

CREATION OF DIGITAL BUILDING DOCUMENTATION BY THE BUILDING TRADE

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For the sustainable and efficient use of buildings, the construction and real estate industry needs the relevant data for the operation of the installed building products and technical systems. In the course of digitization in the construction industry, Building Information Modeling (BIM) is a promising solution for this, which can be used to link product information with a 3D data model, among other things. In Germany, the building trade plays a central role in the creation of building documentation. Efficient and sustainable building documentation contributes to the achievement of the UN's Sustainable Development Goals, making documentation even more important. In the course of this, the topic of sustainability in the construction industry is assigned greater importance, as concrete templates must also be created for the documentation and evaluation of construction products from a sustainable point of view. As part of the research project "BIM Use Cases in the Building Trade", templates for creating building documentation are being developed in collaboration between the BIM Institute at the University of Wuppertal, the Fraunhofer Institute for Factory Operation and Automation IFF and a total of 14 practice partners. These can then be used by public clients as a basis for client information requirements. In addition, an advanced training concept for the building trade is being developed, which can be used to create model-based building documentation with high efficiency.

Keywords: As-built-model, As-planned-model, BIM, Building products, Product Information, Sustainability.

1 INTRODUCTION

Digitization in the construction industry is leading to changes in working methods and project execution that offer potential for all stakeholders. Building Information Modeling (BIM) is an approach to digitization in the construction and real estate industry that can help optimize costs, schedules and qualities as well as achieve sustainability goals (EUBIM 2017). Currently, BIM is mainly used by clients, architects and engineers to optimize planning processes in construction project management. The building trade, which can perform services on the basis of information from the BIM model and also provide information on the building products and materials used, has so far hardly been taken into account in this consideration (Becker 2021). However, linking building product information with the associated component in the BIM model offers great potential for the construction and real estate industry. Thus, with the support of the building trade, an as-built model can be created as a continuation of the as-planned model.

The sustainability of buildings is a goal of the Sustainable Development Goals (SDGs) of the United Nations (United Nations 2015). In addition, a sustainable construction industry directly or indirectly influences 13 of the 17 SDGs and thus forms a key role (DGNB GmbH 2022) BIM can make a significant contribution to achieving these goals. Updating the BIM model with information on actual building products and used technical equipment promotes

e.g. sustainable operational management. In addition, the model-based documentation of the installed building products and materials forms the basis for their sustainable use throughout the life cycle phases of buildings. In the future, used building materials can be recycled or reused as secondary building materials in the form of urban mining based on the product information. (Koutamanis *et al.* 2018) The increasing spread of BIM also has an impact on education and training in the construction industry. It is expected that the use of BIM will increase the demands on the skills and knowledge of specialists in the construction industry. (Egger *et al.* 2013) This requires appropriate concepts to enable all participants equally to implement the specific BIM Use Cases correctly.

2 STATE OF THE ART

BIM is a working method used in the construction and real estate industry to improve work processes and methods throughout the value chain (Federal Ministry of the Interior 2021). This includes project preparation, planning, execution, management and deconstruction of buildings. BIM combines information and data in a 3D building model to avoid media breaks between planning, execution and operation. The goal of BIM is to continuously capture and manage information and data using defined exchange formats and make it available to all stakeholders (Federal Ministry of the Interior 2021). Frequently, information and data are available digitally in construction projects, but they are rarely requested correctly or are only provided in paper form as part of classic construction documentation. This leads to the operator having to laboriously search out relevant information and data from the paper-based documentation (Federal Ministry of the Interior 2021). The building trade has an important role to perform in the recording and digital processing of information during construction. In order to ensure data quality across all services, digital building documentation that has to be as standardized as possible is required. The BIM Master Plan (Federal Ministry of the Interior 2021) for Federal Buildings of the Federal Republic of Germany provides for BIM Use Case 190: Building Documentation, which focuses on the creation of an as-built model containing all relevant information on building products and technical installations. DIN EN 17412-1 has introduced the term Level of Information Need (LOIN) in order to take into account the depth of information needs for the respective stakeholders and their purposes and to provide only the relevant information within the digital building documentation (DIN EN 17412-1 2022). However, currently there are no standardized templates that define which information and data are relevant for installed building products, building materials and technical installations and should thus be linked to the BIM model for efficient and sustainable planning, execution and management.

In addition, buildings are tested and evaluated for sustainability using certification systems such as BREEAM, DGNB, HQE and LEED (Cordero *et al.* 2019). The DGNB system has been particularly widespread in Germany since 2017 and also has the greatest anchoring in EU sustainability policy (BNP Paribas Real Estate 2021, Cordero *et al.* 2019). In addition, there is the BNB system, which is mainly used for public building projects and was developed in cooperation with the DGNB (BNB 2022a). Both systems consider different subject areas, including ecological, economic, sociocultural and functional qualities. Each subject area is subdivided into criteria, such as life cycle assessment of the building. Their fulfillment will be evaluated with points (DGNB GmbH 2021, BNB 2022b).

