Forming a unified information platform for managing a life cycle of a building object

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Abstract. The problem of full-fledged information modeling of the life cycle of the construction project and a single view of the object, including the stages of its construction and operation, is very relevant today and does not have a complete solution. The subject of the article: the organization of the software environment for managing the project life cycle processes on an integrated information platform. The article analyzes the main directions of information modeling in the construction industry; a comparative analysis of IT-systems BIM (Building Information Model or Modeling) and PLM (Product Lifecycle Management system) performed; explored the possibilities of modernization of the design environment and the integration of different applications; revealed the functionality of BIM technologies necessary for the development of the programming environment for the life cycle of a building object. The article shows that the most promising way to solve problems is the integration of Western and Russian technologies using the BIM model on the PLM platform. A technological IT platform should be developed that describes a process model based on a single data source with the possibility of effective interaction of all building subsystems and project participants and allows integrating data into third-party systems.

1. Introduction

Information models are very widely used in project management of buildings and structures. The possibilities and functions of information modeling in construction are evolving evolutionarily. The main prerequisite for the emergence of new opportunities is the development of accessible information, technical, technological and regulatory tools for the interaction of all participants involved in investment and construction processes [1, 2, 3, 4]. The organization of joint activities within the project on a single information platform is currently one of the most pressing problems and the main goal of scientific research in this direction [5, 6].

Information models of each construction object are unique and include specialized software [7, 8, 9]. Small, typical, and medium-sized objects can be collected in low-power viewers of the information model. In small and medium-sized project companies, fairly simple programs are used for this, the power reinforced by additional modules. Large-scale projects, characterized by a huge number of elements of the information model, can only be viewed by powerful visualizes [10, 11, 12]. Accordingly, the developer and other project participants have a need to assess the needs of a particular information model taking into account the complexity of the objects and choose the appropriate solution from Russian and Western software solutions for price and functionality. Tasks arising during the implementation of the life cycle of a real estate development project are usually solved collectively, bringing together a growing number of specialists and experts in large-scale projects for a collective solution.

The concept of a unified information platform for the life cycle of a construction project begins to work in practice only when appropriate software tools appear that are suitable for the enterprise in terms of teamwork needs, functionality and price [13, 14, 15].

2. Materials and methods

From the point of view of the life cycle of the capital construction object, we single out two main areas of development of information modeling processes.

The first direction is newly designed objects, when the ultimate goal is the release of design and working documentation, drawings [16, 17]. At the design stage, the information model consists of special three-dimensional tools of sufficient power to solve the problems of the relevant sections of the project. Mostly BIM tools work here (Building Information Model or Modeling) [18, 19].

The second direction is the development and application of information models for existing and operating facilities, where the creation of project documentation is not the ultimate goal of creating an information model. As practice shows, to create a model of an existing object at the operational stage, software that is natural at the design stage will be redundant. And, at the same time, it does not have the functionality necessary to solve operational problems [20, 21]. For the purpose of information modeling of operational tasks and processes of an object, tools of PLM systems (Product Lifecycle Management system) are used - application software systems for managing the product life cycle [22].

If we compare BIM with PLM, the roots of their appearance are very similar. Moreover, PLM, of course, is a more mature methodology for its application in industries where its main users are located. Not all projects require serious PLM tools. They are in demand primarily in large-scale projects, high technology and high-tech industries. The PLM concept allows you to dive deeper into the specifics and all the features of creating a product [23]. For the construction sector, in which there are many participants and many processes, the general structural exchange of relevant information between subsystems and participants is extremely important. The importance of such information exchange is growing even more in difficult economic conditions, dictating the need for professional understanding and consideration of all possible risks of the construction project [24, 25, 26].

The study of many years of world experience in using PLM information systems at all stages of the life cycle of various industrial enterprises shows that the use of such systems leads to an increase in production efficiency and safety. The analysis shows that this is due to the positive effects of using PLM systems due to:

- More accurate forecasts of the progress of construction and installation works,
- Reducing the time required to put the enterprise into operation,
- Reducing unplanned downtime,
- Speeding up the decision-making process in the event of breakdowns and emergency situations at workplaces,
- Reducing reducing the cost of repairs due to a more accurate understanding and modeling of the condition of the object.

3. Results

The problems of information support of the life cycle processes of a construction object have been raised for a long time, but their systemic solution has not yet been created. The general problem of information modeling is associated with typical and frequent situations when different sections of a project are executed on different platforms, and also when viewers do not read formats of other platforms. And even an ERP-solution (Enterprise Resource Planning, enterprise resource planning), which should cover all aspects of production life due to the historicity and timeliness of the automation process of individual functions in the company consists of separate modules and has restrictions on the data used. In civil engineering, the situation is infrequent, and in the industrial sector this happens regularly. In these cases, the information model of the object must be assembled using a universal viewer that reads graphics, uses an open, universal data format and thereby solves the problem of heterogeneous format semantics.

