

1.4 BIM-technologies in Ukraine

BIM technologies are a new approach to digital information management in the construction industry, which allows you to virtually recreate an object even before its construction begins. It makes it possible to increase the safety and reliability of buildings and structures, control the quality and speed of construction works, significantly reduce the probability of errors in projects, reduce the cost of construction and optimize costs at the operational stage.

Modernization and digital transformation of the domestic construction industry, thanks to the implementation of BIM technologies, will make it possible to solve several systemic problems. It is about the low quality of design and construction, inefficient use of resources, the unpredictability of costs for the operation of built objects, accidents of buildings and structures, lack of investment, resource-intensiveness, and industry inefficiency.

In most countries of the world, during the design, in particular, of objects of increased responsibility and state orders, BIM technologies are mandatory. In Ukraine, they are still used by a few organizations.

First of all, the implementation of BIM technology requires state regulation, in particular, the creation of the necessary regulatory and legal framework, the development of a number of norms and standards, state support for the implementation of pilot projects, the training of specialists with appropriate qualifications, informational, organizational and methodological support.

And there are already results in this direction — changes to the Procedure for the development of design documentation for the construction of objects that allow the use of BIM technologies and to the Procedure for approving construction projects and conducting their examination have entered into force, which can be submitted in paper and electronic form or in the form electronic documents.

Currently, the Ministry of Regions is working on updating 20 standards, developing national estimate norms, and developing a comprehensive plan for revising building norms until 2025 [92].

Building information modeling, or BIM for short, is a process of optimizing design and construction. With the help of BIM technology, an information model is created, which provides an accurate vision of the project as a whole.

The technology of information modeling of buildings consists of the construction of a three-dimensional virtual model of the building in digital form, which contains complete information about the future object. The application of BIM technology in the design of buildings includes the collection and complex processing of technological, architectural, and design, economic information about the building, thanks to which the building object and everything related to it are considered as a single entity [93].

In modern society, there are very rapid changes associated with the rapid development of information technologies. Most countries have already joined the process of transition to BIM technologies. These are Great Britain, the USA, the Netherlands, Singapore, Kazakhstan, Belarus, and other countries. Ukraine has also started work on the introduction of BIM technologies. And we have to develop this direction. This will not only contribute to the implementation of new modern projects in the country and bring the Ukrainian construction industry to a higher level of design but will also increase the quality of control of construction works. This, in turn, will positively affect Ukraine's position in the Doing Business rating for the component "Obtaining construction permits".

Among the advantages of implementing BIM technologies, Partskhaladze named instant access to any information about the object, quality control of works at all stages, avoidance of collisions in projects, a significant reduction in the cost of construction, as well as a more rational use of resources.

The main advantage of implementing BIM technologies in construction is the ability to achieve almost complete compliance of the characteristics of the future object with the customer's requirements, which is very important.

In general, BIM technologies involve the virtual construction of an object before its actual erection. This allows you to reduce uncertainty, increase safety, solve problems, and model and analyze the potential effects of various factors at all stages of construction.

The modern development of information technologies was marked by the emergence of a fundamentally new approach in architectural and construction design, which consists in creating a computer model of a new building that includes all information about the future object - the Building Information Model (BIM). The concept of building information modeling as a means of its parameterization was first proposed by Georgia Institute of Technology professor Chuck Eastman in 1975 in the journal of the American Institute of Architects (AIA) under the working title "Building Description System" [94].

In the late 1970s and early 1980s, this concept developed in parallel in Europe and the USA, and in the USA the term "Building Product Model" was most often used, and in Europe (especially in Finland) - "Product Information Model". At the same time, the word Product emphasized the primary focus of researchers' attention on the object of design, and not on the process. The combination of these two names led to the birth of the "Building Information Model".

In parallel, in the development of approaches to information modeling of buildings, Europeans in the mid-1980s used the German term "Bauinformatik" and the Dutch "Gebouwmodel", which in translation also corresponded to the English "Building Model" or "Building Information Model". These conceptual approaches were accompanied by the development of a unified content of the used concepts, which ultimately led to the appearance in the scientific literature of the term "Building Information Model" in its current meaning in 1992 [95].