3 METHODS

The research project BIM Use Cases Building Trade has set itself the goal of identifying the BIM Use Cases that offer the greatest benefits for contractors and public clients. For this purpose, 11 of 37 Use Cases were selected from the BIM Recommendation for Action that are particularly suitable for users due to their added value and technical feasibility. (MHKBD NRW 2021) In a workshop with 34 representatives of the building trade and public clients, the

selected BIM Use Cases were further prioritized. The results were recorded in an evaluation matrix, which can be seen in Figure 1.

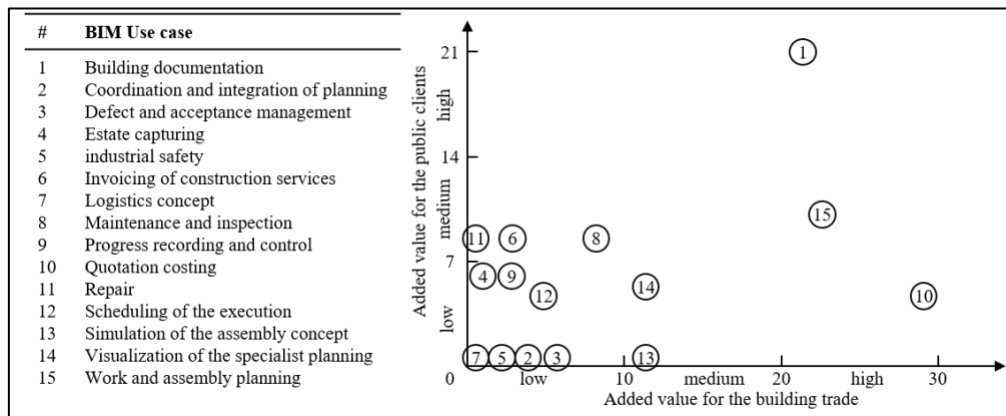


Figure 1. Prioritization of BIM Use Cases (own illustration).

The digital building documentation has been rated with 21 points each and thus represents the BIM Use Case with the greatest added value for both parties. It is defined as follows:

"The digital building documentation (DBD) is the sum of all documents and properties with associated links to the BIM model, which are generated and used to fulfill or perform all tasks during the entire life cycle of a building." (KBOB; IPB 2016).

Building documentation can be divided into the areas of project documentation (PD), object documentation (OD) and archive documentation (AD). This follows the Coordination Conference of Building and Property Bodies of Public Building Owners in cooperation with the Interest Group of Private Professional Building Owners (KBOB; IPB 2016). Thereby object documentation is divided into construction object documentation (OD-C) and technical systems documentation (OD-TS). In the context of the research project, object and archive documentation will be examined in more detail, as this is where the building trade can make a significant contribution, and divided into three BIM Use Cases:

- DBD - Revision documents for building trades (construction)
- DBD - Revision documents for construction trades (technical systems)
- DBD for the verification of sustainable construction.

To analyze the relevant documents and properties for the preparation of the revision documents, lists of documents from public clients and construction companies were compared with each other. Based on the analysis, a coordinated list of documents (see Figure 2) was divided into OD-C, OD-TS and AD and assigned to the service areas of executing trades. Relevant properties for technical installations were also identified to enable media-interruption-free operation and access to relevant information for maintenance and servicing work via the BIM model. The lists of documents for construction documentation and technical systems documentation were designed to have the same structure and to allow project-specific adjustments to be made by the client. The client can use drop-down menus to specify which documents and features have to be linked to the BIM model and at which level of the model structure the link should be made. The DGNB and BNB certification systems, which are the most widely used in German-speaking countries, were used to identify the documents and properties required for proof of sustainable construction. The sustainability criteria of the systems were examined, quantified and prioritized in terms of their relevance and feasibility for construction companies. The resulting documents and properties were discussed and aligned in personal expert interviews with representatives of DGNB and BNB to capture the intersection of identified documents and features from both systems.

4 RESULTS

The lists of documents for the documentation of the construction and technical systems have been designed in such a way that they have the same structure and project-specific adjustments can be made by the client. The client can use drop-down menus to specify which documents and properties have to be linked to the BIM model and at which level of the model structure the link should be made.

