UTILIZATION OF DIGITIZED BUILDING DATA AND INFORMATION MODELS (BIM) IN VALUE ESTIMATION OF BUILDING IN RURAL AREAS

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Abstract. The article describes possible utilization of digitalized building data and information models (BIM) in value estimation. There is a continuous need for estimation of buildings, especially in the residential market. This need may vary, depending on the country legislation, but is a natural part of reality market and government policies. The paper focuses on the possible utilization and benefits of BIM especially in rural areas, where external conditions often complicate simple value estimation or make it harder for estimators and therefore more expensive or source demanding. In the first part of the paper, the value estimation necessity and the rural areas specific issues of value estimation are explained. In the second part of the paper, the possible BIM utilization for value estimation is described. In the third part of the paper, examples of such utilization are mentioned. The first example focuses on the commercial price estimation for personal needs, the second example focuses on the tax related value estimation. At the end of the paper, discussion on the topic and conclusions are presented, as there are many obstacles of implementation of such solution and also many other uses. While the necessity and possible savings in the area of value estimation is not a sole driver for BIM implementation and digitalization of construction industry, there are clear possible advantages of using BIM in this area, which might be secondary drivers for support of its implementation on national level.

Keywords: BIM, value, estimation, digitalization, data.

Introduction

Building Information Modelling (BIM) is becoming a widely used method of construction industry digitalization. Although it is already perceived as a necessary and logical step, the market is still somewhat struggling with advocating and especially quantifying its benefits. These are basically tied with increase in efficiency, quality and risk mitigation. While there are metrics for some of the benefits [1], it is still very hard to quantify the added value for many of them. Every possible BIM utilization therefore opens another argument for further push/pull [2] of BIM implementation. Very important part of BIM is not very accurately addressed as "5D", referring to use of financial aspect of building in the BIM data set. While "5D" is more of a buzzword and is very vague, it is still used in the industry. Most of the time it is referred to in the context of construction costs calculations in the realization phase of the construction process. This data category covers much wider area though, and this area is often overlooked and simplified. One part of the area is the main topic of this article – value estimation of existing buildings.

Value estimation

Reality estate market is dependent on value estimation. There are two main aspects of this necessity. The first is commercial driven – owners and buyers of real estates are trying to agree on a price to successfully complete a transaction. For both of them, it is important to know the real value of the building so they can negotiate the owner's profit. The second aspect is usually connected with legislation and taxes. Whether it is the necessity for estimating the value of the building for building transfer, donation, settlement or inheritance or it is motivated by legal actions, there is always a need for value estimation. Such estimation is usually (based on the market and local legislation) carried out according to relevant law or directives. It is usually based on the available information about the estimated building and its surroundings. This information is then used to evaluate the building.

Traditionally, this process is carried out by an expert, who is either experienced and proficient enough to do that (if the law allows it), or by a professional, who can do this kind of work, based on the certificate, authorization or other kind of mandate. These experts have their own methodologies, which did not change in regard to BIM, and they will probably not change anytime soon. What can change, however, is the way how information is gathered, based on available data. In a traditional process the data gathering phase is usually very complicated and tedious, requiring a lot of effort in local site communication, inspection and research. This is true especially for buildings in rural areas, which are harder to reach for the expert conducting the estimate. This, along with the lower value of

rural areas [3] makes them considerably less interesting for evaluators, which are often very hard to find for such regions. A lot of data are often missing too, so the final value is more an educated guess than proper calculation. With the use of BIM, many required data could be used from the model (digital twin or just the database), which would not only lower the time requirements for creating the estimate, but it would also allow a certain degree of automation of this process.

Materials and methods

As a part of the research, review on this topic was conducted. There are plenty of scientific papers dealing with the cost estimation using BIM. Most of these sources only deal with the topic in the context of estimating costs during construction or pre-construction phases. These papers are usually focused on methodological side of the problem (processes in [4], implementation in [5], project value in [6] etc.), some of them are more specific (like [7] on cost estimating, scheduling and project control). The articles, which are referring to operational phase, are focused mostly on specific problems, usually from technical perspective ([8], which is examining railway tunnels and their long term technical state). Some articles also deal with the topic of "5D" on general level (like [9], in context of quantity surveying) or in context of different project phases (like [10], dealing with architectural study), but they were not useful for the purpose of this research. Some articles deal with the systematic approach for using BIM in specific cost related processes ([11] in terms of process modelling, [12] in terms of LCC), but such papers do not deal with the topic of value estimation of existing buildings in the operational phase of the project.