To create software-compatible formats, BIM technology of building information modeling can be applied. However, at present, in the Russian Federation, BIM technologies are mainly used at the design stage of construction projects. Today on the market there are many software packages based mainly on the BIM concept, which are part of the CAD group (AEC). The task of the BIM system is to collect data and documents and make them available to the user, regardless of the preferences of CAD systems selected by design organizations. Thus, we can assume that the first requirement for the created BIM systems should be the possibility of tight integration with various CAD systems, regardless of the platform chosen and the company developing these CAD systems. A significant obstacle to the creation of compatible data formats is the low level of development of the classification of objects, works and resources in construction. The All-Russian product classifier, developed on the basis of the international classifier, is still far from the need for data exchange in information models of construction projects.

An equally important task of BIM is to provide quick access during the request to the necessary data and documents and to provide bi-directional data exchange, regardless of where the personnel are located, whether it is a project office, construction site or an existing building. This means that the BIM platform must operate wirelessly (LTE and / or Wi-Fi) using various existing mobile devices. Accordingly, the most promising and popular BIM solutions are developed on the basis of the "zero footprint" concept, that is, systems that not only provide access to data, but also provide the ability to process documents of any type and format, including 3D models, without installing additional client applications both from CAD developers and BIM developers.

Recently, new small applications based on BIM technologies have appeared that are related to solving the problem of collisions between projects and checking BIM model data. For example:

- Automatic verification of security requirements and correction of components of the information model to meet these requirements;
- Architectural planning, where according to the digital plan of the construction site with marked construction, sanitary protection zones for buildings, roads, forests, agricultural enterprises, with information about the permissible building density, the optimal location of the building is determined. From the library of available options, its spatial form and type of enclosing structures, the number and location of windows are selected. The resulting project is automatically checked for compliance with standards for lighting, noise protection, fire resistance, etc.

Existing software solves local design problems. In particular, there are products for the direct formation of the information model itself in 2D or 3D formats in relation to the catalog of materials, including for obtaining volumes and estimated cost of the project. In addition, there is highly specialized software for designing an object taking into account the architectural characteristics of existing buildings, for modeling traffic flows, optimizing traffic flows, etc. In general, most of these systems solve a specific problem.

The BIM concept covers both highly specialized computer-aided design (CAD) systems and a wide range of tasks required to manage an object's information model, including its most important elements, such as requirements management, configuration, changes, integration functions, data exchange functions between all participants of creation information model, as well as all subsystems of the project. The integration results are different for each type of application. Integration into financial systems is a high-quality plan-fact analysis of planned and actual costs. Integration with maintenance and repair - visual search for items that require repair or maintenance. The latter applies, in particular, to large industrial construction projects, where it is necessary to find a machine or other equipment that needs to be replaced by the planned repair date or after the equipment has expired.

Integration with geographic information systems (GIS) will help you choose the location of the object, to set various parameters for the tracks and choose the best of them based on spatial source data. For example, in order to correctly choose and carry out a clear feasibility study for a new road, especially if it is known how much the private sector should be demolished. At the design stage, as a rule, one subsystem or assembly pool is enough for the tasks of viewing three-dimensional models, checking for collisions, scheduling the progress of construction using a 4D solution. If we talk about

the full-fledged construction management and the solution of a large number of specific tasks of this stage, then today BIM tools with the necessary functionality for these purposes do not exist.

At the same time, the possibilities of integrating applications from different suppliers are growing. This allows you to modernize the design environment in which the company works, to buy up advanced computing solutions without changing the entire platform of the integrated solution. It should be noted that we are not talking about outdated versions of applications that have not been updated since the 2000s, software components, of course, should be the most current versions. If the tools used are morally obsolete, mechanisms are usually developed to export the data accumulated and collected by the organization during operation to a new integrated solution. In addition, a very important step in combining the efforts of different project teams is to create solutions for working with the information model in one window with the ability to search for collisions and comment on the visualization of the object. This approach allows you to distribute design work and coordination with the project management and the customer and use the skills of various design institutes in the areas of their professional specialization.

When we talk about designing, you can use separate software tools and their further integration into a specific complex, but strategically this is only a temporary solution for testing the BIM methodology itself. It is difficult to give an example of such a company in which all the data necessary from the point of view of the structure of the object for making organizational, managerial, technical and engineering decisions would be collected in a single system, with a single convenient access and with the corresponding types of representations. Therefore, in most Russian companies decisions are often made based on irrelevant and inaccurate data (for example, after closing the accounting period). As a result, it is extremely difficult to increase productivity without high-quality automation of managing the actual engineering data of the facility. To date, there is no single platform on the market that would fully cover all the tasks of BIM. Moreover, there is no coordinated effort between manufacturers to develop BIM-oriented information modeling tools. Hence the problems of connecting different platforms, software products and subsystem design results.

