BIM Technology and Changes in Traditional Design Process, Reliability of Data from Related Registers

Kristýna Prušková 1

1 Faculty of Civil Engineering, Czech Technical University in Prague, Thákurova 7/2077, 166 29, Prague, Czech Republic

kristyna.pruskova@fsv.cvut.cz

Abstract. With the new technology of creating building design, many changes of traditional processes have to be set in order to reach project documentation and project design itself in higher quality level. As a traditional project documentation is changing in “digital twin” of building work, the way of building work design changes too. Building design and project documentation do not serve only for the building construction, maintenance and operation. Project documentation is the output, also the input – both at the same time - in connection with further building legislation, landscape planning, etc. BIM model, nowadays the highest quality of project documentation, should communicate with many related registers. Important basic information is as an input for the project design, afterwards information from the project design should be reflected as an output for the enlisting in related registers. Due to the absence of efficient digitization of the construction industry, the relevancy, correctness and reliability of information in the related registers is not very high in the Czech Republic, at this time. Digitization of construction industry and implementation of BIM technology promises many benefits. The magnitude of these benefits depends on how the data exchange is modified in the construction process during the whole building lifecycle. This paper reveals possibilities of basic principles of the new way of design using BIM technology, connections of BIM model data and related registers and their data exchange in the environment of Czech Republic’s legislation. The more correctly processed the model of the building work, the better and more reliable information for future designs.

1. Introduction
The objective of this paper is to outline the current system, to highlight the needs of change and present opportunities. Current work on the building design proceeds in a somewhat complicated way. At the beginning of the project design is the basic idea of the investor. This idea describes the basic characteristics of the proposed building, such as volume, shape, but also the purpose of the building, etc. Then follows the work of the architect / chief designer and other participants in the construction process, who elaborate the design in detail. The design part of the construction process usually involves several participants. Their work must be coordinated to achieve the right and quality output effectively. In the traditional design process, this coordination is very complex and time-consuming [1]. However, before this process, pre-project preparation must be carried out, including a feasibility study of the project idea. The building idea gets a more precise form of a certain compromise between the requirements of the investor, the architect and thus the legislation according to the priority of requirements [2].
The feasibility of the construction itself is first compared with the legislative requirements and requirements that are determined by the land use plan and its similar tools. To achieve this, it is necessary to obtain all input information. Therefore, the quality of the project design depends (among other things) on the quality of input information: its reliability and accuracy. When the project design is created, permitted and constructed, the building work itself (and also its project documentation) becomes a part of “built environment”. It means that the building work, here the project design, is an output containing information describing the built environment and becoming input information for further building designs.

2. Input information / documentation
Basic input information is extracted from Spatial planning documentation. Spatial planning documentation consists of spatial development principles, land use plan and regulatory plan. Spatial planning documentation is issued in the form of measures of a general nature pursuant to the Administrative Code. Other input information is taken from registers. Their retrieval in the traditional way of designing is done more or less by manually searching the registers. These registers include mainly Register of territorial identification, addresses and real estates, as well as Cadastre and property registers. Furthermore, the selected system of building registration or "Building Identification Number" also plays an important role in the classification of buildings.

The reliability of the input information is closely related to the quality of its processing and also in the form of recording and receiving this information. While the traditional way of designing works with information in a not-too-digitized form, and its transfer is inaccurate, with a possible error rate, BIM technology, due to its high precision digital models - digital twins make inaccuracies and mismatches almost impossible. Another factor increasing the quality of input information processing within the BIM technology is also the way of data transfer. The possibility of automatic processing of digital data will not alter the information that can occur during manual processing.

3. Specification of Project Documentation
Traditional project documentation (in the Czech legislation according to Act No. 499/2006 Coll., On construction documentation) defines the form and content of project documentation according to individual types of buildings and levels of project documentation, mostly in the form of text and drawings.

3.1. Form of project documentation
The application for a building permit is traditionally accompanied by a folder with paper project documentation. This is then manually browsed by an employee of the relevant authority and the entitlement to the building permission is assessed. BIM Technology presents data as a digital twin of the building, where all information is more detailed.

3.2. Content of project documentation
The content of the project documentation depends on the type of construction and the level of project documentation. Traditionally, the content is indicated by the required drawings and text parts. BIM Technology and Digital twins present the whole model of the building, which means it contents unlimited number of possible drawings (floor plans, sections, views) at the same time.

