Deployment of a Standardized BIM Modeling Guideline for the Planning and Construction Industry

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Abstract –

The BIM method is perceived as a synonym for the digitalization of the construction industry. The application of this method enables most of all, the consistent and uniform information management and therefore affords a more efficient communication and collaboration environment to all participants in the life cycle of the respective property. Due to the essential role of the building data model within the BIM method, the requirements for modeling at each level must be clarified in detail before modeling. Some companies have internally developed and documented those requirements in their own modeling guidelines. However, small and medium-sized companies often cannot afford the personnel capacity to do likewise.

The development and provision of a standardized guideline for the modeling of building data models by a neutral institution in cooperation with partners from science and economy intends to create a general foundation for the building industry in that manner. The aim of this guideline is to deliver a general framework for the creation of uniform and standardized building models. For this purpose, general regulations, such as the instruction for naming conventions, structure of the project models regarding different planning domains, or more specifically the description of the modeling of individual units, are documented. Within the scope of model elements, the guideline provides the identification in different classification systems as well as the description of the geometric representation along the levels of geometry and a detailed enumeration of the information requirements with the allocation of responsibilities for information delivery and integration for each element. Therefore, the application of this guideline for the modeling of a building data model supplies a clean information management as a basis for a consistent data transfer between different project participants. The application of the BIM Modeling Guideline as part of the exchange information requirements (EIR) is conceivable. Moreover, the provision of this standardized modeling guideline could also serve as a basis for further development within institutions.

Keywords –

Building Information Modeling; Modeling Guideline; Standardization; BIM Model; Level of Geometry; Level of Information

1 State of affairs

A successful and consistent application of the BIM method throughout the entire life cycle of a real estate depends to a large extent on the coordination of the parties involved with regard to the exchange of data and its contents [1]. In addition to the necessary level of detail of the geometric representation and the attributes, this also includes the general organization and structuring of the project as well as the various models to be created. As a result of the prominent role of the building data model when using the BIM method as the lynchpin of information management, it is necessary to create a uniform structure and defined contents for building data models and to set standards for the modeling of building data models in order to create clarity and transparency for all project participants. Such a procedure is usually documented within the framework of a modeling guideline [2].

Research has shown that SMEs in particular do not have the personnel and time capacities to create their own modeling guidelines, whereas many large companies have already started to document their own modeling standards in the form of modeling guidelines, which are continuously updated. The modeling guidelines created in this way are to be regarded as proprietary, as they describe the way of working on the basis of own processes and workflows. Furthermore, the depth of description of modeling guidelines must be considered, since the scope varies in from a pure description of the application of a specific modeling software to a detailed description of the data exchange. The use of external modeling guidelines is therefore not necessarily useful or

feasible. This fact also indicates that there is no company-wide uniform understanding in the German construction industry of the relevant content and the necessary detailing depth of a modeling guideline.

If a company was to develop such a specific modeling guideline, it is still possible that it is not or not sufficiently communicated and coordinated with the project participants. For the successful use of a modeling guideline in a BIM project, it should therefore be agreed upon by all project participants prior to the project start [3].

The development of a standard for the modeling of building data models with the essential specifications and a basis of information requirements on the model element level should serve as a basis for project- and application-specific requirements which should be supplemented if necessary. This basis essentially brings about two changes: On the one hand, not every company would have to think internally about the same or similar BIM goals and the modeling guidelines necessary for implementation. On the other hand, additional work would be reduced by adapting or revising the information structures by project participants when transferring or enriching information. Thus, a standard with regard to the involvement of SMEs and a holistic use of the BIM method over the entire life cycle of a real estate would be advantageous.

2 Development of a standardized BIM Modeling Guideline

Within the scope of the research project "Development of a standardized BIM Modeling Guideline" by the BIM Institute of the University of Wuppertal, the authors, in cooperation with the Technical University of Darmstadt and 17 other partners from the economy, are working on the development of a practical approach to the problems described in Chapter 1. The aim is to create a generally applicable modeling guideline, which defines and describes the basic working methods and specifications as well as the contents and the requirements for the contents of a building information model in a software-neutral way.

