Development of an algorithm for implementation of operation control automation systems using BIM technologies for a capital construction facility

O V Didkovskaya, O A Guzhova and M F KHairullin
Samara State Technical University, 194, Molodorvareyskaya str., 443001, Russia
E-mail address: guzhova_oksana@inbox.ru

Abstract. The article is devoted to the problem of implementing BIM technologies for the operation of capital construction facilities. The research is relevant due to the problems that arose when transiting from traditional approaches to operation control of capital construction facilities to operation control based on the use of BIM technologies. The result of the research is the developed algorithm for implementing automation systems for operation control using BIM technologies. The implementation of the algorithm allows improving significantly the current operation system of capital construction facilities. The algorithm distinguishes clearly the stages in their logical sequence, result, duration of each stage and the amount of costs.

1. Introduction
The information technologies are developing rapidly. They are changing the world around us including the techniques and methods used in different economic realm. The introduction of modern information and telecommunication technologies can significantly increase the productivity and efficiency of business entities. Nowadays, to build digital economy is one of the main tasks of the country's development.

At present, the world construction complex is undergoing a stage of radical transformation due to the rejection of traditional CAD technologies for designing buildings and structures in favor of a gradual transition to innovative operation control and implementation of investment and construction projects based on the use of modern information technologies. This fact makes the topic of the research relevant. Rapid development of information technologies, specialized software, the use of three-dimensional modeling that includes the creation of a unified information model of a construction facility (BIM-model) have become a key element of the construction development. BIM has become a part of operation control tools in modern construction companies [1].

The term of BIM is given by V.V. Talapov in “Fundamentals of BIM. Introduction to information modeling” as “BIM is all numerically described, properly organized and managed information about a construction facility used both at the design and construction stage of the building and during its operation and even demolition” [2].

According to the definition given in applicable Construction Rules 333.1325800.2017 "Information modeling in construction. Rules for making an information model of construction projects at different stages of life cycle", the information modeling of projects is the process of getting and using information on construction projects under construction and completed projects. It is done in order to coordinate the input data, organize joint production and storage of data, as well as their use for various purposes at all
stages of the life cycle [3].
The issues of applying BIM technologies at the operation stage of capital construction facilities are the least studied in this field. Moreover, operation is the longest and most expensive period of a project's life cycle and it is here that you can get the greatest benefits from the introduction of BIM technologies. Information modeling forms the basis for all operation control decisions throughout a project's life cycle [4].
The purpose of the research is to develop solutions for implementing BIM technologies in the operation of capital construction facilities and an automated system for operation control of facilities based on a BIM model.
The object of research is innovative technologies in the operation of real estate.
The subject of the research is the use of BIM technologies in order to optimize the operation of capital construction facilities.

2. Materials and methods
The methodological basis of the research is a systematic approach that allows considering the process of implementing BIM technologies as a complete project that contains many elements. Various general scientific and special methods were used during the research. The following research methods were used: analysis and synthesis, formal-logical (deduction, induction, justification and argumentation); abstract-logical, empirical, tabular, and others.
The use of the formalization method in the development of the algorithm for the implementation of automation systems for operation control using BIM technologies for capital construction facilities allowed to identify the stages of the algorithm and the logical sequence of their implementation and to form various classifications.

3. Results and discussions
The result of the research is a developed algorithm for implementing automation systems for operation control using BIM technologies for capital construction facilities.
At the beginning of the study, possible options, which should be evaluated for further development of a capital construction facility, were considered:
- to leave “as it”;
- to sell the construction project;
- to motivate the operating company to work more effectively;
- to increase funding;
- to change the operating company;
- to make a decision about implementing BIM technologies.
As it is seen from the list, only one of the options has the implementation of BIM. The most important thing when implementing BIM technologies for a capital construction facility is the owner's decision to organize its operation using information modeling. During the operation control process, property owners must obtain, integrate, edit and update much information related to various building elements, such as operating costs, warranties and specifications from various systems. BIM can effectively combine this primary data and provide convenient storage and retrieval of this data [5]. The main barriers to implementing BIM range from the lack of BIM structure, low awareness of the benefits of BIM, high initial investment costs to staff resistance to change [6].
Uncontrolled and increasing costs for the operation of a project, expenses opacity of the operating company, an increase in the number of accidents and failures, low quality service can be the reasons for using BIM technologies. Stage 1 of the developed algorithm is taking this decision.
Stage 2, the survey, starts after the owner takes the decision to operate a capital construction facility by using BIM technologies. To do this, it is needed to search for performers, consider competitive offers, evaluate the project budget, select a contractor and conclude a contract for implementing BIM technologies along with the entire complex of computer-controlled systems. The site survey is the basis
for the plan of implementing the operation automation systems using BIM technologies and is carried out in order to assess its condition and prepare a proposal for implementation.

The system for monitoring the technical condition of a construction facility should be evaluated by writing a conclusion report. The audit of business should be performed with a company’s business process report. A company’s business processes related to the operation should be described clearly and reliably. International standards ISO 9000 and 14000 series can be used as the audit methodology.

In general, an integrated report is made. On the results of the report, technical guidance on the implementation of BIM technologies is specified. It includes technical and economic feasibility study with a provisional financial plan.

Stage 3 is a plan development for implementing BIM technologies for the operation of a capital construction facility. After developing the implementation plan, the contractor must submit it to the customer (the owner of the building) and confirm its feasibility within the cost limits and deadlines set by the owner. As a rule, a plan for implementing BIM technologies is developed by licensed companies that are involved directly in the operation of information systems.

