E3S Web of Conferences **548**, 03025 (2024) https://doi.org/10.1051/e3sconf/202454803025
AGRITECH-X 2024

Information modeling of agricultural water supply and sanitation facilities

Stanislav Alekseev and *Tatyana* Alekseeva*

Moscow State University of Civil Engineering, Moscow, 129337, Russian Federation

Abstract. This study examines the features of developing an information model for water supply and sanitation facilities serving agricultural production. An analysis of the requirements for attribute data of the information model elements was conducted, and the characteristics of forming these data were studied. Based on the findings, recommendations for information modeling of agricultural water supply and sanitation facilities are proposed. The implementation of the research results will accelerate the transition to a life cycle management system for such facilities. This is expected to contribute to an increase in the quality of water supply and sanitation services in agricultural production, which will have a positive impact on its overall development. The key aspects addressed in this study include: identifying the requirements for attribute data in the information model; analyzing the characteristics of forming the attribute data; proposing recommendations for effective information modeling of agricultural water supply and sanitation facilities and outlining the benefits of implementing a life cycle management system for these facilities. By addressing these critical elements, the study aims to support the digital transformation of agricultural water infrastructure and enhance the efficiency and sustainability of water supply and sanitation services in the agricultural sector.

1 Introduction

One of the most pressing challenges confronting the national economy is the imperative to boost agricultural production, which is a crucial component of the country's overall economic growth and development. This growth is significantly influenced by a multitude of factors, including the effective development and implementation of robust agricultural water supply and sanitation systems, which play a vital role in ensuring the efficient and sustainable use of water resources in the agricultural sector [1].

The main consumers of water in agricultural production are processing organizations of the agro-industrial complex, livestock farms, and poultry farms, among others. These entities are serviced by diverse water supply and sanitation systems, including water intake and treatment facilities, pumping stations, and clean water reservoirs [2].

One of the primary objectives driving the development of the national economy at present is the imperative of digitalization [3, 5]. In line with the Federal Project "Digital Public

* Corresponding author: atr-mgsu@mail.ru

Administration" under the national program "Digital Economy," the establishment of a life cycle management system for capital construction projects has become a critical requirement.

In the process of creating this life cycle management system, it is anticipated that information modeling technologies, commonly referred to as BIM (Building Information Modeling) technologies, will be leveraged . The transition to such a management system is not only necessary but also crucial in the domain of agricultural water supply and sanitation.

The adoption of BIM technologies holds significant importance for the effective management of agricultural water supply and sanitation facilities throughout their entire life cycle. By implementing a comprehensive life cycle management system, these critical infrastructure assets can be better monitored, maintained, and optimized, ultimately contributing to the overall efficiency and sustainability of the agricultural sector.

This shift towards a life cycle management system, underpinned by BIM technologies, aligns with the broader national agenda of digitalization, as outlined in the Federal Project "Digital Public Administration" under the "Digital Economy" program. By embracing these digital transformation initiatives, the agricultural water supply and sanitation sector can leverage the power of information modeling to drive innovation, enhance operational performance, and contribute to the overall development of the national economy [2].

Water supply and sanitation facilities are technologically interconnected and each of them has its own life cycle [4, 5]. At the same time, the duration of the life cycles of buildings and the technological equipment located in them varies. Buildings and structures have a longer life cycle compared to equipment. During the existence of, for example, a pumping station, the equipment located there can be updated several times. These features must be taken into account when creating an information model of such objects and forming a system for managing their life cycle [6, 7]. This model is understood as a set of data about an object in electronic form.

Information modeling of agricultural water supply and sanitation facilities has its own unique characteristics that require careful consideration. The development of these facilities involves a complex interplay of various factors, including the design, construction, and operation of water supply and sanitation systems. Effective information modeling can significantly enhance the efficiency and sustainability of these systems by providing a comprehensive framework for managing the life cycle of these facilities. By addressing current challenges and opportunities, information modeling of agricultural water supply and sanitation facilities can play a vital role in enhancing the efficiency, sustainability, and overall performance of these critical systems.

2 Materials and methods

Information modeling of buildings and structures is a rather complex process. The introduction of BIM technologies into the activities of organizations is not an easy task [8-11]. At each stage of the life cycle of a building or structure, there are specific features of the use of information modeling technologies [12, 13]. Organizations that already use these technologies in their activities have advantages over competitors [14]. For example, when using BIM technologies, the number of collisions during design is reduced.

