

## **BIM – PROCESSES – REALIZATION**

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BIM describes a method to integrate and connect all relevant, building related data into a virtual data model over the whole lifecycle. The superior goal of all BIM-related research projects at the Chair of Construction Management and Economics is therefore to advance the efforts of data model standardization and the corresponding flow of information between all participants involved in a building project. To identify all relevant data, the focus of each project is hence directed to the question who needs which information from whom, how, when and what for. The Project "Development of requirement specifications from the point of view of the construction execution" aims to answer the question, which requirements have to be placed referring the data model in the planning sphere in regard to the content and level of detail, so that this data can be effectively used in the construction sphere. Thereto a detailed analysis of the actual processes of the construction sphere will be conducted, taking into account software-systems available on the market. The aim of this analysis is to standardize the actual processes and to evaluate, which data are necessary in each process.

*Keywords:* Building information modeling, Digitalization, Information delivery, Requirement catalog, Process-orientated method, Modern technologies, Construction, Implementation, ISO 19650.

### **1 OBJECTIVES**

The digitization of the economy has been progressing steadily for several years, also in Germany. With regard to the building sector, the main focus is on the method of building information modeling. Compared to other countries, the implementation of the method has not been applied so far in Germany. Against the background of optimizing the effectiveness and efficiency and strengthening the competitiveness of the associated construction and real estate industry of Germany - even in international comparison - the implementation of the BIM method is also essential during construction work (Bauindustrie NRW 2014). More and more information is being generated and stored digitally to improve the processes in the respective work steps. However, they are often not designed for further use in downstream phases. In practice, companies have to put the information into their systems and adapt it to their needs (Helmus 2014). However, the development of standards for the BIM-based processing of projects is necessary to ensure that the methodology can also be used across the board - for example, in construction work (ARGE BIM-Leitfaden 2013).

The research project "Development of requirement specifications from the point of view of the construction execution" is part of a longer-term overall concept to be set up. The aim is to promote the standardization efforts of building data models with regard to processes and the

associated flow of information between the project participants in all lifecycle phases. At the same time, this will help to create transparency with regard to the BIM method for those involved in construction. Within the framework of the section "Development of requirement specifications from the point of view of the construction execution", the focus is on the phase of the realization of buildings. The objective of the project is to formulate both, contentual and structural requirements with regard to the information to be delivered to the upstream lifecycle phases of the real estate. (International Organization for Standardization 2016)

## **2 RESEARCH DESIGN AND METHODS**

According to the definition of the University of Wuppertal (BUW), the lifecycle of a real estate consists of five phases: development, design, realization, operation & maintenance and demolition. Within these phases, new information is generated from various roles from various information sources.

The extensive consideration of all these phases is not feasible in a single research project. For this reason, the BUW has decided to subdivide the lifecycle of a real estate in a structured manner and to develop the respective sub-areas in independent research projects which are always interlinked. Through the close networking, synergies can be used as best as possible and a broad knowledge foundation can be established. This enables the chair of Construction Management & Economics at the BUW to publish the gained findings in a targeted way in the general public, thereby continuing promoting the digitization of the real estate value chain.

In the following, the above-described linkage of the research projects is presented and explained for the currently running projects in each case. The division takes place on the one hand after separation in the sequence of phases or activities (horizontal axis). On the other hand, by means of the classification of the process detailing levels - subdivision of a process in subprocesses (vertical axis).

- **BIM - Processes - Lifecycle** covers the overlapping frame over all phases of the lifecycle. The processes are viewed in coarser detail levels primarily from the point of view of the overall role of the building owner / operator.
- **BIM - Processes - Realization** considers the phase of the realization and the resulting requirements for the upstream and downstream phases of the real estate lifecycle. The processes are viewed in deeper detail from the perspective of the execution companies in that the information to be exchanged within the value chain with the other project participants (for example in files or documents) is further splited up. The aim is to draw up the requirements for this partial information.
- **BIM - Processes - Work Planning** considers the step of the work planning of small and medium-sized enterprises (SMEs) in the implementation phase.
- **BIM - Processes - Health and Safety** considers the planning, realization and operation phases from the specific point of view of occupational health and safety. The processes are viewed over all process levels and integrated into the overall landscape.
- **BIM - Processes - Demolition** considers the phase of demolition and the resulting requirements in terms of the material cycle. The processes are viewed in deeper detail from the point of view of the demolition and recycling companies.