Cost group 420 - Heat supply plant					
CG 421 - Heat production plant CG422 - Heat distribution networks CG 423 - Space heating surfaces CG 424 - Traffic heating surfaces CG 429 - Other for CG 420					
Grouping	Document type	Properties	Is required by the client?	Delivered by?	Assignment to the model structure:
Specialized contractor information	Specialist contractor declaration	Entrepreneur information (name, address, contact details)	Yes	Contractor	Project
	Specialist construction manager declaration	Site manager details (name, address, contact details)	Yes	Contractor	Project
Product data	Product sheet	Manufacturer information (name, address, contact details) Type designation Item number	Yes	Contractor	Object
	System and functional description	Installation date	Yes	Contractor	Object

Figure 2. Excerpt - Agreed list of documents using the example of a heat supply system (own illustration).

For the determination of the information exchange requirements for the partial application case of sustainable construction, 12 of the 37 sustainability-relevant criteria can be influenced by craft enterprises. For example: Life cycle assessment, Responsible resource extraction, Risks for the local environment.

Table 1. Excerpts from the overview of the proof of sustainable construction (own illustration).

Criterion	Document according to certification system	Requested document	Required properties	Assignment to the model structure
Life cycle assessment	Overview of installed components/materials/surfaces	Product Data Sheet; Environmental Product Declaration (EPD)	Estimated useful life; recovery route; recycling potential	Project
Responsible resource extraction	Self-declaration of the manufacturer about contained secondary raw materials	Self-declaration of the manufacturer about contained secondary raw materials	-	Component
Documentation for sustainable management	Created usage, maintenance and care instructions	Maintenance, inspection, operating and care instructions; maintenance contracts	Maintenance intervals; inspection intervals; required qualification	Project

The result of the intersection of sustainability-relevant documents and properties of both certification systems has been recorded in a tabular overview and serves as a basis for the creation of LOIN tables. An exemplary section is shown in Table 1. It can be seen that not

every document also includes a feature. With the exception of the product data sheet, technical data sheet and safety data sheet, they can thus be assigned to the archive documentation. In the expert interview, key statements were also made about the role of the skilled trades in sustainability certification. The skilled trades have an important role to play, but are currently hardly involved in the process, possibly because of the high costs of dealing with the issue. It is therefore important to raise awareness of the topic among the skilled trades.

Based on the agreed lists of documents (cf. Figure 2) and the analysis of the sustainability criteria, as well as conducting expert interviews with DGNB and BNB staff, the three BIM Use Cases of digital building documentation were described. For this purpose, the current research findings of all BIM Use Cases were transferred into the structure for the description of BIM Use Cases of the VDI/DIN expert recommendation 2552 Sheet 12.1 (cf. Figure 3). In addition to the general description of the Use Cases (Part 1) and the representation of processes (Part 2), this also includes the description of the depth of information requirements (Part 3) in the form of LOIN tables. The description of the BIM Use Cases for digital building documentation can be downloaded from the download area of the BIM Institute of the University of Wuppertal (BIM-Institut 2023).

BIM Use Case	
Digital building documentation – Revision documents of construction trades (technical systems)	
1. General	
Description	The digital building documentation (BWD) - revision documents of building-executing trades (technical installations) is the sum of all documents and features with associated link to the data model, which are generated and used for the fulfillment or performance of all tasks of technical installations during the entire life cycle of a building. <i>Note 1: The revision model can serve as a basis for the operator model.</i> <i>Note 2: The archiving model includes the complete documentation.</i>
Delivery performance / Output	Revision model with all relevant documents required for the construction, management and deconstruction of a building. Archiving model with all documents that are stored for archiving.

Figure 3. Excerpt – BIM Use Case according to the structure of the VDI/DIN expert recommendation (own illustration).

In order to increase the understanding of the Use Case of digital building documentation, the coordinated lists of documents can be issued to the building trade in addition to the description of the BIM Use Cases according to the VDI/DIN expert recommendation.

5 SUMMARY AND OUTLOOK

In the course of the development of the research project so far, the BIM Use Cases with associated information exchange requirements for the three partial Use Cases of digital building documentation have been created. The templates can be used by public sector clients to improve the efficiency of building management and achieve sustainability goals. Likewise, the templates can also serve as initial suggestions for implementing BIM Use Case 190: Building Documentation for Federal Buildings.

In the further course of the research project, information exchange requirements will also be developed for two other BIM Use Cases, which are also intended to represent added value for public clients and the building trade. For this purpose, the innovation path "Digitization/BIM in the skilled trades" took place in September 2022, where interested parties could try out and implement the BIM Use Cases themselves with suitable products. In the final prioritization of BIM Use Cases, building documentation was again named, which once again underlines its importance. Other Use Cases mentioned were "digital measurement/property recording" and "scheduling". In order to enable all participants to implement the prioritized BIM Use Cases, training and further education concepts are also being developed for the

building trade, which are intended to convey both basic knowledge and the practical application of the BIM Use Cases with the aid of hardware and software.

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