Development of agricultural water supply and sanitation using information technologies

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Abstract. The problem of digitalization of agricultural water supply and sanitation is considered. The processes of development of information technologies and the features of their implementation in the activities of construction participants and organizations providing water supply and sanitation in agriculture have been studied. An approach to the creation of an effective system for managing the life cycle of agricultural water supply and sanitation facilities using information technology is proposed. The implementation of the results of the study will help improve the quality of water supply and sanitation services in agriculture and provide conditions for the growth of agricultural production.

1 Introduction

The most important tasks facing the domestic economy include the digitalization of all its sectors, incl. agricultural water supply and sanitation. The main water consumers in agriculture are processing enterprises of the agro-industrial complex, poultry farms, livestock complexes, farms, etc. The water supply and sanitation systems serving them include water intake facilities, pumping stations, treatment facilities, water towers, clean water reservoirs, main water lines and water supply networks and others.

One of the factors in the growth of agricultural production is the development of agricultural water supply and sanitation [1]. To ensure such development, a new approach based on the use of information technology is needed.

The digital transformation of construction participants and organizations providing water supply and sanitation in agriculture is a full-scale restructuring of their activities, incl. modernization and automation, the introduction of information technologies in the life cycle management of agricultural water supply and sanitation facilities, such as BIM technologies, artificial intelligence, big data technologies, the Internet of things, etc.

Also, the digital transformation of agricultural water supply and sanitation includes tasks related to changing relationships with resource providers, subscribers, regulators and other organizations.

The works of scientists [2-18] are devoted to the issues of digitalization of the economy in our country and abroad.

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The federal project "Digital Public Administration" of the national program "Digital Economy" involves the creation of a system for managing the life cycle of capital construction projects using information modeling technologies.

A system for managing the life cycle of agricultural water supply and sanitation facilities using information technology should be created.

2 Materials and methods

The pace of implementation of information modelling technologies for water supply and sanitation facilities in agriculture needs to be increased. It is necessary to modernize the processes associated with the management of investment and construction projects in the field of agricultural water supply and sanitation based on information technology.

Information modelling technologies (BIM-technologies) provide an opportunity to create an information model of agricultural water supply and sanitation facilities. This model refers to the digital representation of various characteristics of such objects, incl. physical, functional, etc. The process of information modelling is continuous throughout the life cycle of these objects from the moment the idea of their construction appears to decommissioning and liquidation [3, 4]. Objects of agricultural water supply and sanitation (structures, buildings with technological equipment, water and sewer networks) are technologically interconnected and this is a feature of BIM modelling in this area.

At the pre-project stage of the life cycle of agricultural water supply and sanitation facilities, a conceptual information model is being formed.

When using traditional technologies, the creation of the concept of the project took place, incl. taking into account the development of various schemes on paper or in the form of flat drawings and documents generated using software.

Information modelling technologies allow creating a 3-D model of objects and visualize the ideas of the customer. Of course, at the pre-design stage, the level of elaboration of the 3D model is quite low. Based on this conceptual model, a feasibility study is being formed, within which, incl. the marginal cost of future agricultural water supply and sanitation facilities is assessed using relevant standards and software.

If information models of analogue objects are developed, then the process of conceptual modelling will be faster and more accurate.

The use of data from such models will greatly facilitate the processes of planning the timing and estimating the cost of future agricultural water supply and sanitation facilities. During information modelling, when data on the planned construction time is added to the 3D model, a 4D level model is formed. And when adding information about the cost of objects - a 5D information model of agricultural water supply and sanitation facilities. Data on marginal cost and mandated timeframes allow the development of a mandated project budget. The use of information modelling technologies provides the ability to manage project life cycle parameters (cost and timing). As the BIM model develops and the stages of the life cycle of the project for the construction of new agricultural water supply and sanitation facilities change, their cost is being specified.

At the design stage, a design BIM model of the objects under consideration is developed. The level of elaboration of the 3D model is already becoming more detailed. Data from the 3D model is transferred to scheduling systems and a 4D level model is formed [5].

Special software systems allow you to bind estimated norms to the elements of a 3D model and perform several other processes, which allows you to “link” computer-aided design systems and software for developing estimate documentation. Thus, at the design stage, an information model of agricultural water supply and sanitation facilities of the 5D level is created. Information modeling technologies provide the possibility of parallel execution of the processes of developing a 3D model and determining the estimated cost of

construction, which certainly saves time and costs. The integration of computer-aided design, scheduling and cost modeling systems makes it possible to solve the problems of managing the cost and timing of the construction of agricultural water supply and sanitation facilities more effectively.

Information technologies make it possible to reduce the number of errors during design, check and eliminate the intersection of structural elements of a building, structure, etc.