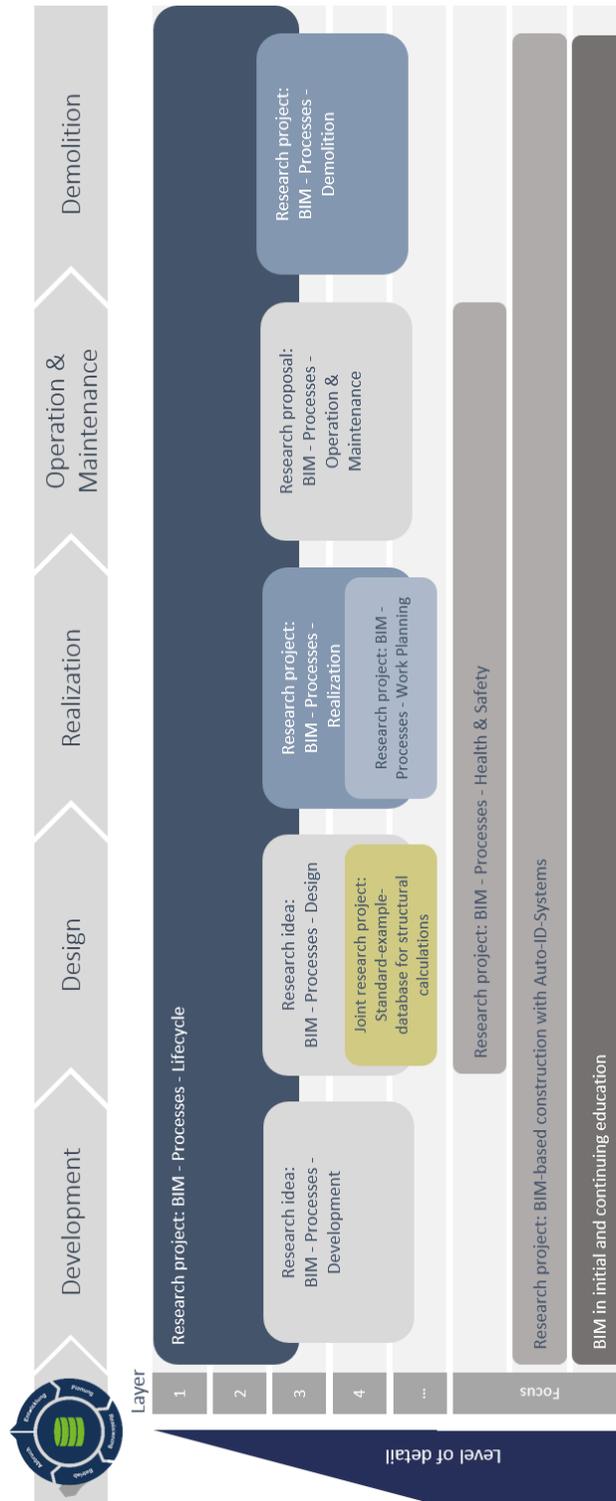


Figure 1. Integration of the BUW research projects in the real estate lifecycle.

On the basis of initial literature research and subsequent expert interviews, the respective research projects have brought together information from which basic principles have been developed. Based on this, the project teams use the information in a database-based BPM software. It enables a central collection of the entire knowledge and thus ensures that the described overall concept can be implemented. Finally, the gained and implemented findings are verified by the practice partners.

### **3 RESULTS**

On the basis of the defined real estate lifecycle phases, processes from specific points of view were standardized and displayed in the common process map. This was used to investigate the extent to which the processes change by implementing the BIM method.

Even with the actual processes, a consistent, continuous flow of information can be generated. This allows the required information to be linked to an associated process as input and the condition that each process produces exactly one output. Thus, the processes recorded so far represent a human process flow (independent of auxiliaries), which cannot be changed in principle for the introduction of BIM. Through the digitization, only parts of it are supported or carried out with the help of the IT, thus supplemented by a technical process and requirements.