A little earlier, in 1986, the Englishman Robert Aish (Robert Aish), at that time the creator of the RUCAPS program, then for a long period of time an employee of "Bentley Systems", who recently moved to "Autodesk", used the term "Building Modeling" for the first time in his article in its current understanding as information modeling of buildings. Then he first formulated the main principles of such an informal

approach in design: three-dimensional modeling; automatic receipt of drawings; intelligent parameterization of objects; corresponding object databases; distribution of the design process by temporary stages, etc...

Robert Aish illustrated a new approach in design: an example of the successful application of the building simulation complex in the RUCAPS PC is the project of the reconstruction of "Terminal 3" of the London airport "Heathrow". This experience is the first case of using BIM technology in global design and construction practice [95].

The term BIM (Building Information Modeling) first appeared in 1992 in the work of G.A. van Nederveen and F.P. Tolman from the Netherlands. Since about 2002, the concept of the Building Information Model has been adopted by software developers, making this concept one of the key concepts in their terminology. Soon BIM was adopted by Bentley Systems, Autodesk and Graphisoft, etc. Later, the acronym BIM entered the lexicon of specialists in automated design systems and became widely used throughout the world [94].

BIM can be used both to refer directly to the building information model itself and to the process of information modeling. For example, Graphisoft, the author of the widely distributed ArchiCAD package, introduced the term VB (Virtual Building) - a virtual building, which is essentially BIM. Sometimes you can find a phrase similar in meaning to electronic construction (e-construction) [97, 98].

Principles of implementation of BIM technologies and implementation of the concept.

The implementation of BIM has a long-term nature, but technological, economic, and political conditions can make certain adjustments to the process, effective implementation of the concept is possible by observing the basic principles according to which it was developed.

Harmonization with the European approach. Based on the positive and negative experiences of other countries, the most effective option is to use the best implementation practices instead of finding your own unique path. These principles are based on the association agreement with the EU [92]:

- The principle of preventing the creation of legal and technical barriers for the benefit of any interested party in the implementation of BIM for development, software, expertise, etc.
- The principle of Open BIM is the use of open formats (including IFC) and the ability for construction companies to freely choose any software without restrictions.
- The principle of anti-corruption and transparency in the formation of mechanisms necessary for the implementation of the concept.
- The principle of harmonization of international and European standards, rather than developing one's own.

1. Careful approach

Implementation should be gradual and use only the necessary resources at each stage:

- The principle of subsidiarity, solving issues at the appropriate level of state power, which has sufficient powers for this.
- The principle of gradualness, namely the establishment of the Concept of specific steps necessary for the introduction of BIM technologies in Ukraine, where further development is regulated by future relevant strategies.
- The principle of proportionality, according to which actions for the implementation of VIM should not exceed the level of necessity.

2. Interaction and cooperation

Successful implementation is possible only with the coordination and cooperation of all stakeholders:

- The principle of cross-sectoral consolidation of efforts between the state, business, and the public for effective implementation of the Concept.
- Consensus principle – studying and taking into account the positions of all interested parties in the implementation of BIM technologies.
- The principle of equality is when the state creates conditions for the market.
- The principle of stimulating and encouraging the use of BIM technologies in Ukraine by the state.

3. Evidence-based implementation

Decisions based on data are more objective and reliable, and less dependent on the perception of specific individuals:

- The principle of implementation taking into account existing strengths, i.e. borrowing the successful experience of Ukrainian business and technologies.
- The principle of making necessary decisions based on data (statistics, expert discussions, and international experience).

Criteria for evaluating the success of concept implementation should correspond to the best international approaches.

For a synergistic effect, it is necessary to take into account the interaction of construction and related areas, as well as all the main stages of the life cycle of the construction object:

- The principle of taking into account the goals of sustainable development to use the positive impact of BIM technologies not only in construction but also in related areas for the development of the state in general, namely: ecology, energy, education, safe production, preservation of cultural heritage, etc.
- The principle of creating conditions and mechanisms for the transition to life cycle management.

The analysis of world experience showed that for the implementation and development of BIM technologies, communities were usually created, which served as a tool for the promotion and implementation of BIM technologies [99, 100]. As was mentioned in the prerequisites, there is no expert environment with BIM at the state level in Ukraine, but it is available in the business. Therefore, the logical strategy of creating a joint platform for the promotion of BIM consists of the interaction of representatives of all interested parties with equal voting rights: the state, business, and the public.