It is very obvious that a model created using the BIM capabilities can be useful at the stages of construction and operation of an object with the following functions and instrumental capabilities:

- If we can manipulate the model (change the geometry and attributes, relate all types of documents, etc.) and analyze the accumulated data;
- If we allow manual entry of newly appearing data into the system;
- If we can integrate the model with the surrounding IT landscape, in particular with MRO-systems (Maintenance, Repair and Overhaul - technical inspection and repair).

All these functions are implemented using the BIM model on the PLM platform. With this approach to integration, a model created using BIM tools becomes cost-effective and can be successfully used not only at the design stage, but also at the construction and operation stage. Accordingly, a single PLM platform is needed and needed to use the BIM model. The market offers similar platforms of Western and Russian development.

Until recently, IT solutions and PLM tools in the Russian market were Western, which obviously makes them expensive, and also creates problems with language, staff training, taking into account industry specifics of construction, adaptation of standards, etc. As a result, they are available, cost effective and are used only in very large companies. At the same time, active marketing work is being carried out on the industry market for interested market participants, such as foreign vendors, engineering and consulting centers, training centers for BIM-technologies, mass media, etc. They promote expensive foreign software in Russia, providing training and consulting to all market participants. This is done, as a rule, without understanding the traditions and characteristics of the construction industry of the Russian Federation and leads to additional problems with the introduction of information modeling technologies, significant and unreasonable material costs.

4. Discussion

In our country, there are separate developments and software solutions in the design field that require development in order to become a full-fledged competitive system in comparison with foreign

solutions. Today, Russian tools with a clear language and ready for use in various industries, available for use in medium-sized companies and projects, have appeared on the market. This is, first of all, the Russian system of engineering data management NEOSYNTHESIS, which provides means for storing, accessing, exchanging and analyzing data from civil and industrial construction objects during their life cycle, including design, construction, operation, reconstruction and repair. Within the framework of this system, a consolidated information space is proposed for project management participants from various services, organizations and contractors, subcontractors, design and research organizations; bodies of supervision and control. On the part of Western software providers, these are comprehensive cloud IT solutions from Intergraph, Bentley and Aveva. In a certain sense, they make up a "capsule", which makes it possible to transfer the information model of an object from the design stage to the next stages of its life cycle. Moreover, these IT solutions allow you to transfer the model of the object in a non-static form, changing it, following the changes in the real building object. This distinguishes them from BIM technologies, where there is no such massive use of information models at the construction and operation stages.

The PLM toolkit is aimed at creating an object structure and linking all data, documents and data representation types for this element with elements of the object structure. This speeds up access to data and ensures its relevance, helps to avoid errors in the process of data transfer and composition. Thanks to the complete PLM system, an environment is created for the effective coordination of architectural and construction information. This allows to transform the methods of interaction of project participants and form a life cycle management system for construction projects. In this environment, the work of designers, subcontractors, subcontractors is structured, which makes it possible to timely identify design conflicts and the causes of possible failures. When the information model is filled with design data (design and working documentation), as well as construction data (executive survey, etc.), the BIM model is converted to the operational model of the object. It contains complete information about the facility, including inspection, work, a list of operating organizations and areas of responsibility of each of them, etc.

Taking into account current trends in the development of PLM systems in the world, it is very likely that BIM systems will enter the path of using portal solutions and cloud technologies. In the context of strategic forecasting, BIM modeling as a whole can be described as an IT industry with the following relevant development directions:

- Cloud technology - file sharing service in the cloud;
- 3D visualization - virtual and augmented reality technologies for quick detection and correction of collisions;
- Laser scanning to directly create an information model of an existing facility;
- Development of applications and add-ons in specialized software systems for performing special tasks of information modeling: calculations, project checks for collisions, correction of errors during modeling, data management of the information model, model conversion for correct data transfer, etc.;
- Development of classifiers and libraries of standard building elements, units, structures, materials, price guides for use in information modeling.

5. Conclusions

Thus, taking into account the above promising areas, one can single out the urgent task: developing a unified information platform for the life cycle of a building project based on a single source of consolidated data with the possibility of effective interaction of all building subsystems and project participants (designers, builders and management companies). Effective interaction in the information platform model of this level of coverage requires and involves the development of a single standard for integrated information modeling by connecting and integrating the information model with third-party software products.

It seems that the prospects for the further development of BIM technology are related to its extension to a broader concept of integrated information modeling (Integrated Information Modeling), combining all technologies (GIS, PLM, ERP, etc.) in a single information field. The development of

such an integrator will minimize risks at all stages of the life cycle, reduce the time and cost associated with the design, construction and operation of facilities.

The analysis shows that in order to solve the accumulated problems and urgent tasks for the development of BIM in the country, it is necessary to create information model operators with storage and organization access functions for collective work with the model to the participants of the construction project and the real estate market: contractors, banks, management companies, regulatory authorities and other.

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