the road map to the ‘Digital Twins for Federal Trunk Roads’ is defined via a **three-phase model for BIM rollout**. By means of a segmented rollout of the BIM use cases, this phase model structures the time frame for the required evolution and design of the use of the BIM method at Autobahn GmbH and in the federal state authorities with delegated powers in a targeted manner.

Implementation of the BIM method will be staggered within the three phases:

- In the **first phase** starting in 2021, BIM implementation at Autobahn GmbH and in the federal state authorities with delegated powers will be strategically and organizationally aligned and driven forward collaboratively. This is intended to transition BIM implementation to a uniform, standardized basic level throughout Germany.
- In the **second phase**, the BIM method is to be expanded and used intensively in all branches/centres of Autobahn GmbH as well as in the federal state authorities with delegated powers.
- The goal of the **third phase** is to conclude BIM implementation at Autobahn GmbH and in the federal state authorities with delegated powers. The BIM method is to become the standard for all projects at Autobahn GmbH and in the federal state authorities with delegated powers.

Implementation of this Masterplan will be concluded when BIM is comprehensively used as a standard process at the targeted full development level.

In order to actively support this gradual implementation of BIM at Autobahn GmbH and in the federal state authorities with delegated powers, the Ministry provides a **uniform nationwide framework** based on four strategic action areas – guidelines, processes, technologies and people. The Ministry provides **model guidelines for BIM (MG BIM)** for project management and **recommended actions for BIM (RA BIM)** for establishing the necessary organizational structures at Autobahn GmbH and in the federal state authorities with delegated powers. As part of an accompanying BIM piloting and evaluation programme, both the MG BIM and the RA BIM will be successively adapted and updated.

Cross-organizational BIM implementation is **coordinated and managed** in the official BIM meetings of the Federal Government and federal state governments, as well as in the associated BIM Steering Group. The systematic establishment and ongoing development of BIM expertise at Autobahn GmbH and in the federal state authorities with delegated powers is an important component of this Masterplan. To ensure this, a BIM maturity assessment and a target agreement process will be established between the Ministry, Autobahn GmbH and the federal state authorities with delegated powers, taking into account the respective organizational sovereignties.

With its vision for the future and implementation strategy, the Masterplan points the way forward for Autobahn GmbH and the federal state authorities with delegated powers, and initiates an ambitious and concerted expansion of BIM in federal trunk road construction.

# 1. Introduction

A modern and efficient federal trunk road infrastructure is a prerequisite for the mobility of our citizens and essential for German competitiveness in the global economy. Autobahn GmbH and the federal state authorities with delegated powers<sup>1</sup> are responsible for planning, construction, maintenance and operation of the federal trunk road network. They use time-tested and proven methods when performing their functions. Nevertheless, there have been repeated delays and budget overruns in the past, especially in the planning and construction of major projects.

Against this background, the 'Construction of Major Projects Reform Commission' was launched in 2013. It was asked to identify problems in the planning and delivery of major projects, to find causes, to explore possible solutions and to develop recommendations for action, among other things for more cost stability and efficiency in major projects. Experts from industry, science, the public sector, chambers and associations have prioritized the use of digital methods such as Building Information Modelling (BIM) and recommended 'building twice; first digitally, then physically' (BMVI, 2015).

Building on this, the Road Map for Digital Design and Construction was developed in 2015 to trial the digital BIM method with all its requirements. Various BIM projects have already been piloted to date in almost all federal states based on the specifications in the Road Map and used for focused knowledge building.

Initial analyses and evaluations of the BIM pilot projects to date show that the BIM method, when applied professionally, can have significant potential in terms of cost savings, cost transparency and on-time delivery in small, medium-sized and large projects. This Masterplan was developed to leverage this potential and to ensure that the BIM method is applied in a targeted manner at Autobahn GmbH and in the federal state authorities with delegated powers. It defines the common understanding of BIM

in federal trunk road construction and points the way forward for the use of the BIM method at Autobahn GmbH and in the federal state authorities with delegated powers with its vision for the future, 'Digital Twins for Federal Trunk Roads'.

The implementation strategy describes the sustainable and phased implementation of BIM at Autobahn GmbH and in the federal state authorities with delegated powers from 2025 on. Comprehensive deployment of BIM throughout the entire building life cycle is the goal. The Masterplan thus ties in directly with the Road Map and fleshes out the use of BIM for federal trunk road construction.

In order to actively support this digital transformation at Autobahn GmbH and in the federal state authorities with delegated powers, the Ministry is providing a uniform nationwide framework in the form of model guidelines for BIM (MG BIM) for project management and recommended actions for BIM (RA BIM) for the organizational structures required at Autobahn GmbH and in the federal state authorities with delegated powers. In this way, the Masterplan points the way forward for Autobahn GmbH and the federal state authorities with delegated powers, and initiates an ambitious and concerted expansion of BIM in federal trunk road construction. In close cooperation with Autobahn GmbH, the federal states, DEGES (the German Unity Planning and Construction Company for Trunk Roads) and other public- and private-sector organizations, the Ministry intends to mainstream the BIM method in the value chains of infrastructure projects. The national BIM Centre (BIM Germany – Centre for the Digital Transformation of Construction), which was founded jointly by the then Federal Ministry of Transport and Digital Infrastructure and Federal Ministry of the Interior (BMI) as part of the Building Masterplan 4.0, a 5-point plan presented in 2017, provides support in this regard.

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1 DEGES Deutsche Einheit Fernstraßenplanungs- und -bau GmbH is currently implementing motorway projects on behalf of Autobahn GmbH and federal highway projects on behalf of the federal state authorities with delegated powers.

## 2. Common understanding and definition of BIM

Success factors for the nationwide establishment of BIM include a uniform definition and a common understanding of the application of Building Information Modelling as a digital work method in federal highway construction:

BIM is “a cooperative work method which makes it possible, based on digital models of a building, to consistently collect, manage and exchange, for further processing, by way of transparent communication between those involved, information and data relevant to its lifecycle (...)” (Federal Ministry of Transport and Digital Infrastructure – Road Map for Digital Design and Construction, 2015)

The BIM process considers the entire life cycle of a structure, from development, planning, construction and use to dismantling. To this end, depending on the requirements, corresponding BIM use cases are defined that describe the services to be provided in the context of the respective objective.