Traditional form and content of the project documentation lacks any form of digitization of the construction industry within the Revolution of Industry 4.0. This traditional way of creating project documentation, granting building permits, building realization and also building operation documentation is very ineffective. Due to modern trends, larger buildings, as well as the application of many modern technologies, the traditional way of documentation of buildings also gives space for high error rates both in documentation and during construction, not to mention unnecessarily high
environmental burden. BIM technology provides an efficient way of designing in many ways. Today, however, it is not fully defined how to handle BIM technology, yet. Lot of processes has to be set to achieve all positive BIM applications.

BIM Technology presents project documentation as a Digital Twin of the building. The level of detail and level of information are very high. Digital model in BIM can also view any site from any point of view with an overview of the different categories. Due to the accuracy of this information, we can consider the data reliable.

Of course, project documentation in BIM needs to have set other specifications. It’s not just about the data format (ifc, xml, and others), but also about the data architecture and structure, use of suitable codebooks, level of detail and other specifications. Standardized environment for exchanging information in BIM, generally called Common Data Environment (further CDE) is very helpful [3]. The issue is the lack of specification and definition of data containers / packages.

4. Issue of data transfer
During the whole building lifecycle, a lot of data is generated. This data should be updated during the different phases of the cycle. Traditional documentation does not allow this much. BIM technology, however, comes with the possibility to update data in real-time, not only in the sequence of design creation, but also during construction, and especially during the construction operation phase.

Already during the design process of the building, and actually after its realization and use phase, the data are made more precise, further information requirements are created and the project documentation of the construction is further elaborated. BIM technology offers the possibility to more easily incorporate these requirements into the project documentation.

Next to the management of processes in BIM [4] related to the building lifecycle and data transfer [5], it is important to realize that the definition of data containers / packages is necessary to properly interconnect all the entities through which the data for the whole life cycle of the building passes. These containers / packages should contain the form, structure and content of the data to be stored for certain purposes. Described data transfer is pictured in the Figure 1. The scheme of data transfer during the building lifecycle.

5. Output information / documentation and back to the beginning
If there are any input data at the beginning of the construction, it is important to realize that the data output of such a cycle is the construction itself, resp. its exact project documentation. The information and data from this output must be projected into the relevant registers again, where it is the input for further designing of buildings.

6. Reliability of transferred data
This topic doesn’t concern just about new buildings. Mentioned registers often contain outdated and unreliable information about existing buildings. It would therefore be appropriate to carry out also general information in the registers on existing buildings. There are several methods to do this effectively, eg using digital photogrammetry or 3D scanners [6].
Figure 1. The scheme of data transfer during the building lifecycle
7. Conclusions
As revealed in scheme, Reliability of input information is the basic stone of precise elaboration of project documentation and creation of reliable construction data. We talk about the built environment and how this environment affects other project proposals. It is necessary to realize that the data transfer takes place in a circle. Each input information leads to output that becomes part of the built environment and is therefore an input for the further development of that built environment. The built environment is presented in this case curtly in the given registers, which must be adapted to the implementation of BIM not only in their content of data and information, but especially in their management and transfer.

It is therefore essential to work with reliable and accurate information from the beginning for a quality design of a construction work. Building life cycle is a complex scheme that enters many participants in different roles, but above all it is a complex transfer of voluminous data of different character. Only by quality management of the building life cycle is it possible to achieve quality output with accurate and reliable information. Within the framework of this management it is also important to define not only the individual roles of the participants in the building life cycle, but also their communication, which in the world of digitization consists mainly in data transfer.

Acknowledgment
This work was supported by the Grant Agency of the Czech Technical University in Prague, grant No. SGS19/146/OHK1/3T/11.

References
[1] K. Prušková, and J. Kaiser, “Implementation of BIM Technology into the design process using the scheme of BIM Execution Plan,” IOP Conference Series: Materials Science and Engineering, vol. 471, ISSN 1757-899X, 2019.
[2] J. Myslin, and J. Kaiser, “Priority of Requirement and Method for Definition of Project Scope,” Int Business Information Management Assoc, pp. 4002-4013, 2017.
[3] J. Rádl, and J. Kaiser, “Benefits of Implementation of Common Data Environment (CDE) into Construction Projects,” IOP Conference Series: Materials Science and Engineering, vol. 471, 2019.
[4] J. Kaiser, “Process Modeling for BIM,” Central Europe towards Sustainable Building 2016 - Innovations for Sustainable Future, pp. 781-788, June 2016.
[5] J. Rádl, and J. Kaiser, “Information Insufficiency Problems in Construction Projects,” Vision 2020: Sustainable Economic development, Innovation Management, and Global Growth, pp. 5059-5070, 2017.
[6] M. Dědič, “Evaluation of the processes of creating project documentation of an existing building using 3D scanner”, 19th International Multidisciplinary Scientific GeoConference SGEM 2019, vol. 19, pp. 127 – 132, 2019.