The business size of the participating companies in the project vary from large companies to SMEs, which provide planning and construction services at the core of their activities, supplemented by software providers with a focus on BIM content and consulting enterprises. This diversified mix of participating companies allows the identification of a comprehensive cross-section of the current handling of modeling guidelines and modeling in the context of BIM in Germany in general. In addition, the composition of the participating partners enables the consideration of a multitude of perspectives of participants within BIM projects. All companies have already gained experience with the BIM method or are actively implementing it. Figure 1 displays an overview on the respective background of provided modeling guidelines from the project partners.

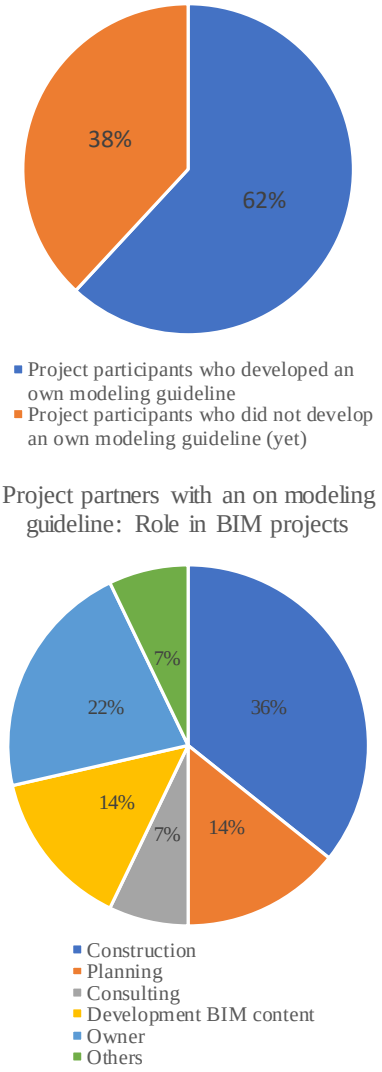

Figure 1. Provided modeling guidelines and their respective background

For the development of the standardized BIM Modeling Guideline, the first step was to analyse the modeling guidelines provided by the project partners, if they have one, and to catalogue content using defined criteria. Some partners, who do not have such a documentation, but implement their own modeling standards, were interviewed for this purpose. The consolidation and analysis of the respective working basis thus provides a view of the best practice currently being lived and implemented within BIM projects and was used as a starting point and working basis for the BIM Modeling Guideline to be created as the project

progressed. The analysis was used to develop an initial definition of the contents and the need for regulation of such a modeling guideline, which was discussed and fixed in an exchange with the project partners: in addition to the description of basic and general principles and specifications for the modeling with the aim of ensuring a clean project and model structure, for example for the coordination of the specialist models of different planning disciplines, content requirements (information requirements) for the building information model to be created are described and additional modeling recommendations are provided. The latter results in a comparison of different working approaches, which can be selected project-specific and according to requirements, for the users, as well as for inexperienced users a simplification of the entry into this complex topic. Considering product neutrality with regard to the use of various modeling applications, the contents are described in such a way that they can always be implemented.

3 Structure of the BIM Modeling Guideline

The BIM Modeling Guideline is divided into a main document and currently into three appendices: the main document of the BIM Modeling Guideline sets a general and descriptive framework around the topic of modeling construction data models using the BIM method. The introductory part of the document describes the motivation and the objectives for the preparation and usage of the document and also clarifies the added value of the application of a (standardized) modeling guideline through cross-institutional standardization of the project and model structure and the model contents. For this purpose, the modeling fundamentals are described with the essential basic principles of model creation, i.e. that the building data model is to be used as the only source for the derivation of plans and documents according to the principle of Single Source of Truth (SSoT), that it is to be modelled according to the actual building process, that the model elements are to be modelled and classified with the appropriate tools and that the data are to be maintained consistently and checked for completeness and correctness before data transfer. In addition to these basic principles, further rules to be considered are listed, such as the handling of model units, schematic representations, labels and regulations, which are particularly necessary for the communication and coordination between non-proprietary authoring systems. These include, naming conventions that must be consistently adhered to for file names, storey definition and the names of model elements and their attributes, or which describe the coordination of the technical implementation of combining different models into one project. Furthermore, the creation of a so-called coordination body is intended to aid bringing together different specialist models to form a central interdisciplinary coordination model, which defines the point of insertion and the reference to the geometric project zero point and serves as the basis for a correct and interdisciplinary quality control. Moreover, modeling specifications on object level for rooms and building elements in general are mentioned, which are especially relevant for a clean geometric mapping and a clean derivation from the geometry, such as that the acidic intersections of the elements or the elements must not be modelled twice. After the description of these modeling definitions follows a list of project-specific aspects to be defined, which have to be agreed upon and documented with all participants before and during the modeling, such as the project structure, the definition of the classification system to be applied or the insertion point.