The IT-supported or semi-automated handling of processes requires more stringent regulations on storing information etc. This is because the automatisms are based on pre-programmed queries, which can only cope with the situations that were taken into account during programming. This increases the complexity with regard to the planning of the information flow. In terms of construction, this is described by the so-called BIM information management process. It describes aspects which have to be clarified for a smooth flow of information in advance. In order to transfer the actual processes into the BIM target process, it is therefore necessary to identify the locations in the existing process map that are used to clarify the aspects taken up in the information management process and to insert the respective sub processes of the information management process into the process map. The BUW BIM information management process is validity gained by different workshops with various national parties of the real estate lifecycle. The frame of the BUW information management process is also in accordance with the still not published international BIM information management process ISO 19650.

To clarify the questions in the information management process, the project participants must initially set up their requirements for both the human and the technical process. The collaborative process landscape of the BUW considers this with BIM targets, BIM uses and BIM requirements, which together result in the so-called BIM application container. The information to be entered there from the relevant viewpoints is used for the corresponding research projects, as described in Chapter 2. Based on this, lists can be derived as a basis for the establishment of the information management process and various other information for the most diverse tasks.

The project **BIM - Processes - Realization** investigates the requirements of the execution companies out of BIM-uses with regard to the data transfer to the project partners in the preceding lifecycle phases. Examples of such BIM-uses could be:

- BIM-based storage space management and calculation
- construction progress visualization
- automated progress tracking

Based on the findings of the above-described steps, requirement-catalogs are to be drawn up from the point of view of the executors to other project participants. The focus, similar to the

process recording, will be on the information flow, i.e., the provision of the required information from previous processes. The catalog will be adaptable, filterable and differentiated depending on the sub-process area under consideration by direct generation from the process landscape. In this way, it can be used as a support for the entry of companies - also SMEs - into the BIM method as well as the basis for the design of corresponding contracts.

Definitions of requirements in general and of construction work for the implementation of the BIM method will serve as the basis. The latter provision embodies the summary of the needs of accomplishing companies, some of which are already apparent from the expert interviews. It is necessary to differentiate the general requirements of the general public from those which were mentioned in the expert interviews, but which are related to company-specific procedures such as the BIM-based calculation using a specific software. The concrete assignment to the existing general processes from the created process map can ensure that the recorded requirements are not company-specific.

Assigning requirements to explicit activities requires compliance with the consistent structure of an extension of the established criteria for the collection of needs. For this purpose, existing considerations, such as the classification into formal, structural and contentual requirements, are concretized and defined.

In addition to the structured implementation of the requirements in the process map, programmed queries are necessary in order to be able to retrieve the distributed information bundled for a specific purpose (e.g., requirement-catalogs). The structure of these automated extracts is carried out as soon as the provisions on the extended process structure have been developed. An earlier start is not useful, since only from that point in time it becomes clear where and in which form the information will be stored in the database. To what extent a detailed description of the structure of the queries in the specific software is appropriate for the final result of the research project, the authors cannot yet estimate at the present time. However, the following generalized procedure and the excerpts produced are described in detail by means of examples in order to make the results available to the public in a comprehensible manner.

#### **4 CONCLUSION**

Over the next few years BIM will appear to be well established. In doing so, the processes as a basis for the planning of digitally supported or fully automated processes will inevitably gain in importance. To this end, standardized process models, such as the process landscape developed by the BUW, will serve as a basis for the specific situations in companies and projects to be displayed more quickly. The process landscape of the BUW is best suited for this task, since you describe the human processes in general. In addition, due to the structured structure, you can flexibly adapt and expand.

The essential basis for the implementation of BIM is to implement the process landscape as well as the will of the industry and the acceptance of the employees. In the practice of construction, implementation variants have already been developed and tested in first steps, such as the provision of tender preparation. The intensive investigations of the subject area have shown, however, that the input information is mostly not suitable for immediate further processing. Therefore, the creation of the requirements catalogs represents a gap closure in the digitization of the value chain of construction.

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