The study revealed that there are currently two approaches to the acquisition and implementation of information systems in Russia (table 1).

| Name of the approach | Recommended projects to use                  | Software                                                                 |
|----------------------|----------------------------------------------|--------------------------------------------------------------------------|
| Boxed software       | Small projects                               | IBM Maximo, EcoDomus, 1C Enterprise "Operation Management"               |
| Customized software  | Large and complex industrial complexes       | RDC "Constructor", LLC "NPO SpecTech" (manufacturing group "TRIM"), ErmaSoft |
|                      |                                              | (manufacturing group "IGS-Zdaniye"), Sodis Lab (manufacturing group "Lement Pro"), LOY&HUTZ AG. |

| Table 1. Approaches to the acquisition and implementation of information systems. |

Each type of software is specific and requires the owner to make careful analysis and selection.

As a result, the owner should have a pack plan for implementing an automated operation control system. A consulting company or software developers should make this plan.

Stage 4 of the algorithm developed by the study authors is the implementation of BIM. On average, the information modeling implementation plan takes 4 months and costs up to 20 % of the project scope, while the implementation of BIM takes about 6-8 months. This conclusion is based on the experience of implementing such projects in Russia.

Stage 5 of the algorithm for implementing automation systems for operation control using BIM technologies for a construction facility is to control the results. To analyse the results is possible in a year from realizing the algorithm. It can be made by comparing the annual financial performance of the project's operation before the introduction of BIM and after the introduction of the new operation system. Based on the analysis, it is possible to draw appropriate conclusions and monitor the results of implementing BIM technology.

It should be noted that each construction project has its own characteristics. Construction projects differ in size, performed functions, technical condition, availability of technical documentation, qualification and motivation of personnel of the operating company, the amount of funding allocated, etc. As a result, there is no standard solution for automating the project operation tasks. In each case, you need your own project that takes into account the features of the project.

The stages discussed are shown in table 2.
Table 2. Developed algorithm for implementing BIM technologies for capital construction facilities.

| Stages of the algorithm | Result of the stage implementation | Stage duration, months | Expenses, % of the project scope |
|--------------------------|------------------------------------|------------------------|----------------------------------|
| Stage 1. The decision of the owner | Terms of reference for the survey | x                      | x                                |
| Stage 2. Survey | Integrated report and technical guidance for implementing BIM | 2-3 | 10 |
| Stage 3. Plan development for BIM implementation | Pack plan for BIM implementation | 1 | 10 |
| Stage 4. Implementation of BIM | Implemented BIM | 6-8 | 70 |
| Stage 5. Monitoring BIM results | Reasonable implementation results, conclusions | x | 10 |

The authors considered a construction project with an operational model of good detailing. This model is operated by using a specialized software package. If an emergency occurs with engineering equipment at the facility, the operating company must identify the defective equipment and get all the necessary information about it: what kind of equipment it is, who installed it, where it is located, and how to turn it off. When working with an operational model, an employee refers to this model. The model shows what technological circuits the equipment is connected to, how to turn it off, turn on duplicate reserves. After that, they start the repairing. In order to generate the repair requirements correctly, complete information about the construction project and its engineering systems is required. This data is in BIM model that contains engineering documentation provided by the equipment manufacturer, various certificates, operating instructions, and so on.

Having found and identified the fault, the operating company starts making the activity plan and calculating the necessary funds to perform the work. With a small amount of work, the activity plan may not be developed and the fault will be fixed by the operating company in terms of ordinary working arrangements.

When the repair is completed, operating set of documents (register books, acts) is formed. It is reported in financial documents and in the operational model itself.

Thus, in the presented algorithm, each stage of implementing BIM technology for the operation control of capital construction facilities is considered in details. By using the algorithm, considerable time saving is achieved when the process is operated by a BIM technology model.

4. Conclusions

Operation of a construction facility using the building information model has significant advantages over traditional methods: the main indicators of operation become transparent and the response speed increases many times over. The research is of practical significance, as the developed algorithm for implementing automation systems for operation control using BIM technology for capital construction facilities allows improving the current system of capital construction facility’s operation significantly. The results of the research indicate the need for active development and implementation of BIM technologies not only in the investment and construction sector, but also in operation control of capital construction facilities.
References

[1] Mesároš P and Mandičák T 2017 Exploitation and Benefits of BIM in Construction Project Management IOP Conf. Series: Materials Science and Engineering 245 (6) 062056

[2] Talapov V V 2017 The Basics of BIM. Introduction to Information Modeling (Saratov: Profobrazovanie) p 392

[3] Construction Rules 333.1325800.2017 Information Modeling in Construction. Rules for Creating an Information Model of Objects at Various Stages of the Life Cycle

[4] Kamenev A A, Abakumov R G and Yudov A E 2018 BIM Technologies in object and process management innovative economy: prospects for development and improvement (Kursk: University Book) 3 pp 59-64

[5] Siniak N, Žróbek S, Nikolaiev V and Shavrov S 2019 Building information modeling for housing renovation – example for Ukraine Real Estate Management and Valuation 27 (2) pp 97-107

[6] Wang Y, Wang X, Wang J, Yung P and Jun G 2013 Engagement of Facilities Management in Design Stage through BIM: Framework and a Case Study Advances in Civil Engineering 13 pp 1-8