The digital building models created when implementing the BIM use cases are continuously maintained and updated throughout the entire life cycle. All necessary data and information are consistently recorded, managed and exchanged among the project stakeholders on the basis of

these digital models, as a data pool and virtual image ('digital twin') of the structure to be built and its use.

The method revolves around cooperative work, which is characterized by communication and data management in a shared data environment.

In the practical application of the BIM method, relevant technical information, such as cost, schedule, building material and manufacturer data or operational information, such as inspection reports or damage documentation, is assigned to the objects in a digital building model (cf. Figure 1).

BIM enables object-oriented organization of structural data, ensuring continuity, discoverability and targeted distribution of relevant information as well as optimizing project communication. At the same time, the quality of planning and construction can be increased in accordance with the guiding principle 'build twice; first digitally, then physically' (BMVI, 2015). In the digital model, errors are detected at an early stage (e.g. through collision tests) and corrected there before the real construction. This leads to increased planning, schedule and cost certainty and creates a consistent data basis for operation (see Chapter 3.1).



Figure 1: Digital building model of a bridge with linked information



# 3. Strategy model for BIM implementation

In its vision for the future, the Ministry describes what it aims to achieve in the long term by using BIM in federal trunk road construction. The implementation strategy describes the road map to the vision for the future via a three-phase BIM rollout model and defines how this vision is to be achieved. In this way, the Ministry sets the strategic direction for Autobahn GmbH and the federal state authorities with delegated powers, and provides reliable and uniform nationwide guidance on digitalizing the planning, construction, maintenance and operation of the federal trunk road infrastructure with BIM. In the objectives, the Ministry specifies the strategic framework conditions as well as the purpose of BIM implementation, particularly also in the socio-political context. BIM implementation is operationalized by means of numerous measures that are classified into four strategic action areas (see Chapter 5).

## 3.1 Vision for the future: planning, construction, maintenance and operation on the basis of digital twins

In the long term, the planning, construction, maintenance and operation of the federal trunk road infrastructure will be based on fully integrated digital twins. Digital twins digitally map the physical federal highway infrastructure with all relevant information and in all its complexity. The consistent application of the BIM method over the entire life cycle of the infrastructure lays the groundwork for the establishment of extensively interconnected digital twins and the resulting potential for data analysis and use.

While the Federal Trunk Roads BIM Masterplan concentrates on planning and construction

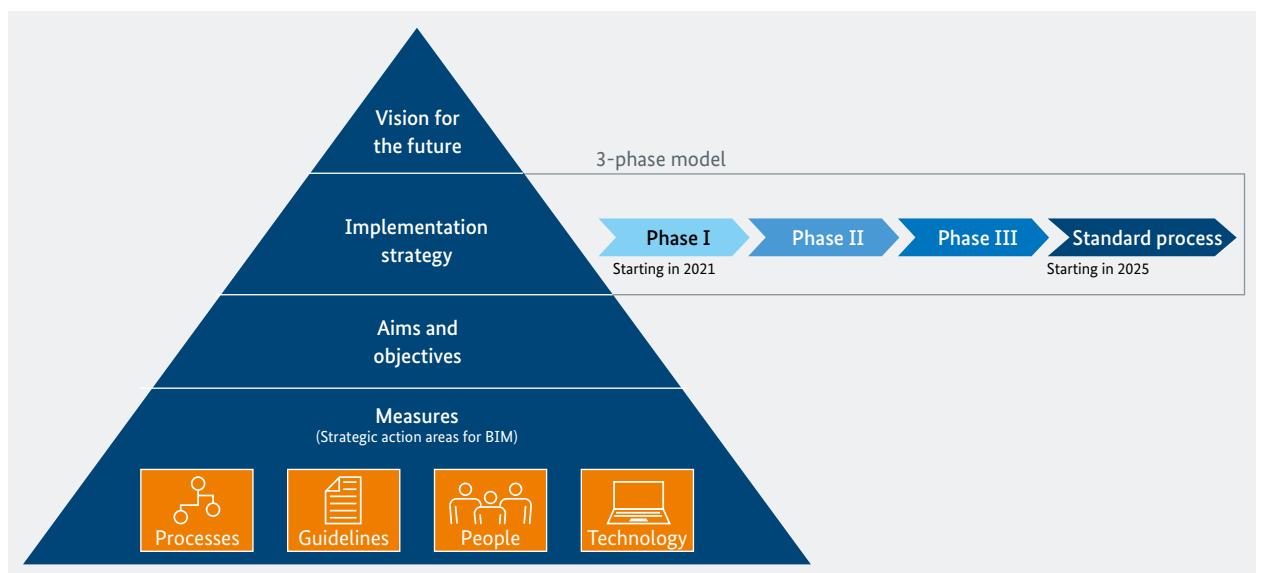


Figure 2: Strategy model for BIM implementation

use cases, the vision for the future focuses on maintenance and operation. This is accompanied by other complex forward-looking technologies, such as the networking of real-time data (e.g. sensor technology), model-based simulations and forecasts, the increased integration of manufacturer and machine data, the networking of digital twins with autonomous vehicles, or the integration of artificial intelligence. Important aspects of this include the dynamics or timeliness of the data, which is the benefit of a digital twin. Up-to-the-minute data makes digital twins efficient tools for the operational phase in terms of analyses, forecasts, control and monitoring. For example, this is likely to allow investment in maintenance and replacement infrastructure to be optimized for planning, while use of sensor-based preventive maintenance can ensure that the infrastructure is operated in such a way that the structural fabric is maintained (cf. Chapter 4.1).

This vision of the future is to be implemented on the basis of universal BIM use from 2025 on (cf. Figure 3). As part of this, the necessary measures will be initiated in the course of this Masterplan in order to conceptually prepare the future implementation framework for the ‘Digital Twins for Federal Trunk Roads Masterplan’. These measures are pooled in BIM digital twin testbeds (cf. Chapter 6.4).

### 3.2 Implementation strategy

The implementation strategy for federal trunk road construction is based on the recommendations of the Construction of Major Projects Reform Commission and the Road Map for Digital Design and Construction. With this Masterplan, the Federal Ministry for Digital and Transport is following up on the specifications of the Road Map and providing a more in-depth implementation strategy for the federal trunk roads.