Other materials used for the research are market specific. In the Czech Republic the cost estimation is done according to the law 151/1997 and directives 441/2013 and 457/2017. This law and directives are also extended by some other laws and directives (like law 121/200, 237/2004 etc.), this will be referred to as the evaluation directive. The evaluation directive usually changes a little bit for every year and contains specific terminology and processes for evaluation of assets, it covers buildings as well. Every modern national market has some kind of such laws and directives, which usually vary in degree of detail (they are either specific or very general) and in the methods. The principle of utilization of some data to generate results stays usually the same, though.

Because of the lack of research on this topic and because of the lack of practice in the field of value estimation with BIM, the conducted research was mainly of explorative character. The main aim of the research is to postulate possible BIM use and argument its benefits, along with possible obstacles that need to be overcome. This would lay the foundation for future research on this topic.

The results of the research were confronted with experts on BIM and value estimation. Based on their responses, some aspects of the research were reviewed and in the iterative way adjusted, resulting in the presented results.

Utilization of BIM for value estimation

In the principle, value estimation has three levels, based on utilization of BIM:

- traditional approach,
- simple BIM approach,
- integrated approach.

The traditional approach (Level 1) of value estimation (Figure 1) requires an intensive data gathering process, which often cannot be automated. It also depends on the data sources, which are usually owners, other relevant parties (when applicable), generally available data (like data from the land register etc.) and the building itself. Such data might not always be available (white boxes on Figure 1) and the communication process between the stakeholders might result in many obstacles, making the estimate harder or prolonging the period for its creation. This might be especially relevant for rural areas, as stated in the introduction of this paper.

Figure 2 shows the simple BIM approach (Level 2). It is basically very similar to the traditional approach. If the information model or similarly structured database exists, it should contain majority of necessary information for value estimation, especially data about the estimated building, but also data from other sources. As opposed to the traditional system, there are three main advantages:

1. The data loss during the project life-cycle is lower [13], therefore the information model should contain data, which might be lost or hard to access in the traditional approach.
2. Sharing of the information model should be much easier and convenient for the owner, speeding up the process of estimation.
3. Structured data (as in the information model) are easier to use, which might result in better efficiency of the estimator, thus resulting in the lower price or higher quality.

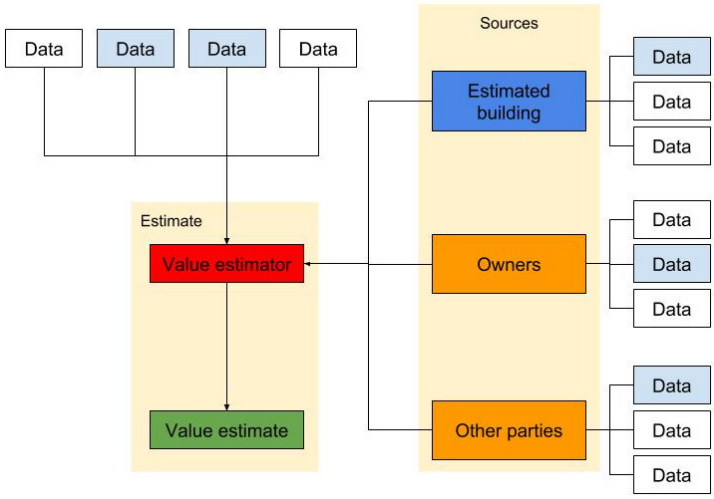

Fig. 1. **Traditional approach (Level 1) schematics**

Unfortunately, using BIM for the estimation process is based on the actual information model existence. Such information model should also contain required data in required structure. It could be valuable for the estimator even if data would be only partial, but its usability would be lower. Levels of utilization of BIM for the explained purpose are therefore fuzzy, stretching the necessity for proper documentation and owner requirements specification during the model creation. In the practice, even models which are not up-to-date are useful. In many cases, the value estimator is creating own estimate for specific date in the past, especially in the law or directives related estimations. Version tracking features of BIM might be beneficial here.