Technologies have already appeared that provide the ability to automate the processes of choosing the most effective design solution, checking collisions, etc. We are talking about the use of artificial intelligence in design.

Special software, which is built on artificial intelligence and machine learning technologies, can help design specialists in the field of agricultural water supply and sanitation in the development of space-planning solutions.

The program allows choosing a more rational option from a large amount of data. Preliminary, this program is given parameters, according to which, based on a large amount of data, it self-learns and then generates the best options for the user.

At the construction stage, actual data on the progress of work are entered into the information model of agricultural water supply and sanitation facilities based on the results of the executive survey, as a result, an executive BIM model is formed.

Also, based on these data, a comparative analysis of information related to the actual performance of work and what was planned is carried out.

Special software allows you to visualize discrepancies in terms of time and cost. When such discrepancies exist, change management processes are implemented.

The use of the Internet of Things technology during construction allows, for example, connecting construction equipment, construction equipment, etc. to a single network to track information in real time. This will allow combining disparate information for the purpose of effective management.

In practice, traditional technologies are usually used, when such data is recorded on paper. The introduction of the Internet of Things technology at the construction stage will reveal new data that has not been collected before, i.e. if workers have smart watches, then you can get information about the time of their movement.

After the commissioning of agricultural water supply and sanitation facilities, their information model is transferred to the operation service of a service organization, for example, a water utility. The specialists of this service supplement the model with data on the maintenance of agricultural water supply and sanitation facilities, plans for their repairs, etc.

Thus, an operational BIM model of these facilities is formed. Information from such a model will be needed when searching for hidden building systems and its elements during maintenance.

Also, information from the operational model may be required if it is necessary to upgrade equipment, etc.

At the operational stage, other effective information technologies can also be used, for example, the Internet of Things and Big Data [6-8].

Based on the data of the Russian Water Supply and Sanitation Association, a high degree of deterioration of water supply networks is noted. This problem also needs to be addressed in agriculture.

In Russia, such wear is on average 60–70%, and water is lost due to leaks every year. These losses account for about 22% of its total volume.

At the beginning of 2022, the Digital Vodokanal software package was launched, which can determine unaccounted for water consumption on water supply mains and record pressure drops in pipes.

The introduction of new information technologies in the field of agricultural water supply and sanitation dictates the need to search for new approaches, mechanisms, and methods to ensure the effectiveness of this process.

3 Results and discussions

As a result of the study, it was revealed that the pace of introduction of information technologies in the design, construction of agricultural water supply and sanitation facilities, as well as in the activities of organizations operating them, needs to be accelerated. The authors analysed the development of information modelling technologies in our country and abroad [9-16]. Adaptation of such experience for agricultural water supply and sanitation will contribute to solving the problem under consideration.

Some processes related, for example, to the management of investment and construction projects in the field of agricultural water supply and sanitation require first modernization using BIM technologies, and then integration with other digital technologies.

So, in practice, when determining the estimated cost of construction of agricultural water supply and sanitation facilities, traditional technologies are still used, when this cost is determined on the basis of flat drawings, specifications and bills of quantities. It is necessary to modernize these processes using BIM technologies, i.e. implement a "relationship" between programs for 3D modeling and estimated software. To ensure the choice of an effective design solution based on a large number of reliable data, it is advisable to introduce artificial intelligence technologies into these processes.

One of the factors in the development of agricultural water supply and sanitation is the formation of a system for managing the life cycle of water supply and sanitation facilities in this area using information technology. This requires a systematic approach. It involves the identification of priority information technologies for participants in the construction of water supply and sanitation facilities in agriculture and the organizations operating them, and then further modernization of their processes using these technologies.

4 Conclusions

The approach proposed in the article will provide the possibility of transition to an effective system for managing the life cycle of agricultural water supply and sanitation facilities.

The introduction of BIM technologies, artificial intelligence, Internet of things technologies and other information technologies has a huge effect both for construction participants and organizations operating agricultural water supply and sanitation facilities, and for agriculture.

The introduction of these technologies at the stage of development and implementation of investment and construction projects will reduce the number of collisions, reduce the design and construction time, ensure savings in infrastructure investments, improve the quality of construction of agricultural water supply and sanitation facilities, etc.

In the operation of these facilities, the use of information technology also has its advantages, incl. significant financial savings. Such savings consist in the possibility of reducing the time to search for hidden systems of the building and its elements, in the timely updating of technological equipment, in carrying out repairs of buildings and structures and in reducing the costs associated with the operation of agricultural water supply and sanitation facilities.

The introduction of information technologies in the processes of managing the life cycle of agricultural water supply and sanitation facilities will contribute to the growth of agricultural productivity and its development.

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