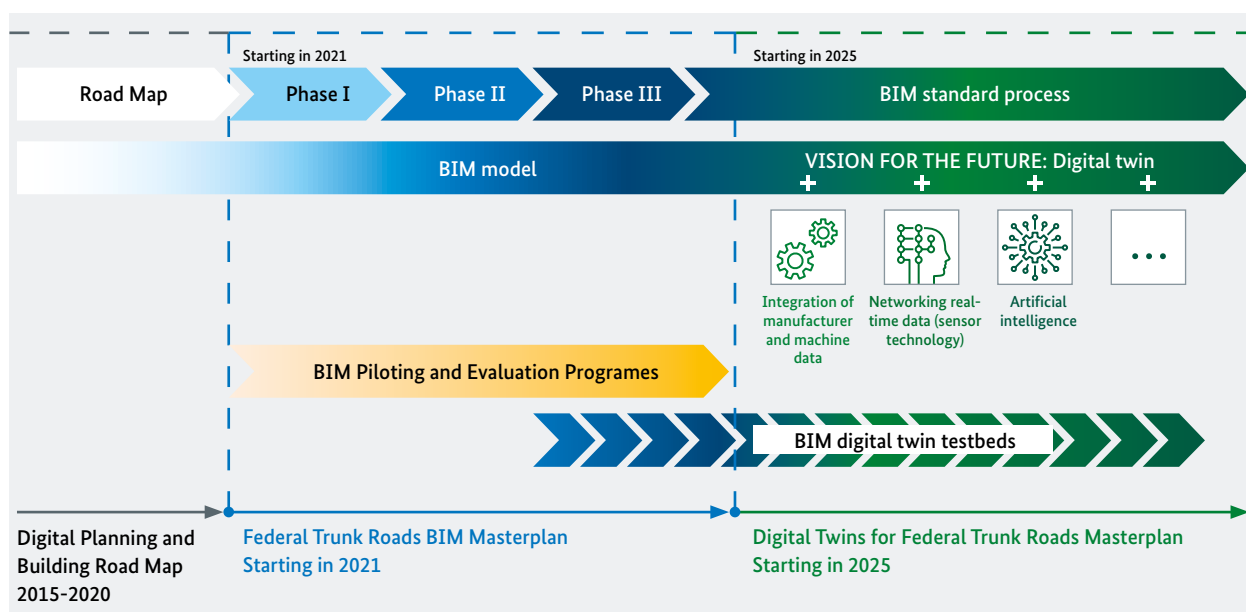


Figure 3: Phase model for BIM implementation strategy

The main strategic component is a **three-phase model** for gradual evolution of the BIM method in accordance with the requirements of federal trunk road construction. This model leads to universal application of BIM as a **standard process** at Autobahn GmbH and in the federal state authorities with delegated powers, and is the basis for operational BIM for digital twins (cf. vision for the future, Chapter 3.1).

In this context, the Ministry is providing targeted support in building up the required expertise and development at Autobahn GmbH and in the federal states with long-term measures that cover the necessary strategic and operational action areas to roll out and standardize BIM (cf. Chapter 4). This is to be ensured by a BIM piloting and evaluation programme accompanying the phases (cf. Chapter 6.3).

In addition, the Ministry would like to further ensure that BIM develops in line with market needs by maintaining close lines of communication with relevant representatives from the construction industry and the scientific community via already established platforms and associations. Furthermore, research needs identified are supported by means of dedicated research contracts and continuously supplemented on the basis of new findings. By continuing the close cooperation between the Federal Government and federal state governments and coordinating the BIM implementation via the official BIM meetings of the Federal Government and federal state governments (cf. Chapter 6.2) in cooperation with BIM Deutschland, the Ministry wants to ensure continuous sharing of lessons learned and knowledge building as well as a uniform approach to BIM implementation throughout Germany.

# 4. Strategic goals of BIM implementation

By rolling out BIM nationwide with this Masterplan, the Federal Ministry for Digital and Transport is pursuing the following strategic goals:

- increase efficiency and on-time and in-budget delivery;
- optimize sustainability;
- improve communication by facilitating interaction;
- introduce vendor-neutral, model-based, and centralized data management;
- harmonize and standardize BIM implementation.

## 4.1 Increase efficiency and on-time and in-budget delivery

The ‘build twice; first digitally, then physically’ principle (BMVI, 2015) results in significantly higher rates of on-time and in-budget delivery, since the use of the BIM method means that planning services are coordinated and quality-assured based on a model (unlike conventional planning). This can reduce risks in the construction process, construction costs and schedule delays. Planning errors that would lead to costly changes later in the construction process can be detected much earlier and corrected in good time. Reliability and a common understanding of planning and construction can be significantly increased with BIM, which boosts the binding nature and predictability of the cost ceiling. All the information required for relevant engineering and financial decisions is already available to those responsible in good time at an early stage of planning.

