BIM-MODELING OF TRANSPORT INFRASTRUCTURE OBJECTS

1st Victoria Shamraeva
Department of Data Analysis and Machine Learning

Financial University under the Government of the Russian Federation
line 4: City, Country
line 5: VVShamraeva@fa.ru and
ORCID 0000-0003-0858-7793

***Abstract*— The article analyzes the geographic information system (GIS) of the Avtodor state company (developer "Indor-Soft", Tomsk). The implementation of the project through BIM modeling is described, on the example of construction of transport infrastructure facilities of the Far Western bypass of Krasnodar project (FWBK). Issues of standardization and database creation of information models in urban planning and road construction are currently priority areas in the Russian Federation. Evidence-based reasoning is given that it is optimal to use GIS at the operational stage of a complete BIM model of the road. Are revealed the main functionality and examples of using of the Avtodor state company IndorRoad GIS for data entry, accounting and analysis, to solve practical problems of road maintenance.**

Keywords—BIM for road constructing and maintenance, road information model, geographic information system, transport infrastructure component

I. INTRODUCTION

The main components of the digital transformation of the road industry are: mobility; safety; efficiency; use of information modeling when building models of linear-extended road sections [1]. Geographic information systems (GIS) are tools for managing the state of transport infrastructure objects at the operational stage: both Building Information Modeling (BIM-modeling) and GIS are interrelated, since they are based on an information model and a common data environment (CDE).

The article analyzes the geographic information system (GIS) of the Avtodor state company (developer "Indor-Soft", Tomsk). The main tasks assigned to the GIS of the Avtodor are listed on the site https://avtodor-eng.ru/services/arenda-spetstekhniki/geoinformatsionnye-sistemy. The implementation of the project through BIM modeling is described, on the example of construction of transport infrastructure facilities of the Far Western bypass of Krasnodar project (FWBK).

The need for the exchange of 2D and 3D information between computer-aided design (CAD) systems has existed for a long time, as well as in a standard that records changes in an infrastructure object throughout all stages of its life cycle [2], [3]. Issues of standardization and database creation of information models in urban planning and road construction are currently priority areas in the Russian Federation. The international non-profit organization buildingSMART based on the NAICS Association, has been dealing with these tasks since 2017 in Russia. National BIM standards have not yet been fully developed and there is a lack of software compatibility in the road sector, as not only domestic developers say [4]. At the moment, the use of digital models of capital construction objects is regulated by Resolution N 1431 of September 15, 2020 (see https://ipbd.ru/doc/0001202009220002/).

Let's note the differences between the information model of capital construction facilities and linear-extended transport infrastructure facilities. For transport facilities, design and construction are carried out in separate sections, which takes into account different implementation periods, that is, they are simultaneously at different stages of the life cycle (for example, construction, operation and repairs can be carried out on the same road at the same time) and the project itself is usually performed by several contractors. Therefore, it is optimal to use GIS at the operational stage of a complete BIM model of the road [5]. The main functionality and examples of using of the Avtodor state company IndorRoad GIS for data entry, accounting and analysis are disclosed in [6], to solve practical problems of road maintenance. The approach to the formation of GIS of the Avtodor state company serves as an example of interaction between the state and business and will help develop common standards and regulations for information exchange

II. BIM-MODELING IN RESEARCH AND DESIGN

Currently, the state-owned company Avtodor is implementing a project to build the FVBC highway, which is part of the North-South transport corridor. To justify the investment in the project, a consolidated model of FWBK was created (Project model_2108018_dop_attributes.nwd) in the Autodesk Navisworks environment, using the NWD file format, which is a data exchange format for summary models. This format is static, meaning that the data contained in the file cannot be changed and used to create 2D drawings. The individual models that make up the BIM summary model correspond to different sections of the project and are integrated using different formats (including dwg, dwf and fbx). Not all of these formats allow you to load feature attribute data into a BIM model. The geometric parameters of the information model elements are completely correct (see Fig.1). The level of detail of objects is very high.

Fig. 1. Section of the BIM model on a road section

When planning a project using the InfraBim [7] tools, you need to define the basic Levels of Development (LOD). The most optimal in this project is the LOD 500. Let's list the LOD results:

- **LOD 100**: territory diagrams with models of existing and planned highways (2-D model)
- **LOD 200**: an area plan with the planned highway in the form of a highway model (number of lanes, configuration of junctions and intersections, etc.)
- **LOD 300**: engineering model of the highway route, structural lines, road surface and roadbed, road markings, artificial structures, construction site development plan, etc
- **LOD 400 - LOD 500**: 1) a Production model with a detailed work schedule, logistics for the supply of products and materials, etc. (including 3D models for automated control systems for road construction machines) 2) Executive model (models of laser scanning of the highway, etc.) 3) Operational model (formed on the basis of the Executive model)

The LOD 500 model has clearer relationships and the most complete data for all elements of the model (see Fig.2).

