Digital Asset in the System of Real Estate Management

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Abstract. This study examines the definition of a digital asset and considers its properties in the system of managing real estate that helps to reduce transaction costs. The intermediate results of the development of a service for digital asset management are presented. In practice, a method of accounting and using data about an object with the use of information modeling technologies is shown. The structure of the code from the point of view of programming is given. The proposed method is aimed at recording data throughout the entire life cycle of a capital construction facility with an emphasis on the operation&maintenance stage, as at the life cycle stage, the least susceptible to the introduction of information modeling technologies. The current research areas in the field of «digital asset» management and digital «asset management» are identified.

1 Introduction

For real estate objects, with the development of information technology, more and more tools for digital design, creation and operation are available. Among such technologies associated with construction projects, first of all, we can distinguish the technology of building information modelling (BIM) and digital twins (DT). These technologies act as digitalization tools, respectively, of construction objects and production technologies. In particular, the integration of these technologies is most relevant within the so-called "Factories of the Future", in the physical image of which there are both production technologies and production infrastructure with buildings, structures and systems included in it, taking into account the role of information modeling systems [3]. At the same time, locally applied technologies BIM [1] and DT [2] can be linked to GIS-systems [4]. To form a full-fledged digital asset, a theoretical base and approbation of approaches are needed at civil engineering facilities, as on less complex technical systems than industrial facilities. To ensure the economic feasibility of the proposed methods, the concept of “digital asset” is considered and semantically analyzed. The relevance of the study is due to the need to

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digitize construction facilities to reduce operating costs at the operation stage and at other stages of the building's life cycle.

According to economic theory, an “asset” is any resource owned or controlled by a company or an economic entity [5]. This is everything (tangible or intangible) that can be used to generate value, is in the possession of an economic entity and can produce positive economic value. Therefore, we use the term “digital asset” to describe a digital object (resource) that is owned (or partially owned) by the owner and can potentially create economic value.

According to the definition given by Elena Konvisar, Digital asset = BIM + EDMS (engineering data management system) + business processes of construction and operation [6]. We propose to expand the definition of a digital asset to any digital resource potentially capable of generating economic benefits.

Practical research is aimed at the formation of an information model of the life cycle - a digital resource of the owner of a physical asset that can potentially bring material benefits, reduce operating costs, and therefore considered as a digital asset. The relevance of the project for Russia has significantly increased with the release of Decree of the Government of the Russian Federation No. 1431 on September 15, 2020 "On approval of the Rules for the formation and maintenance of an information model of a capital construction object, the composition of information, documents and materials included in the information model of a capital construction object and presented in the form of electronic documents, and requirements for the formats of these electronic documents, as well as on amending clause 6 of the Regulation on the implementation of engineering surveys for the preparation of design documentation, construction, reconstruction of capital construction facilities "[7]. At the moment, there is no toolkit for fulfilling the requirements specified in the DG regarding the accounting and inclusion in the information model of such documents as building permits, commissioning permits, survey reports and others. The study solves the problem of the lack of approaches and solutions to the fulfillment of the requirements of the Decree of the Government of the Russian Federation No. 1431 of September 15, 2020.

This article presents the intermediate results of creating a service for managing the life cycle of construction objects. Approbation was carried out on a real object (a school in the Moscow region and an object of cultural heritage - a manor in the city of Kislovodsk). Since the project is aimed at managing the entire life cycle of a building, approbation takes place both at the new construction site and at the existing restoration site. The potential beneficiaries, respectively, are the owners and operators of civil and industrial construction projects.

The Forge environment created by Autodesk was used as a tool for developing a web service and its corresponding digital asset.

2 Methods

From the field of application point of view on a digital asset in the field of real estate and construction, the most common ways to reduce operating costs were identified using the analytical method.

The study assumes the linking of the operational BIM model with the ERP system, the inclusion of the Autodesk Forge product in the system project for the digitalization of real estate lifecycle management, the inclusion in the application of a web navigation system, a library of operational data about building elements, information in case of emergencies, the creation of as-built BIM models based on the results of laser scanning, comparison with an as-designed model and the formation of an actual HVAC model at the construction stage for subsequent use in operation (a stage at which there will be no open visual access to all

engineering systems), digitalization of the process expertise, establishing information flows between the facility and GIS systems, planning repairs and generating purchase lists, digitalization of marketing, security, resource consumption and space management.

The needs for the development of modern real estate objects set the trend for new digital technologies, and their competitive advantage will be the adaptability of the building to changing requirements using integrated BIM technologies.

An integral element of the digital asset of a building is also a management system - technology SIM (System Information Modeling) [8]. SIM technology is understood as supporting the digital modeling process of a complex interconnected system, which is a common information resource that forms a reliable knowledge base. We can say that SIM takes into account the transformation of the object management process depending on changes in technology, adapting to these changes [9].

The service being developed is being tested at two capital construction sites: the existing one and the one designed to include functionality at different stages of the life cycle. Existing object modeled in Autodesk Revit software from laser scanning and point cloud processed in Autodesk Recap software. In this case, the so-called Scan-to-BIM technology [10] is used. The resulting information model is semantically saturated both with the properties of materials and due to the binding of documentation to the elements of the object, groups of the object and the object as a whole.

The web service is built on the basis of HTML, CSS, JavaScript. HTML - defines the structure of the web page. CSS - responsible for styling. JavaScript is a programming language that combines an object-oriented, functional paradigm. The Autodesk Forge API is used to render the information model.

All the described methods are combined in the experimental prototype of web-service for digital asset management. Approbation of the prototype is held on two construction objects: existing one and designed one.