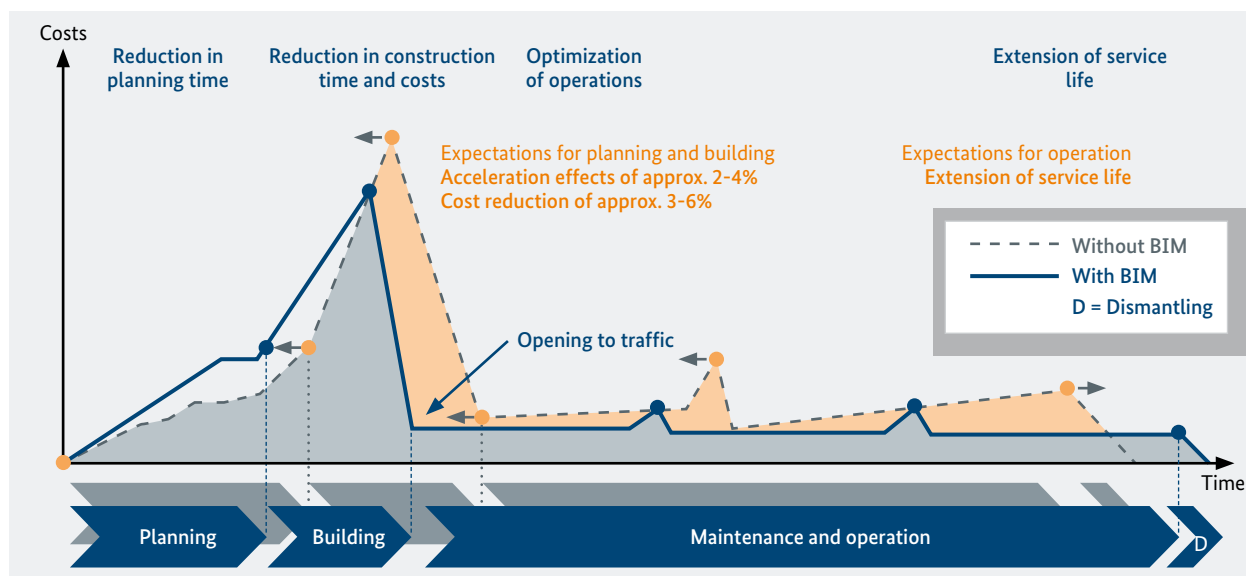


Figure 4: Hypothesis on the economic benefits of BIM

In the BIM pilot projects to date, the selective use of BIM has already shown potential savings in small, medium and even major measures. International studies on the economic benefits of BIM (Fischer & Drogemuller, 2009; Azhar, 2011; Sen, 2012; Berg, 2017) show potential savings of up to 15 percent over the entire life cycle of a structure. It should be borne in mind that the construction industry must first go through a ramp-up and investment phase before savings potential is fully realized. However, savings through improved planning quality and quantity reliability can already be realized in the short term.

Extrapolated to comprehensive and complete use of BIM in federal trunk road construction, a hypothesis was developed on the expectations regarding the economic benefits of BIM: The Ministry expects the reduction in errors to speed up construction progress by two to four percent and lead to total cost savings of three to six percent. In Germany, no studies are currently available to quantify the specific savings potential. As part of this Masterplan, this is to be validated by means of scientific monitoring. During this validation process, key indicators are also to be identified to evaluate the economic benefit.

In addition to the targeted potential financial savings, operational use of digital twins is expected to optimize the service life and maintenance costs of the infrastructure (cf. Chapter 3.1).

## 4.2 Optimize sustainability

BIM makes an important contribution to the sustainable construction and operation of the federal trunk road infrastructure. Consistent use

of BIM already facilitates analyses and statements on the life cycle assessment (e.g. carbon footprint analyses) of the infrastructure projects and their environmental impact in the early service phases. The simulation of dismantling and the early evaluation of the recycling of unmixed building materials are further examples of sustainable construction with a focus on the entire life cycle – from development and planning to dismantling.

## 4.3 Improve communication by facilitating interaction

The BIM method adds most value by improving communication between all parties involved. Communication deficits are one of the main causes of construction delays and cost increases in project delivery. In particular, a common understanding of the project content is established by using descriptive information models and intensifying the networked work culture between all project participants. For example, automated quality assurance processes and verification using the information model in the common digital project space (CDE) increase the planning and execution quality.

The digital building models enable realistic and comprehensible project visualizations that facilitate early public participation and make the project accessible to non-professionals. These visualizations can also be used in plan approval procedures to increase the acceptance of federal trunk road projects. For example, resident impact studies can be implemented based on a model, or simulation results on noise propagation can be visualized.

## 4.4 Introduce uniform data management

BIM is a collaborative and model-based method that requires a central data and information management environment. For efficient and optimized use, all existing and future relevant data and information on the federal trunk road infrastructure must be available to all parties involved in a suitable form, for a smooth exchange of information among other things. Central data management of this kind reduces the risk of redundancy, increases data continuity, enables information to flow between the various comprehensive sources without media discontinuity and, in particular, enhances the quality of data sets on the federal trunk roads. In the course of this, the compatibility of (operationally) relevant specialist systems of Autobahn GmbH and the federal state authorities with delegated powers must be evaluated and, if necessary, developed to meet the requirements of central data management.

## 4.5 Harmonization and standardization of BIM implementation

The nationwide use of BIM requires uniform framework conditions for Autobahn GmbH and the federal state authorities with delegated powers as well as harmonized BIM standards for project management. Among other things, this should also significantly reduce the implementation workload and ensure a uniform approach across the federal states.

When using the BIM method, a wide range of different types of information and data are used. The efficient exchange of this data between all parties involved requires mature, open and neutral interfaces that ensure the necessary data compatibility. The IFC format (Industry Foundation Classes) and OKSTRA® (Object Catalogue for Roads and Transportation) have established themselves for open exchange of data in the infrastructure sector in Germany.

The necessary harmonization and standardization are challenges that can only be met through coordinated cooperation and close coordination between the Federal Government and federal state governments. BIM Deutschland, the Federal Highway Research Institute (BAST), the Road and Transportation Research Association (FGSV), and the Federal/State IT Coordination Group (ITKo) are responsible for supporting the Federal Government and federal state governments in evolving technical regulations for the road and transportation sector and in accompanying national and international harmonization efforts.

# 5. Strategic action areas and operational measures for BIM implementation

The successful implementation of BIM at Autobahn GmbH and in the federal state authorities with delegated powers, and thus the achievement of the strategic goals (Chapter 4), requires measures in four strategic action areas (cf. Baldwin, 2019): guidelines, processes, people and technologies. Accordingly, to sustainably establish BIM in the projects, the organizational structures at Autobahn GmbH and in the federal state authorities with delegated powers need to be adapted with regard to the above-mentioned action levels on the one hand, while on the other, detailed specifications for digital planning, construction, maintenance and operation are required for project work with BIM. For this purpose, the Ministry provides a nationwide uniform framework in the course of each phase in the form of recommended actions for BIM (RA BIM) and a model guideline for BIM (MG BIM) (cf. Figure 6):

- **The model guideline for BIM (MG BIM)** contains framework documents for specific project work, such as those on use cases or data management. They provide practically driven recommendations for project work and offer flexibility for organization-specific development and fleshing out as well as for the definition of further project-related content.
- **The recommended actions for BIM (RA BIM)** provide supporting advice and procedures for the implementation of BIM at Autobahn GmbH and in the federal state authorities with delegated powers. The focus is on the overall organization of Autobahn GmbH and the federal state authorities with delegated powers, and not just the organizational units temporarily responsible for the projects. The Ministry is developing nationwide standardized

recommended actions for the respective phases and making them available to Autobahn GmbH and the federal state authorities with delegated powers. These are to supplement, formulate and implement the RA BIM with the specifics required in each case. Accordingly, there is a conceptual component for the Federal Ministry for Digital and Transport as well as an implementation component for Autobahn GmbH and the federal state authorities with delegated powers in response to the conceptual design for each action area (guidelines, processes, people and technologies).