According to this model, process participants will be involved in the development of decisions in a balanced way, which will have a more positive effect on their implementation than the forced administrative implementation of orders from the mountain. Considering the large volume of work, their versatility, and the long time

required for the implementation of the Concept, it is necessary to create a separate organization that will coordinate the efforts of the process participants, based on their practical experience, but without excessive bureaucracy [101, 102].

For the effective implementation of the Concept, the creation of the UA BIM Task Group community is envisaged for the period necessary for the sufficient integration of BIM in the construction industry (approximately 10-15 years) [93]. Involvement of representatives of all interested parties in the organization is necessary for the formation of a common vision for the implementation of VIM technologies, consolidation of efforts, understanding of the entire range of problems related to implementation, distribution of functions and responsibilities among interested parties for solving these problems, creation of a powerful expert platform, regular intersectoral dialogue (state-business-society), transparency of the implementation process, joint development of the following strategic documents, conducting activities to popularize the use of BIM technologies in Ukraine, promoting the creation of educational programs and courses for training BIM technologies, attracting financial resources for the implementation of BIM technologies, regular research of the state of implementation of BIM technologies and related processes [103].

The organization should consist of three components:

membership – representatives of all interested parties who have a proportionally equal number of votes and make decisions. The composition includes representatives of legal entities.

expert – experienced specialists who provide their assessment before making decisions in a certain direction. It includes both legal entities and individuals.

secretariat – coordinating body of the organization to solve current and administrative tasks.

The strategic goal of the created organization is to, together with all participants, formulate their own vision for further work and draw up a plan for the implementation of the developed concept.

In Ukraine, there is an example of a similar formation, which includes representatives of various sectors - CoST (consultative and supervisory group, CoST,

Construction Sector Transparency Initiative). If such a group is created under a certain ministry, there is a risk of reducing the activity of other participants in the process. At the same time, joining the state structure creates certain frameworks for actions within the Budget Code, even if additional funding sources are involved. This will lead to a decrease in the efficiency of the group's work and additional costs for reporting and duplication. In addition, not all donors are ready to finance organizations under state institutions, which significantly limits the range of potential partners [104].

It should be noted that different departments play a leading role at different stages of implementation, so the creation of the UA BIM Task Group will provide an opportunity to comprehensively approach this issue.

The international experience of implementation is also marked by the creation of similar organizations that are engaged in the development of VIM technologies in the state, uniting representatives of interested parties. For example, in Great Britain during the implementation phase from 2011 to 2016 it was the UK BIM Task Group, and then from 2017 CDBG & UK BIM Alliance, and in Germany Planen-Bauen 4.0. GmbH etc. The activities of the UA BIM Task Group can be divided into separate directions [92].

Implementation of BIM requires a large number of resources, including funding. For the effective implementation of BIM implementation, the process is divided into four main phases:

- **Phase I** – introduction of BIM technologies in Ukraine. Starts with BIM level 0 and goes to BIM level 1 at the end of the phase. The possibility of using BIM technologies at private and state-ordered facilities. Training of customers, designers, and experts in the use of BIM. During this phase, pilot projects are implemented with a limited number of projects, expert organizations, and state customers.

- **Phase II** – development of BIM technologies in Ukraine to BIM level 2. Establishing requirements for the mandatory use of BIM for individual objects of state order according to the relevant criteria. Training of builders in the implementation of objects using VIM technologies. The experience of phase I is being disseminated to a wider range of state customers, experts, and project organizations. Pilot projects involving construction organizations are being implemented.

- **Phase III** – development of BIM technologies in Ukraine to BIM level 3. Expansion of criteria for mandatory use of BIM technologies at state-ordered facilities. Learning to operate objects using BIM technologies. At the beginning of phase III, we expect a sufficient number of BIM projects that have passed the examination, as well as a wider involvement of construction organizations. In this phase, pilot projects with operational organizations are launched.

- **Phase IV** – mandatory use of BIM at state-ordered facilities and consideration of the need to establish criteria for private ordering. BIM projects cover the stages of the life cycle of buildings, including operation.