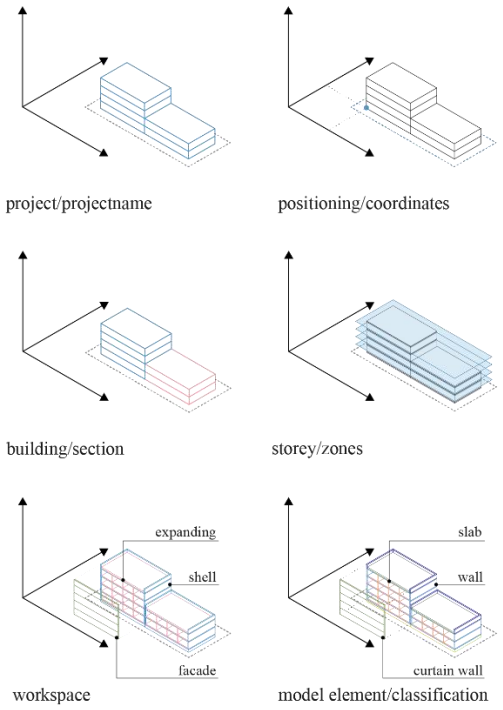

Figure 2. Content of the BIM Modeling Guideline - main document

The main document concludes with some modeling recommendations that have proven themselves in practice, but which are highly dependent on the software and the method (open BIM/closed BIM) and therefore cannot be formulated as a general rule. Topics such as the placement of model elements in the right floors, the extension of vertical and horizontal elements, the handling of multi-layered model elements or baselines are explained and have to be considered.

Appendices 1 and 2 represent user-supporting

documents within the BIM Modeling Guideline: Appendix 1 provides the user with a comprehensive checklist for the definition and documentation of the project organization within a BIM project as an orientation aid. The contents of the main document are divided up and structurally prepared according to the specific topic, so that the project group can implement it quickly and easily.

Appendix 2 takes up the necessary designation system (codification) for models and model elements (beyond the respective classification identifiers) described in the main document and offers detailed suggestions for this. A consistent codification of the model elements as well as of the individual models throughout the entire duration of the project enables, among other things, a simplified and transparent data management [4].

Appendix 3 of the Modeling guideline describes the requirements for the model elements of the architecture, both for the geometric and for the informatic representation. The model elements were catalogued and described in detail depending on the respective workspace: In addition to the respective identifiers of different classification systems (IFC, DIN276, OmniClass, Uniclass) and the graphical representation of the model element, a model element-specific list of the geometric level of detail and the information requirements is provided, depending on the level of detail, Level of Geometry (LoG) or Level of Information (LoI). The geometric level of detail therefore describes the geometric representation of the object to be modelled along the LoG scale from 100 to 500 in keywords, also naming contents that are not to be modelled. The information requirements are described in tabular form along the LoI scale from 100 to 500, considering the designation, the data format and the SI unit. In addition, example values are given for each information requirement. A matrix is used to assign the information requirements to the level of detail. An essential aspect to be considered within the scope of the information requirements is the definition of the information supplying (information generating) and information implementing (information modeling) responsibilities. Considering the project-specific constellations of different participants and different scopes of services, these contents are to be defined in a project-proprietary manner. The modeling guideline and Appendix 3 offer suggestions for the respective spheres of responsibility for each information requirement and model element. The information requirements described in this appendix also represent those information requirements which are to be regarded as fundamental, viz. BIM application-neutral. The consideration of BIM application-specific information requirements is therefore not covered by the current status of the BIM Modeling Guideline.