These fundamentals form the basis for uniform management of BIM projects and contribute to a nationwide uniform understanding and a coordinated approach at Autobahn GmbH and in the federal state authorities with delegated powers. As part of the BIM piloting and evaluation programme (cf. Chapter 6.3), both the MG BIM and the RA BIM will be continuously adapted and updated.

## 5.1 Guidelines action area

For project management with BIM, guidelines, modelling guidelines, object catalogues, etc. are required to define the operational method at Autobahn GmbH and in the federal state authorities with delegated powers, and to provide employees with a reliable framework for action for the new digital way of working with BIM. Besides the guidelines for operational project management, binding legal frameworks must also be created for various topics, such as the liability of those involved in the planning process. In addition, users are to receive support in choosing one of the many remuneration models currently under discussion.

The following toolkits are being developed by the Ministry's Federal Trunk Roads Directorate-General in cooperation with Autobahn GmbH and the federal state authorities with delegated powers:

- Guideline for plan generation in accordance with RE 2012
- BIM use case definition
- Definition of the building models
- Guideline for plan derivation in accordance with RAB-ING
- Model Employer Information Requirements (EIR)
- Model BIM Execution Plan (BAP)
- Development of a specific object catalogue over the entire life cycle of the road
- Outline for a remuneration model for BIM services
- Recommendations for defining responsibilities and roles of all parties involved in the planning process
- Legal recommendations for terms of use for databases
- Recommendations for contractual arrangements that meet the high level of transparency, collaboration and joined-up thinking that BIM-based planning requires

## 5.2 Processes action area

Central challenges include developing BIM work processes, minimizing inconsistencies in the planning, execution and operational processes,

as well as preventing data loss with defined data exchange processes. Successful and holistic application of the BIM method at Autobahn GmbH and in the federal state authorities with delegated powers will take more than adapting conventional processes; the institutions will have to evolve them under their own responsibility. This will be ensured with the following activities at least.

The following outlines are being developed by the Ministry's Federal Trunk Roads Directorate-General in cooperation with Autobahn GmbH and the federal state authorities with delegated powers:

- Development of an outline for model-based data management
- Development of an outline for model-based quality assurance (e.g. automated checks, approvals, reports, etc.)
- Initialization of a transformation of regulatory systems and processes

Implementation by Autobahn GmbH and the federal state authorities with delegated powers:

- Adaptation of the Federal Trunk Roads BIM Masterplan by drawing up an implementation plan with milestones as a guiding process for Autobahn GmbH and the federal state authorities with delegated powers
- Simultaneous and successive establishment and trialling of model-based data management
- Simultaneous and successive establishment and trialling of model-based quality assurance (e.g. automated checks, approvals, reports, etc.)
- Other appropriate activities that prove necessary in the course of implementing the Masterplan



## 5.3 People action area

The BIM rollout is a comprehensive and far-reaching change process that substantially alters the established and individual working methods of all those involved in the life cycle of a structure. Winning over employees for this process, supporting them and motivating them through it as well as qualifying them for the upcoming tasks ahead is to be ensured by means of the following measures.

The following outlines are being developed by the Ministry's Federal Trunk Roads Directorate-General in cooperation with Autobahn GmbH and the federal state authorities with delegated powers:

- Development of training and continuing professional development outlines for the BIM method
- Development of an effective communication strategy with the public for the rollout of BIM at Autobahn GmbH and in the federal state authorities with delegated powers

Implementation by Autobahn GmbH and the federal state authorities with delegated powers:

- Introduction and establishment of the new BIM roles
- Establishment of internal BIM competencies (e.g. BIM specialist department, regional BIM centre of excellence, etc.) to pool BIM expertise within the organization and to manage the organization's own strategic BIM implementation
- Implementation of BIM training and continuing professional development outlines
- Ensuring innovative capacity by fostering employees (e.g. by developing junior BIM staff in-house)

- Conducting regular internal BIM information events
- Forming strategic cooperation partnerships for joint BIM application at local level
- Active participation in the established project groups of the official BIM meetings of the Federal Government and federal state governments
- Other appropriate activities that prove necessary in the course of implementing the Masterplan

## 5.4 Technology action area

The rollout of modern, IT-backed processes and technologies for planning, construction, maintenance and operation of structures requires a uniform and consistent exchange of data between the stakeholders involved. The effectiveness of BIM depends, among other things, on the degree of digital consistency across all processes. Heterogeneous databases, decentralized communication channels or media fragmentation during the transitions in the work processes and the individual phases from planning to construction and operation must be avoided. The technical framework conditions and prerequisites, such as comprehensive data and communication management, open and interoperable data formats etc., must be put in place for a smooth implementation of BIM processes. This also results in increased demands on software and hardware. In particular, the aspect of software compatibility must be taken into account to ensure fair competition and the required product neutrality in procurement.

For fruitful interaction between all those involved in the BIM processes, a central platform must support the uniform handling of public construction projects and provide the necessary information.

In particular, the use of a shared data environment in BIM projects also brings data protection and data security into focus.