During the formation of an information model of a water supply and sanitation facility serving agricultural production, its 3D model is first formed (for example, a digital information model of a pumping station, water intake structure, water treatment plant, etc.). It includes geometric and attribute data of elements: walls, ceilings, windows, doors, technological equipment, etc.

The geometric data of each element of the 3D model determines the shape, dimensions, as well as its spatial location. Attribute information represents the properties of such an element. These properties define the characteristics of an element in the form of text data (for example: length, width, height, material grade, etc.).

There is the concept of “level of development of the information model” (LOD), i.e. a set of requirements that determines the completeness of the development of a model element [4]. This complex specifies the minimum amount of geometric and attribute data in order to solve certain information modeling problems at a specific stage of the object’s life cycle. As the BIM model develops during the life cycle of the object, the volume of this data increases and is supplemented.

The basic requirements for the levels of development of the information model are reflected in the rules for its formation (SP 333.1325800.2020) and are indicated for all stages of the life cycle. For example, at the design stage, such characteristics as: codes of elements and materials according to the construction information classifier, description of elements, their weight, dimensions, brand, GOST, etc. are indicated. The cost of these elements, completion time and other information are also indicated.

Certain data must be extracted from the information model of a building or structure [6, 15, 16]. This data includes:

- Flat data (2D), which represents the structure's layout in a two-dimensional format.
- Spatial data (3D), which captures the structure's dimensions and layout in three dimensions.
- Information about the time and timing of construction of the structure (4D), which details the project timeline and milestones.
- Information about the cost of a model element (5D), which provides financial data for each component of the structure.
- Information about the operation of the facility (6D), which includes data on the facility's maintenance, usage, and performance over time.

The composition and content of information models of buildings and structures are influenced by various factors [4, 6]. For agricultural water supply and sanitation facilities, such factors are as follows: the goals and objectives of the investment and construction project, the type of facility (for example, a pumping station, wastewater treatment plant, etc.), the stage of the life cycle of this facility, the requirements presented by the customer, the requirements specified in the regulatory and technical documentation, etc.

3 Results and discussion

As a result of the study, features of the formation of attribute data of elements of the model of water supply and sanitation facilities serving agricultural production were identified.

The designer is responsible for the formation of attribute data of model elements such as: length, width, height, area, volume, mass, etc. In practice, sometimes a situation arises when some of these parameters are not indicated in the properties of the elements and then the estimator is forced to enter the necessary data based on the project using special software to generate a BIM estimate.

Requirements for attribute information of model elements should be reflected in the organization’s BIM standard. According to the rules of information modeling, the attributes of model elements also contain information about their cost. The process of forming the cost of model elements at the design stage is shown schematically in Figure 1.

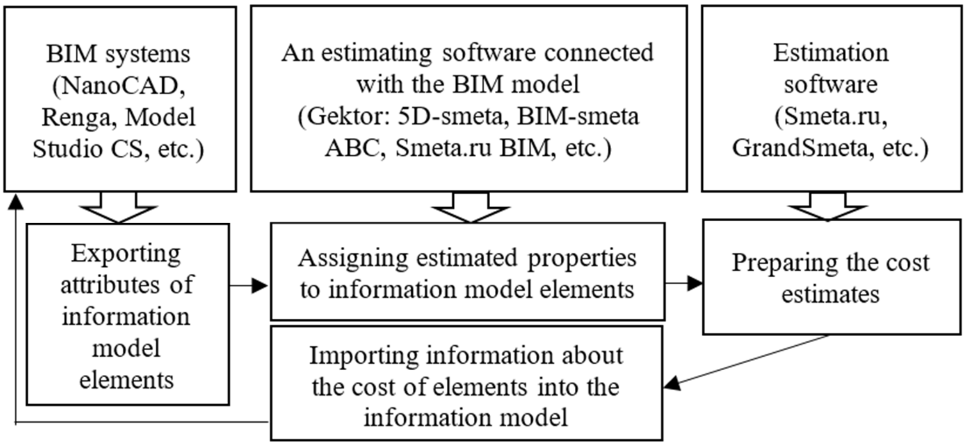

Fig. 1. Scheme of the process of forming the estimated cost of elements of a digital information model.

From the BIM system (NanoCAD, Renga, Model Studio CS, etc.), information about the parameters of model elements required for estimating costs is transferred to a special software package (Gektor: 5D-smeta or BIM-smeta ABC, Smeta.ru BIM, etc.). This information is then linked to model elements using estimated properties (estimated standards and resources). Correction factors are assigned, and the structure of the estimate is formed.