In the further course of the project, a further document will be prepared which describes the requirements for the model elements of the technical building equipment, whereby the structure and design of this catalogue of requirements will correspond to those of Appendix 3.

4 Benefits

As a result of the development, documentation and provision of the BIM Modeling Guideline, a software-neutral guideline for the modeling of building data models will be made available, which aims to enable and establish transparent information and consistent data management. As a result of the description of project-specific requirements up to the detailed processing of the information requirements for each model element, a working and communication basis is also provided, which can be used or taken as a basis for the tendering and contracting of planning services: both contracting parties start from the same point of understanding and communicate a transparent performance picture along the BIM Modeling Guideline, whereby the understanding of both the expected and the owed performance can be discussed and defined more clearly than ever [5].

Due to its general nature, the BIM Modeling Guideline can also be used for all BIM projects that have chosen object-oriented modeling as the basis for information management, whereby the specification of the authoring software used and the associated processes such as the creation of a model, data transfer or communication may be necessary. The present modeling guideline is therefore particularly suitable as a basis for the development of an institutional modeling guideline for the users or the target groups, which usually use software applications already in use due to their own preferences, existing license agreements or lock-in effects. A one-time adjustment of the BIM Modeling Guideline to the own structures therefore leads to a standardization of all future projects. The shortage of resources of many SMEs for the documentation of their own modeling standards in their own modeling guidelines, as described in Chapter 1, is significantly reduced by the provision of the BIM Modeling Guidelines. This reduced, one-time effort for the adaptation to the own structures is then to be contrasted with the synergy and efficiency effects in future projects.

5 Outlook

In addition to Appendix 4 (Catalogue of Requirements for Model Elements of the Technical Building Equipment) already mentioned in Chapter 2, the BIM Modeling Guideline is to be used and validated in various pilot projects. For this purpose, the authors are in

contact with some of the project participants and other external parties interested in such an implementation. The knowledge und results gained in the course of the practical application enables a determination of the quality, applicability and practicability of the current state of work, which in return allow the derivation of indication and control measures for a revision of the BIM Modeling Guideline. The application in pilot projects promises, beyond the improvement of the quality of the documents, an increased acceptance of these documents, since the BIM Modeling Guideline would thus already be tested in practice in the first stages.

In the further course of the project, the developed modeling guideline is to be transferred to a database in order to make the content more flexibly available. In addition to the provision of the entire modeling guideline (as currently available), the possibility of exporting specific subsets of information requirements via various filters is to be created. By processing the data and integrating these filters, the infrastructure to provide BIM application-specific data packages is created. In this way, it is possible to export exchange requirements per BIM application according to requirements, or conversely, to derive BIM application-specific modeling guidelines. This last step is optional in the context of this project, since the definition of information requirements per BIM application is not part of the project.

Based on the creation of the database and the possibility to output structured data, the aim of the project is to transfer the information into various modeling software. For this purpose, the import requirements for each modeling software are currently being analyzed and the resulting structures are being set up in order to be able to implement such a mapping of the data in the target system. The development of this communication bridge between modeling guidelines (database) and modeling software results in an added value for the user of the BIM Modeling Guideline due to an automated, requirement-oriented mapping of necessary information requirements per model element.

Furthermore, the development of model review rule sets, for example for model checker applications, based on the defined requirements according to the BIM Modeling Guidelines, is to be implemented on the export of the mentioned structured data. The authors are currently analyzing the model import and the systematic structure of the test data and already available model review rules of various applications. As a result of the generation of model review rule sets based on the contents of the BIM Modeling Guideline, the user is enabled to review a model created or received at different points in time of the project (depending on agreed or defined levels of detail) for completeness and/or correctness. The client is thus given the opportunity to track the actual state of work of the planning project participants and to initiate corrective measures if necessary.

6 Notes

As a result of the ongoing project work, updated versions of the modeling guideline including all appendices are developed and made available. When applying the modeling guideline, it is therefore recommended to check that the respective version is up-to-date before using it and to exchange respective documents if necessary. The latest version of the documents can be downloaded free of charge in German language from the authors' homepage.[1]

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