For this purpose, the Ministry (Federal Trunk Roads Directorate-General) is developing the following outlines in cooperation with Autobahn GmbH and the federal state authorities with delegated powers:

- Development of an outline for data and communication management
- Development of an outline for data protection and data security
- Development and provision of a central platform to support the handling of construction projects (BIM portal)
- Evolution of the specialized information systems at Autobahn GmbH and in the federal state authorities with delegated powers

- Development of an implementation recommendation for a common data environment (CDE) for reliable and plannable use at Autobahn GmbH and in the federal state authorities with delegated powers

- Software guide
- Hardware guide

- Development of an outline for the BIM workplace of the future

Implementation by Autobahn GmbH and the federal state authorities with delegated powers:

- Simultaneous and successive building and trialling of common data environments (CDE)
- Trialling and establishment of the BIM portal
- Other appropriate activities that prove necessary in the course of implementing the Masterplan

# 6. Implementation outline

This outline comprises the four main components for the sustainable implementation of the BIM method at Autobahn GmbH and in the federal state authorities with delegated powers as well as to prepare operational deployment of BIM on the digital twin:

- A phase model of BIM implementation for a staggered introduction of specific BIM use cases
- Multi-federal state steering of BIM implementation and the measurement of BIM maturity development by means of transparent criteria
- A specific evolution of the BIM method for federal trunk road construction via a piloting and evaluation programme for step-by-step development of the model guideline for BIM and the recommended actions for BIM
- Initiation of BIM digital twin testbeds for evaluation of BIM in operation based on digital twins of the federal trunk road infrastructure in preparation for the Digital Twins for Federal Trunk Roads Masterplan implementation framework

## 6.1 Phase model for BIM implementation

A three-phase model was developed for the structured and successive rollout and establishment of the BIM method. This phase model (cf. Figure 5) represents the time frame for the required evolution and design of the BIM use cases at Autobahn GmbH and in the federal state authorities with delegated powers.

The BIM use cases will be rolled out gradually within the phases: In the process, the BIM use cases prioritized in advance will be tested for practicality and optimized in BIM pilot projects at Autobahn GmbH and in the federal state authorities with delegated powers. At the same time, additional BIM use cases, which will be evolved in evaluation projects as part of a continuous improvement process (cf. Chapter 6.3), are being tested in preparation for the follow-up phase. The number of projects carried out with BIM is being steadily increased and is, as a basic principle, to include small, medium and large projects.

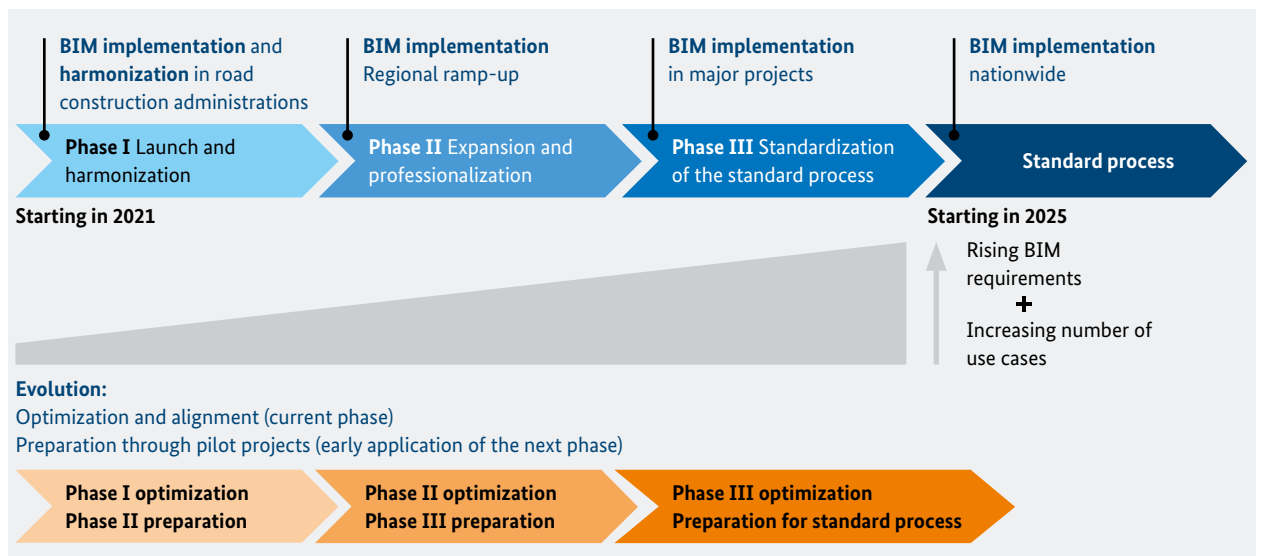


Figure 5: Three-phase model for BIM rollout

The aim is to apply the BIM method comprehensively, uniformly and in a harmonized manner throughout Germany after completion of the third development phase and to transition BIM into a uniform standard process.

This approach takes into account the different levels of experience with BIM at Autobahn GmbH and in the federal state authorities with delegated powers. Accordingly, the first phase can be realized with an affordable initial investment for all parties involved. At the same time, those who already have sufficiently extensive experience in applying BIM can participate in a continuous optimization, fleshing-out and expansion of the requirements beyond the respective phase goal, for example in the context of further piloting and evaluation projects.

The three development phases are described below.

### **6.1.1 Phase I: Kick-off and harmonization (from 2021)**

In the first phase, BIM implementation at Autobahn GmbH and in the federal state authorities with delegated powers is to be strategically and organizationally aligned and driven forward collaboratively.

Building on the infrastructure-specific use cases according to BIM4INFRA2020 and the practical BIM experience at Autobahn GmbH and in the federal state authorities with delegated powers, Phase I will initially push the rollout of jointly prioritized BIM use cases for federal trunk road construction. This is intended to transition BIM implementation to a uniform, standardized basic level throughout Germany.

This phase starts with a minimum use case requirement in line with MG BIM Version 1. Autobahn GmbH and federal state authorities

with delegated powers will be called upon to enhance the experience gained by implementing already trialled and additional BIM use cases in new projects to be started and to put in place the necessary conditions in the organizations. Building on this, Autobahn GmbH and the federal state authorities with delegated powers will initiate the integration of BIM in their organizations and develop an Autobahn GmbH- or federal state-specific BIM implementation strategy based on RA BIM.

Phase I requirements are as follows:

- Uniform application of the BIM method according to MG BIM Version 1 (framework documents)
- Initiation of an individual target agreement process between the Ministry's Federal Trunk Roads Directorate-General and Autobahn GmbH as well as the federal state authorities with delegated powers for use of BIM in projects
- Creation of Autobahn GmbH- and federal state-specific implementation strategies

### **6.1.2 Phase II: Expansion and professionalization**

In the second phase, the implementation measures at the Autobahn GmbH and in the federal state authorities with delegated powers will be expanded and professionalized.

