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Functional assessment of BIM methodology based on implementation in design and construction company

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Abstract

The paper presents new technology on polish market – BIM. Nowadays method of project management and construction did not change for many decades. Traditionally, all information were handed over in the form of flat drawings: sketches, graphics, technical drawings and nowadays in program generated visualizations. Documentation form has involved, but it was always two-dimensional. Over last years, the new conception has raised, which base on changing the technology of design. BIM – Building Information Modeling is one the most latest and important technologies for architecture, civil engineering and construction management. Information are handed over in the form of three dimensional model which consists of separated models. They are characterized by parameters such as: mass, length, layer, level, phase of construction process when element is used or produced. In other words, they are ideal illustration of components, which are built in to building. This way the reliable virtual copy of building is created.

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Keywords: BIM; Parametric modeling; Investment process

1. Introduction

The construction sector is one of the largest sectors of the economy in almost every country. Economic growth generally is reflected in the amount of construction investment, which in our country appropriates a big part of the civilization, which makes it one of the best developed sectors and having a lot of good practices. Innovations or new

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technologies that will make it change on a global scale appear rarely. Modern methods of project management and execution have not changed significantly for many years. In accordance with those conventions construction law [1] defines the 4 parties of the investment process:

- Investor,
- Designer,
- Site Manager,
- Supervising Investor.

Each has a distinct role and is responsible for its own piece of the process. It’s a very rare situation when through the whole process, from the beginning to the end of its duration, all parties are attending constantly and represented by the same person. That creates a situation, in which during process’ lifetime there is no continuity in the transfer of knowledge about the project and the concept.

Another feature of this proven approach is a way of transferring information. It’s accepted that it’s submitted in the form of flat drawings, graphics, sketches: accurate drawings, and in the modern times also generated from computer programs. Form of documentation has evolved over the centuries, but always remained two-dimensional — flat. Even in the case of visualization — despite the fact that they should accurately reflect reality, are a result of the lengthy and time-consuming calculations, because of which only a very limited quantity is dedicated for the project. In addition, drawings and visuals are still a set of points, lines, or solids, which carry only visual information.

2. BIM as a new process and tool

Decision BIM, or Building Information Modeling, is one of the most important discoveries of recent times for environments related to the architecture, engineering and construction. The information is forwarded in the form of a three-dimensional model in which contained are all the elements forming separate objects. They are characterized by additional features — parameters — such as mass, length, layer, floor, built-in phase or manufacturer. In other words, they are an accurate reflection of the components that will be built into the work. In this way, its exact virtual copy, is created. During the whole process of working on a single model, which is constantly improved and enriched with details. Thanks to gaining a continuous flow of information and is easier to take over the entire project. After the completion of the design, these models contain complete information on the geometry and the data needed for the pricing, design, prefabrication and other procedures related to the construction process.

BIM models also allow to use them for further calculations related to sunlight, energy efficiency, and statics. They also serve as the base element of the exchange of data between parties involved in the project. BIM software and the changes that it introduces into the construction process are described in more detail later in the paper.

3. BIM in legislative terms

Making Subject is all the more interesting, because the European Union also steps into the BIM technology. Adopted directives say that, in respect of public works contracts, Member States may require the application of specific electronic tools, such as electronic data modeling tools or similar (see e.g. Article 22 (4) of Directive of the European Parliament and of the Council on 2014/24/EU of February 26, 2014, on government procurement).

Although the adopted directive does not enforce entry into national legal systems of the obligation to apply the electronic construction data modeling tools and only allow the introduction of such obligation, it seems that the solution can give a positive impetus to the development of the infrastructure of BIM in Poland and increase the frequency of using it.

It is estimated that the design in accordance with BIM can save you money. The ability to maintain more cash in hand has convinced now some Western countries. For example, in England, the Netherlands, Denmark, Norway and Finland a requirement to use BIM in public procurement will be binding beginning in 2016 (in England this has emerged already in 2011: see. Cabinet Office, Government Construction Strategy, May 2011, p. 14). In our
assessment, Poland should be leading in the course of its work on the implementation of the new directives subject BIM.

Even if we want only giving the contracting authority for requirement’s use, it will require the development of new ready legal solutions, inter alia: public procurement law, contract law, construction law and environmental law. It’ll be then worth to create a customized to BIM infrastructure contract models that’d be concluded between entities participating in construction investment process. Hence, today the work should be undertaken on specific legal juridical constructs (law), so as to the existing does not counteract the effective use of new solutions. [3]

4. BIM levels

4.1. Introduction

Par When talking about BIM we differentiate between different stages of completion and use of BIM in the whole process. These are called levels. At present, the commonly used levels referred to in the process are: 3D, 4D and 5D. In this nomenclature if reference is made to the level of the 2D, it’s for the traditional methods of design. Definition and scope of the division between the different levels is not precisely defined. The most widely used distribution in Poland is described below.

4.2. 3D level – 3D designing

3D design or creation of a 3D model. The result is a model of the building in the format *.rtv or *.ifc (the second format theoretically works on any software). Properly done model contains all the information necessary to build a designed object. It is also the basis for the implementation of 2D documentation printouts. However, it arises directly from the model, making sections, views, details and elevations consistent with each other. One model also includes all branches coordinated with each other. When speaking about the level of 3D according to BIM it should not to be confused with the ordinary 3D modeling.

The product obtained from 3D:

- 3D building model containing all industries
- Library of the materials used,
- 2D drawings.