The information is then transferred to any estimate software (Smeta.ru, GrandSmeta, etc.) to develop estimate documentation. The cost information is then exported back to the model and reflected in the properties of the advisory elements as a cost attribute. Various formats are used to import and export cost data, including the ARPS 1.10 data exchange format, which was previously used, and the XML format, which is currently used.

However, Russian developers have created a new data exchange format, TIMML, which provides the most complete transfer of information. When using this format, great prospects open, as cost information can be transmitted not only to estimating BIM systems but also to scheduling systems and other information systems of the organization.

4 Conclusion

The article explores the key aspects of creating an information model for agricultural water supply and sanitation facilities.

Each element of such a model must contain certain information. To generate such information, it is necessary to implement a number of processes. Some processes are fully automated. Obtaining information about the length, width, height, volume, area of an element in special software is carried out automatically. Other information, for example information about the mass of the element, must be provided by the designer. And it is important to indicate this responsibility in the BIM standard of the enterprise.

It is significant that before the cost estimation process the model, it is properly prepared in accordance with the requirements of the BIM standard and the estimator does not then have to modify anything for the designer. Obviously, all this affects the timing of project development.

To reflect information in the properties of a model element about its cost, it is necessary to perform rather complex and time-consuming processes. These processes involve several specialized software systems. Such software must be integrated with each other in a single information space of the organization. At the same time, it is important that it fully meets the needs of the organization's specialists (user-friendly interface, separation of workstations for estimator and designer, intelligent linking of estimate standards, etc.).

To generate other attributes of model elements, for example, data on deadlines, it is also necessary to implement a set of certain processes. In addition to special software, techniques are also needed to manage these processes. Some of them have already been developed, while a number of techniques remain to be created.

The formation of an information model of agricultural water supply and sanitation facilities is necessary to create a system for managing their life cycle. Using information modeling technologies, it becomes possible to reduce design time, automate control of changes during construction, and save investments. Based on data from such a model, processes can be provided for managing the timing and cost of these objects. Furthermore, information from the BIM model can be used to plan energy and resource-saving measures during the operation phase. The transition to a life cycle management system for agricultural water supply and sanitation facilities, based on information modeling technologies, will contribute to the development of agricultural production.

References

1. A.N. Rozhkov, Plumbing, Heating, Air conditioning **4(136)** 34-37 (2013)
2. S. Alekseev, T. Alekseeva, E3S Web of Conferences **390** 03020 (2023)
3. V. V. Talapov, A. S. Nesipbayev, A. V. Khapin, B. E. Makhiev, Bulletin of D. Serikbayev EKTU **1** 111-119 (2022)
4. T. Alekseeva, S. Alekseev, Lecture Notes in Civil Engineering **231** 23-31 (2020)
5. V.I. Bazhenov, D.A. Danilovich, G.A. Samburskii, V.V. Bazhenov, The best available water supply and disposal technologies **6** 38-48 (2017)
6. V.I. Bazhenov, Science and business: ways of development **1(139)** 8-16 (2023)
7. Yu. N. Pokhil, P. I. Andrianets, A. P. Andrianets, Water supply and sanitary technique **4** 75-80 (2019)
8. B. Manzoor, I. Othman, S. S. S. Gardezi, H. Altan, S. B. Abdalla, Applied Sciences **11(12)** (2021)
9. N. V. Anikina, T. R. Ishtryakova, Modern Economy Success **6** 37-42 (2021)
10. K. Wang, C. Zhang, F. Guo, S. Guo, Journal of Management in Engineering **38(4)** 04022033 (2022)
11. L. Kong, Q. Yang, Q. Zhou, J. Xing, X. Sun, R. Zou, Journal of Building Engineering **49** 103999 (2022)
12. Yu.Ch. Lin, Ya.T. Hsu., H.T. Hu, Advances in Civil Engineering **2022** 1901201 (2022)
13. T.F.L. Da Silva, A.V. Arroteia, S.B. Melhado, M.M. De Carvalho, D.R. Vieira, Journal of Modern Project Management **8(3)** 125-135 (2021)
14. Ya. Xiao., J. Bhola, International Journal of System Assurance Engineering and Management **13(1)** 111-120 (2022)
15. A. Kuzminykh, A. Kukina, G. Bardina, Smart Innovation, Systems and Technologies **247** 667-675 (2022)
16. S. Banihashemi, S. Khalili, M. Sheikhkhoshkar, A. Fazeli, Innovative Infrastructure Solutions **7(3)** 1-25 (2022)