To this end, Autobahn GmbH and the federal state authorities with delegated powers will expand the integration of BIM in their organizations and add further BIM use cases to their projects. During this phase, the BIM method is to be expanded at Autobahn GmbH and in the federal state authorities with delegated powers, where it will be used intensively on a consistent basis. This phase will also be actively used to further develop the MG BIM and RA BIM in preparation for Phase III.

Phase II requirements are as follows:

- Uniform application of the BIM method according to MG BIM Version 2 (framework documents)
- Implement and professionalize the BIM method in all branches/centres
- Coordinated use of BIM in major projects and projects of particular public interest

### 6.1.3 Phase III: Standardization

The objective of Phase III is to complete the implementation phase at Autobahn GmbH and in the federal state authorities with delegated powers. In this way, it is to make available the nationwide uniform MG BIM for comprehensive BIM application in federal trunk road construction projects.

The updated MG BIM Version 3 is available to Autobahn GmbH and the federal states authorities with delegated powers in Phase III, and already allows optimized and consistent use of BIM in all project phases for federal trunk road construction.

The BIM method is to be implemented as standard for all projects at Autobahn GmbH and in the federal state authorities with delegated powers. This is especially true for all new major projects and for projects of special public interest. Final BIM pilot and evaluation projects will be initiated for conclusive validation of the MG BIM and the development of the subsequent standard BIM process.

Phase III requirements are as follows:

- Uniform application of the BIM method according to MG BIM Version 3 (framework documents)
- Universal use of BIM in major projects and projects of particular public interest

- The BIM method is implemented in all new projects

### 6.1.4 Standard process (from 2025)

Implementation of this Masterplan will be complete when BIM is universally used as a standard process at the targeted full development level. For this purpose, the Federal Ministry for Digital and Transport gives Autobahn GmbH and the federal state authorities with delegated powers a standardized nationwide model guideline for BIM (MG BIM standard process). It gives Autobahn GmbH and the federal state authorities with delegated powers a comprehensive and binding framework for the consistent and uniform use of BIM.

## 6.2 Steering of BIM development

In order to ensure that BIM is implemented successfully and in a coordinated manner at Autobahn GmbH and in the federal state authorities with delegated powers throughout Germany, all BIM activities must be managed on a cross-organizational basis and documented using transparent criteria. To this end, the systematic establishment and ongoing development of BIM expertise at Autobahn GmbH and in the federal state authorities with delegated powers are important components of this Masterplan. To ensure that steering is cross-organizational, the following steering mechanisms will be established in the course of BIM development, taking into account the respective organizational sovereignties:

- **Coordination of BIM implementation in the official BIM meetings of the Federal Government and federal state governments**  
To steer and coordinate the overarching BIM implementation process in federal trunk road construction, the Ministry set up the official BIM meetings of the Federal Government and federal state governments in 2018. The BIM rules of procedure provide binding regulations for the organizational cooperation between

the Federal Ministry for Digital and Transport, Autobahn GmbH, the federal state authorities with delegated powers and BIM Deutschland for implementation of the BIM method in federal trunk road construction. It is the top-level BIM decision-making body for federal trunk roads. With its steering group and programme structure, it makes a significant contribution to the coordinated and cross-federal state development and implementation of the BIM method. Through the close cooperation between the Federal Government and federal state governments and the involvement of industry, research and the scientific community, the Ministry ensures an enduring exchange of experience and knowledge building among the stakeholders involved. Findings from project work, from the strategic organization of Autobahn GmbH and the federal state authorities with delegated powers, and on the basis of market developments will thus continue to be compiled centrally on a regular basis.

- **BIM maturity assessment at Autobahn GmbH and in the federal state authorities with delegated powers**

The ongoing development of BIM expertise at Autobahn GmbH and in the federal state authorities with delegated powers is an important component of this Masterplan. Accordingly, an evaluation scheme is being developed to analyse the BIM maturity level. In this scheme, the current degree of implementation is identified for each BIM project – based on the model guideline for BIM and, for specific organizations, on the recommended actions for BIM – using standardized questions. As we progress to the next phases in the transition to a standard process, the level of implementation is identified in increasing detail. In this way, the development can be tracked and, if necessary, corrective measures can be taken to ensure that the BIM development continues.

- **Establishment of a target agreement process between the Federal Ministry for Digital and Transport, Autobahn GmbH and the federal state authorities with delegated powers**  
At the beginning of each development phase (cf. Chapter 6.1), individual target agreements are concluded between the Ministry, Autobahn GmbH and the federal state authorities with delegated powers in order to flesh out the requirements from Phases I to III and define them in a binding manner. They include, for example, the number of projects to be carried out, participation in the Federal Government's BIM evaluation projects, or the respective targeted BIM maturity level at Autobahn GmbH and in the federal state authorities with delegated powers.

### 6.3 Evolution and harmonization of BIM via pilot and evaluation programmes

The model guideline for BIM and the recommended actions for BIM (MG BIM and RA BIM) must be assessed with regard to their practicality on small, medium and major projects and continuously adapted and expanded throughout the implementation process. For this reason, the Ministry will continue and evolve the pilot project practice that has proven itself in the Road Map. As part of the Masterplan, a BIM pilot and evaluation programme will be set up in each development phase (cf. Chapter 6.1).