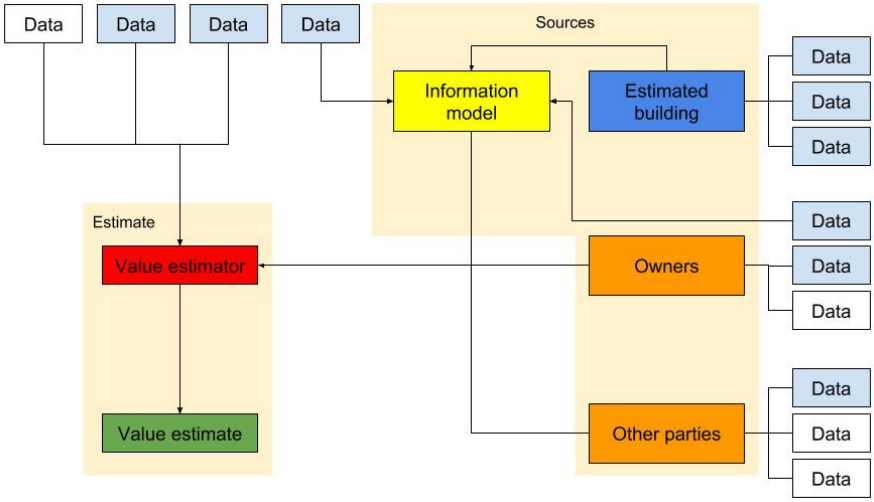

Fig. 2. **Simple BIM approach (Level 2) schematics**

The integrated approach (Level 3) is the most advanced one. BIM is not represented only by a model, but more as a methodology. In this context, to improve the data gathering process, the central repository is necessary. This central repository may be an isolated or shared central or federative (even distributed) database, run by a commercial subject for its own purpose or run by the public sector. This subject would allow access to information models, which would be in the required standard. This is presented in Figure 3. This would, of course, require necessary maintenance and there are legal aspects

to such scheme, but it would improve the possibility to use BIM for estimation even more. Because of the centralized approach, even more data might be conserved and therefore available to estimators. Such concept has even more use for the industry, as a part of the whole industry 4.0 digitalization strategy. Unfortunately, such concept is highly theoretical and currently not applicable in practice.

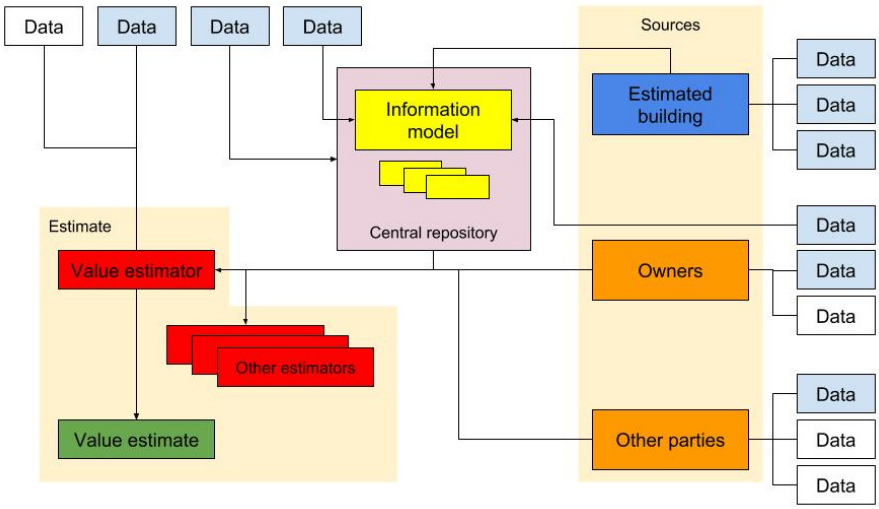

Fig. 3. **Integrated approach (Level 3) schematics**

The level 2 and level 3 approaches could also be used for partial automation of cost estimate. If proper tools and processes would be developed, the side of the value estimator might be completely eliminated or simplified (for example, for estimate certification). This would, on the other hand, require even higher degree of standardization and, of course, relevant tools. This could be perceived as the public sector service, though.