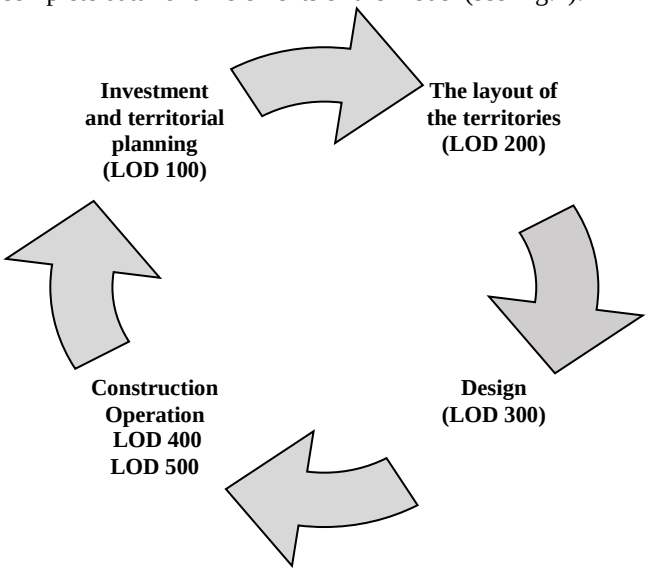

Fig. 2. Road projects life cycle and LOD levels of detail

III. Common data environment for project implementation

CDE and the BIM model at the operational stage are described in [6]. An information model in GIS is generated for roads that are being operated using CDE during surveys, routine diagnostics, and engineering surveys. A BIM model is formed for roads under construction and under design. These processes will continue to develop in parallel for quite a long time due to the significant length of the road network. Thus, only the use of CDE will allow avoiding contradictions and ensuring the reliability of the information model data in both cases. The description of aspects of the organization of CDE is given in the UK BIM standard [8], [9].

In [5], we present evidence – based arguments that the GIS of highways are CDE and BIM model of roads in the operational stage at the same time. The use of the web-based General data environment (geoportal) GIS allows online use of a digital terrain model with subdecimeter accuracy for unmanned vehicles. The development of unmanned vehicles and "convoy" technology for autotransport trains requires interaction between the road infrastructure, on-Board computers and computer vision of cars: Avtodor state company prepares GIS and CDE interfaces for interaction with such vehicles based on V2I (Vehicle to Infrastructure — vehicle to infrastructure) [6].

In 2020, specialists of JSC "Institute Stroyproekt" implemented a BIM model of FWBK in the S-INFO environment (see https://sinfo.tech/ru/portfolio/dalnij-zapadnyj-obhod-krasnodara). Experts determine whether this model is suitable for breaking down construction and installation works into stages and getting a General idea of the implementation of construction and installation works, and also specify to what extent it can be used for the operation and maintenance of infrastructure facilities. In the current state, the BIM model can be used to get an idea of construction and installation works and structures under construction, update data on the volume of earthworks and control geodetic works.

Conclusion

The operational InfraBim model of FWBK will provide uniform principles of data storage, access and processing for applied tasks. Avtodor state company implementation of the FWBK project is an example of successful interaction between the state and business. The use of BIM tools in the implementation of transport infrastructure development projects will allow solving the main tasks that are set for the road area – optimizing time and money when planning and implementing activities at the stage of operation of infrastructure facilities.

References

[1] V. V. Shamraeva, "Predicting the effectiveness of implementation of financial models for toll collection on the road," Transport business of Russia, 2020, No 1, pp. 37-41.

[2] S. Znobishchev, V. Shamraeva, "Practical use of BIM modeling for road infrastructure facilities [Prakticheskoye primeneniye BIM modelirovaniya dlya ob"yektov dorozhnoy infrastruktu]," Architecture and Engineering, 2019, vol. 4, No 3, p. 49-54.

[3] V. V. Shamraeva, "Analysis of business processes of construction and operation of highways on a toll basis using bim tools BIM-modeling of transport infrastructure objects", Information Technologies and Mathematical Modelling: 19th International Conference, ITMM 2020, named after A.F. Terpugov, Tomsk, Russia, November 2-5, 2021, pp.429-440.

[4] L. Sandeep, "Challenges with BIM Implementation: A Review of Literature", 53rd ASC Annual International Conference Proceedings of the Associated Schools of Construction, 2017. URL: https://www.researchgate.net/publication/317842173_Challenges_with_BIM_Implementation_A_Review_of_Literature

[5] V. V. Shamraeva, E. G. Kuzovlev, S. V. Barannik, "Implementation of geographic information systems in the road sector as one of the directions of information modeling" [Realizatsiya

geoinformatsionnykh sistem v dorozhnoy oblasti kak odnogo iz napravleniy informatsionnogo modelirovaniya] // Vestnik komp'iuternykh i informatsionnykh tekhnologii, 2018, No 6 (168), pp. 20-26. DOI: 10.14489/vkit.2018.06.pp.020-026

[6] V. E. Dmitrienko, E. G. Kuzovlev, L.G. Shamraev, "GIS application of the avtodor state company for solving practical tasks of road maintenance", CAD & GIS for roads, 2019, No 2 (13), pp. 52-59.

[7] V. Shamraeva, E. Savinov, "Infra-BIM for manage the business processes of highways consrtuction and operation", Architecture and Engineering, 2021, in press

[8] Draft standard for information management in the phase of capital construction using information modeling. Standard No. PAS 1192-2:2013. Available at: http://bimstandart.tilda.ws/pas1192-2

[9] British standard. Joint production of architectural, engineering and design information - norms and rules. Standard No. BS 1192:2007. Available at: http://browniesoft.com/uploads/files/BS_1192_2007_new_ru_demo.pdf