- **Pilot programme:** The use cases for phases II and III as well as the standard process are being developed in suitable pilot projects. This is based on the latest version of MG BIM. Within the pilot projects, on the one hand, the BIM use cases already deployed are assessed for practicality and lessons learned are collected as findings. On the other hand, further BIM use cases are being tested in preparation for

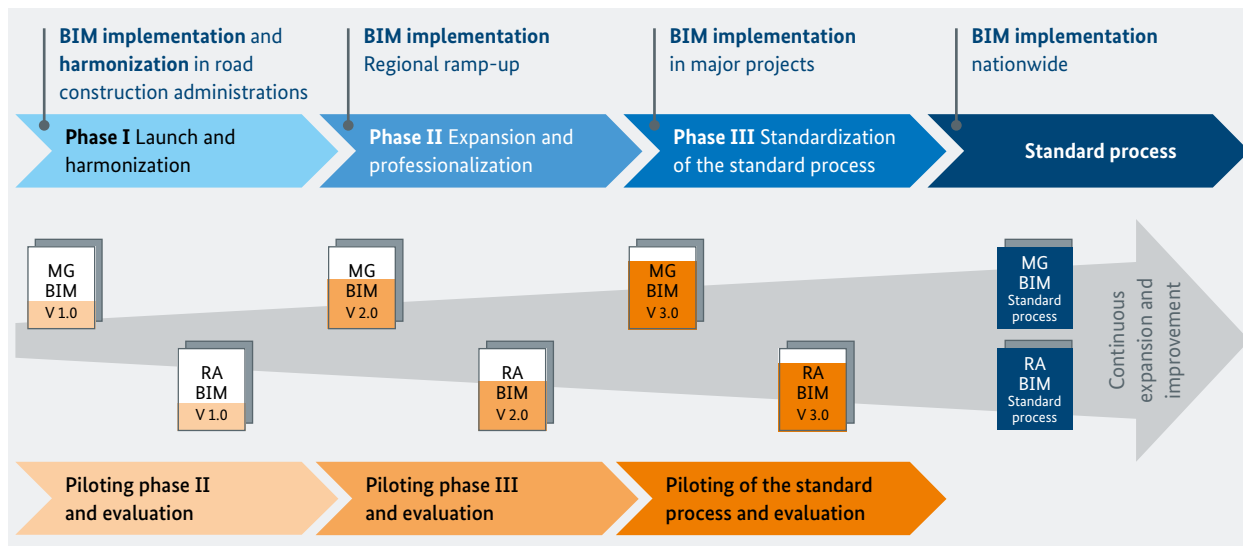


Figure 6: Phased development of MG BIM and RA BIM

the follow-up phase. The findings and new developments feed back into the evaluation programme. The BIM maturity level is measured after completion of each pilot project.

- The findings from the pilot projects are combined to form evaluation projects based on specific topics in the evaluation programme. The MG BIM and RA BIM will be systematically evolved in the course of this continuous improvement process. Furthermore, additional BIM use cases will be standardized within the evaluation projects in preparation for the follow-up phase. In each development phase (cf. Figure 6), the MG BIM and RA BIM will be published in a new major version as a result of the continuous further development and improvement process.

## 6.4 BIM digital twin testbeds

In order to achieve the vision for the future of 'planning, construction, maintenance and operation on the basis of digital twins' (cf. Chapter

3.1) and to identify the potential and innovations of digitalization in federal trunk road construction in a targeted manner, the Ministry will support Autobahn GmbH and the federal state authorities with delegated powers in establishing BIM digital twin testbeds. A BIM digital twin testbed is a digital twin of existing physical infrastructure on federal trunk roads with an appropriate route length and complexity to pilot a wide range of use cases and innovative technologies. The aim is to derive the digital developments and innovations required for the operational phase and, for example, to verify the possible combination of classic construction supervision and Internet of Things-driven construction and condition monitoring in an overall outline. The digital twins are built, tested, evaluated and evolved under real-world conditions. What is more, immense impetus for market development can be expected – i.e. dynamic research and development will be triggered. A nationwide masterplan for the establishment and operation of digital twins will be derived from the results of the BIM digital twin testbeds.

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## 8. Abbreviations

BAP	BIM progress schedule
BAST	Federal Highway Research Institute
BIM	Building Information Modelling
BIM-TDZ	BIM digital twin testbed
BMDV	Federal Ministry for Digital and Transport
BMI	Federal Ministry of the Interior, Building and Community
CDE	Common Data Environment
CO <sub>2</sub>	Carbon dioxide
DEGES	Deutsche Einheit Fernstraßenplanungs- und -bau GmbH (German Unity Planning and Construction Company for Trunk Roads)
EIR	Employer Information Requirements
FGSV	Road and Transportation Research Association
GmbH	Limited liability company
IFC	Industry Foundation Classes
ITKo	IT Coordination Group
MG BIM	Model guideline for BIM
RA BIM	Recommended actions for BIM
RAB-ING	Guidelines for Drawing up Design Drafts for Engineering Structures

# References

Azhar, S. (2011). *Building Information Modeling (BIM): Trends, Benefits, Risks, and Challenges for the AEC Industry. Leadership and Management in Engineering.*

Baldwin, M. (2019). *Der BIM-Manager: Praktische Anleitung für das BIM-Projektmanagement. (The BIM Manager: Practical Guide to BIM Project Management.)* (M. u. GmbH, eds.) Berlin - Vienna - Zurich: Beuth Verlag GmbH.

Berg, H. (2017). *BIM for Infrastructure through the lifecycle - How governmental BIM and VDC requirement is pushing the Norwegian infrastructure business.* Copenhagen.

BMVI. (2015). *Construction of Major Projects Reform Commission.* Berlin: Federal Republic of Germany.

BMVI. (2015). *Stufenplan digitales Planen und Bauen (Road Map for Digital Design and Construction).* Berlin: Federal Republic of Germany.

Deutsche Bahn AG. (2019). *Implementierung von Building Information Modeling (BIM) im Vorstandsressort Infrastruktur der Deutschen Bahn AG. (Implementation of Building Information Modelling (BIM) in the Infrastructure Division of Deutsche Bahn AG.)* Berlin: Deutsche Bahn AG.

EU. (2017). *Handbook for the introduction of Building Information Modeling by the European Public Sector.* Brussels: European Union.

Fischer, M., & Drogemuller, R. (2009). *Virtual design and construction.* In P. Newton, K. Hampson, & R. Drogemuller, *Technology, Design and Process Innovation in the Built Environment.* United Kingdom: Routledge.

Hamburg Port Authority AöR. (2019). *BIM-Strategie: Digitales Planen, Bauen und Betreiben (BIM Strategy: Digital Design, Construction and Operation).* Hamburg: HPA.

Sen, S. (2012). *The Impact of BIM/VDC on ROI, Developing a financial model for savings and ROI calculations of construction projects.* Stockholm: KTH University.

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