Case examples

The first case example. The owner needs to create the expert estimate for the purpose of selling the building. If there is the information model of that building, he could provide it to the estimator. Estimator can then easily get the idea about the building, while normally it would be necessary to find the data in traditional documentation and blueprints, which are often incomplete. In case the information model is according to the required standards and up-to-date, this would allow the estimator to significantly increase the efficiency, because only other relevant data (like regional price adjustments, externalities, real conditions, owner liabilities etc.) would have to be gathered.

The second case example. The owner acquired a building as a gift. In the Czech Republic, there is an obligation to pay a tax from such gifts, based on circumstances. That is the case of the owner. To calculate the value of the building, he has to find a certified expert to conduct an estimate. This might be very hard, because such registered expert is usually overwhelmed with other more important work related issues. Such estimate also often requires a site visit, which might push the expert even more to the side of declining the request in case of rural areas. The Ministry of Finance of the Czech Republic already identified this issue and addressed it by creating the online tool [14] to assess the value of building for tax reasons based just on data input from the owner. While useful, this tool is still very complicated for use. This tool operates with relatively simple data about the building location, dimensions, used materials, age and the condition of the building. If standardized in proper way, the information model could easily be imported into the system to fill the information on behalf of the user from 70-90 percent.

Results and discussion

While the possibility of utilization digitized building data or information models (BIM) for value estimation in the construction project operational phase is not the main reason for implementation, adoption and use of BIM, it is another possible use of data and added value of using such method.

There are obvious obstacles for successful and systematic value estimation using BIM, but these obstacles are not related to the proposed utilization itself. They will have to be dealt with during the process of BIM implementation in the market, because there are other BIM uses (along with digitalization of construction industry), which will require this. Possible use of BIM for value estimation can be just another argument for speeding up this process, during which it is also necessary to understand the possible use of BIM for value estimation. This way developing standards, practice and other processes can reflect not only the main BIM uses, but also the proposed use for value estimation. Unfortunately, the postulated BIM use is applicable mostly only to residential buildings, as other types of buildings require a different approach, as stated, for example, in [15] and [16] regarding infrastructure construction.

The presented results are the first part of the research, which will be further extended by following steps.

- Field research among experts and value estimators on their understanding of the topic and on the possible rationalization of the research project.
- Technical data requirements specification for different fields for value estimation of buildings.
- BIM interpretation of technical data requirements.
- Further steps of analysis for implementation theoretical knowledge to practice (i.e. software solution, methodical manual, legislation implementation etc.)

In the Czech Republic, the research is currently very much limited by the lack of numerical data. The reason for this is the current absence of existing information models of residential buildings in the required data standard, because it is still being developed. Simple detail specification by LOD or similar is not enough for the described method, as LOD is too vague. Another reason is unprepared data environment as described. Although some of databases do exist on national level, they are not harmonized and they do not allow the user to machine-read them through API or any other way. That is why the human factor is still necessary for conducting the estimate. While paper is describing possible BIM utilization, the actual limit in the Czech Republic is not the BIM itself, but it is more the lack of digitalization in the Czech government. This issue is currently being solved by various incentives on national level and will hopefully allow to present more specific results along with some numerical data as a part of following research.

Conclusions

In the paper, simple overview of possible use of BIM for value estimation of buildings in the operational phase was presented. This addresses another possible BIM use, extending the current body of knowledge and helping implementing and advocating this modern method of construction industry digitalization.

The main conclusions of the paper are:

1. Using BIM for value estimation of existing buildings in the operational phase of the project is possible.
2. There are three basic levels describing BIM utilization for value estimation of existing buildings in the operational phase of the project.
3. There are obstacles for successful use of BIM of value estimation of existing buildings in the operational phase of the project, resulting in lowering the possible benefits of utilization of such methods, based on how current the data are in the model and how their structure is standardized.
4. Using BIM for value estimation of existing buildings in the operational phase of the project requires up-to-date or time specific models, which are not common in the current practice and therefore a more systematic approach is necessary for full utilization of the proposed BIM use.

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