4.3. 4D level – Investment preparation

3D models, whether done in accordance with BIM or not, are well known and they are already on the market for some time. They are often also used in presentations. These models are ideal for visualization of the appearance of object or building, or as it fits in the current landscape. 4D level introduces other, broader applications for the geometry in the model. You can simulate the process of execution. From the model, you can enumerate, for example the number of elements of the construction, and then use this information when you create a quote or schedule.

During this process appropriate implementation technologies can be chosen, construction site can be designed or the working centers divided. This information will be reflected in the model. When all the data is available, you can perform a schedule in which the items are related to the time required to implement them. It is also possible to add connections, and specify the order of execution of individual work.

4D BIM often uses linear schedules. This is an alternative to the schedules presented in Gant’s scheme. You can read from it the information about both the time and location of the activities.

The product obtained from a 4D:

- Premeasures for all industries
- Table of the elements
- Schedule – together with an indication of the areas for optimization.
4.4. 5D level – Cost analysis

The fifth dimension of BIM enriches the investment realization simulation process with the investment cost information relating to labour, material and equipment. Through a combination of model, and the elements contained therein with the costs, fifth level also allows for rapid execution and calculation of cost of changes made to the project. The quota programs are even able to detect differences in the newer version of the model, and illustrate on the model and schedule, as well as premeasure them. If this is not a significant change, the difference can be calculated automatically on the basis of the previous valuation. Of course, if the whole process does not supervise the quote controller, it's very easy for errors to pop up.

The tools also allow for quite precise and quick preparation of the cash flow for investment. Just quoting process can also be based on the price catalogues, such as the one issued by Sekocenbud.

The product obtained from a 5D:

- Cost estimate,
- Cash flow,
- The basis for the change management process.

5. BIM environment, platforms and available tools

**BIM tools** are special-purpose applications that provide concrete result. Examples of these are tools for cost estimation, collision detection, creating a model, energy calculations and visualization. The result of each tool is usually a separate product, such as a report, figure or table. An example of such a tool is the "wall tool" in the Revit platform.

**BIM platforms** are applications, mostly to design, that generate the data for further processing. They form the basic models, which serve as a source of information on a given platform. The most common platforms for BIM have a BIM tools described above included. In addition, they are enriched with the most user-friendly interface possible, through which access to the BIM tools is carried out with varying degrees of integration with the program. Multiple platforms share the main interface and mode of operation, making it easy for the user to use multiple programs without having to learn them from the beginning. This is a typical marketing move. Examples of such applications are Revit Architecture and Revit MEP (at the moment are already one Revit package).

**BIM environment** is a way to manage BIM project related data stream from both platforms and tools. Commonly they are server environments for integration of results and data of all participants of the process associated with the design or performance. Very often the environments are not managed in an orderly manner because they create themselves to suit your needs. BIM environment allows you to transmit much more information than just the data for the model. For example, these can be videos, photos and other data used during the design process. BIM platforms are not designed to manage the flow of data, and to their internal storage. Hence comes the need for environments. The simplest BIM environment is a cloud file storage available for the participants of the process. A more developed form of the BIM environment is a specially prepared data server with the internal procedures for cataloging, access and update of data.

6. Traditional and integrated process - conclusion

BIM implementation enabled better use of ideas related to the integrated project management. The same concept of an integrated approach to projects – IPD (Integrated Project Delivery) – has been described thoroughly and put on by the American Institute of architects and is described in the paper "Integrated Project Delivery: A guide" [2]. On the basis of this paper the main differences in the assumptions of different models are described.
Table 1. The team

<table>
<thead>
<tr>
<th>Traditional process</th>
<th>Integrated process</th>
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<tr>
<td>In the traditional process project teams are often separated from each other. Many of the collaborative companies lead the project by isolated individuals. Teams are created on demand for a given task. The size and involvement of the team are minimal, but sufficient for the execution of the task assigned. The work of the team and its structure is hierarchical and controlled top-down.</td>
<td>In the integrated process an interdisciplinary team is created. Its composition is created from employees of various companies. The group has also a representative of the investor. Cooperation is promoted from the very beginning. By identifying the persons responsible for the project, along with its launch the team is formed and has a common goal.</td>
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Table 2. The process

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<td>In the traditional approach the project processes are linear. Many of them carried out separately. The information that is required to execute them is collected in the minimum needed. Information is kept only by some members of the process. Often the person actually carrying out the project has the least knowledge about it.</td>
<td>Full access to the knowledge of all members of process. Processes are carried out in many ways, very often use the iterative methods. An ideal integrated process also implies the principle of partnership and mutual trust team members.</td>
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Table 3. The risk

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<tr>
<td>Risk management is carried out individually by the participants in the process. Actions to reduce, transfer or remove the risk are taken separately.</td>
<td>Risk management is carried out jointly, the risk is shared by all the participants. Actions to reduce risk are also taken inside of the team.</td>
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Table 4. The profit

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<td>The profit of the various process participants is developed on an individual basis. Each party tries to maximize their profit. The propagated approach is biggest profit possible for the least possible contribution.</td>
<td>A common approach to project profit maximization. Final profit of all the participants of the project depends on the results of the project. An additional motivation to achieve a good result.</td>
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Table 5. Communication and technology

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<td>Documentation in paper form. Electronic documentation only flat – 2D. All forms of spatial data to be charted as a composition.</td>
<td>Digital records of all projects and information. Documentation is done in accordance with BIM at all levels (in accordance with subchapter 2.6).</td>
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Table 6. Agreements

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<td>Unilateral contracts prevail, negotiated from a position of market power. Agreement written only in order to completely transfer the risk to other entities. No partnership.</td>
<td>Agreements are designed to support the partnership and to share the risk on the parties of the process.</td>
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References