3 Results and Discussion

3.1 Formation of a digital asset

The set of digital technologies and their bidirectional connections with the physical world is considered in this article as a digital asset, that is, a digital resource that can potentially generate material benefits for the owner of a physical asset. This study examines a digital asset in the field of real estate, with special attention paid to the operation&maintenance stage, since at the design and construction stages information technology has already proven itself [11,12]. Material benefit or reduction in transaction costs becomes potentially possible due to the following components of a digital asset:

Documentation. Accounting for facility documentation based on the Decree of the Government of the Russian Federation No. 1431 of 15.09.2020 [7].

Navigation [13]. Delivery of navigation data from a BIM model.

Location of building components. Maintenance personnel have access to information on the location of components such as ventilation and air conditioning, electricity, gas and water systems (often not directly accessible to the naked eye) simplifies the task of locating equipment and materials during regular maintenance of building components. Search, filter, routing access to the required component. Providing tools for accessing information and navigation in the BIM model will reduce the dependence of performers on office workers and paperwork. The result is the separation of information from the medium.

Visualization and Marketing [14]. The BIM model allows you to create renders, visualizations of buildings and structures.

Maintainability check. [15] Maintainability in this case refers to the ability of a component / system to demonstrate the required level of performance while minimizing life cycle costs. The BIM model allows you to both simulate and more accurately predict LCC (LifeCycle Cost or Life Cycle Cost) at the design stage, and to evaluate it for existing buildings in the case of as-built BIM.

Creation and updating of digital assets. [16] Due to the fact that buildings and structures are complex technical systems, digitalization of all its components to form a database of property and digital asset becomes a labor-intensive process. Today, by purchasing a real estate asset, the owner and operating organization also have the opportunity to purchase a digital asset, which becomes possible thanks to the development of BIM technologies.

In the context of business digitalization, firms face special management problems, old rules do not apply, barriers to entry to markets disappear, a fundamentally new digital business infrastructure appears - digital platforms [17-19]

Space management. [20] The BIM model can be used as a space management tool. This will optimize the capitalization of the real estate asset and the use of space. In addition, efficient space management can increase the productivity of staff working on site.

Planning and feasibility studies for non-capital construction. [21] In this case, during reconstruction and non-capital construction, the advantages of BIM are similar to the design and construction stages: detection of collisions and intersections of systems, optimization of the construction process, calculation and accounting of material volumes, etc.

Prevention of collisions at the design stage, with proper control over the compliance of the building under construction with the information model, reduces labor costs for finalizing the executive model, i.e. the one that is formed by making changes to the model, on the basis of which the design documentation was formed, in parallel with the construction and installation work, and is fully consistent with the executive documentation and can be used after the completion of the modeling process. [22]

Emergency management. [23] In case of emergencies (fires, terrorist attacks, earthquakes, strikes, etc.), management decisions depend on a number of reasons, in particular related to the workspace. The organization of this information is simplified with the use of BIM, it becomes possible to accumulate decision-making scenarios depending on the current emergency.

Energy control and monitoring. [24] Optimization of energy costs. Sensors providing real-time information.

Personnel training and development. [25] Having a BIM model will allow inexperienced personnel to train and navigate the constituents of a real estate asset not through verbal and visual explanations, but using a digital twin.

Augmented reality. [26] Add-on to the information model of visualized production instructions.

Expertise. The information model of the object can also be used when conducting an examination, eliminating comments, simplifying the interaction between an expert and a customer of the examination.

As a result of the study, the first version of an experimental prototype of the BAM web service was created for managing the life cycle of a capital construction object. The figure below shows an interface with functionality based on a BIM model obtained from the results of laser scanning.

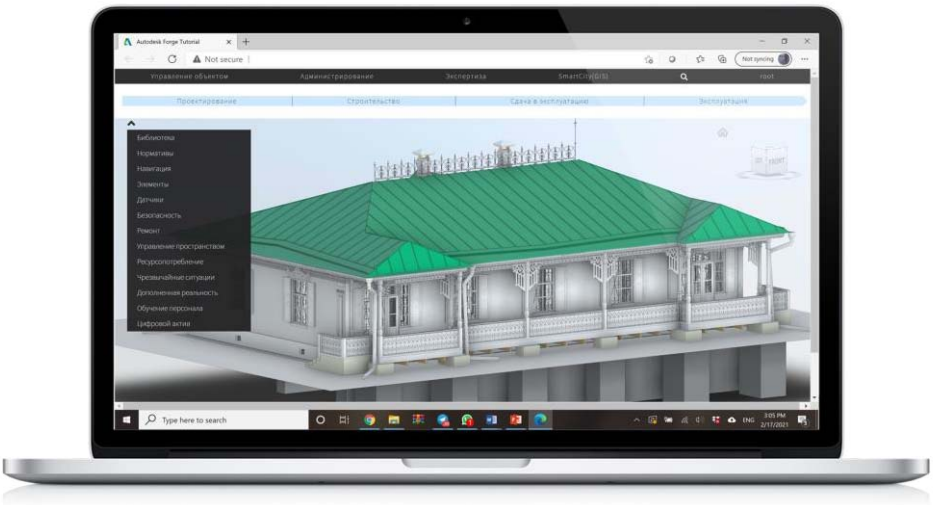

Fig. 1. An experimental prototype of a web service for managing the life cycle of a capital construction object

Reconstruction and major repairs in the operational phase of the real estate life cycle especially clearly show all the advantages of using BIM technologies in this area. Reconstruction of a real estate object is carried out to maintain or improve the operational parameters of the object in order to lengthen the life cycle. In the presence of a digital model of a building, all these processes can significantly save both time and material reserves (Fig. 2).

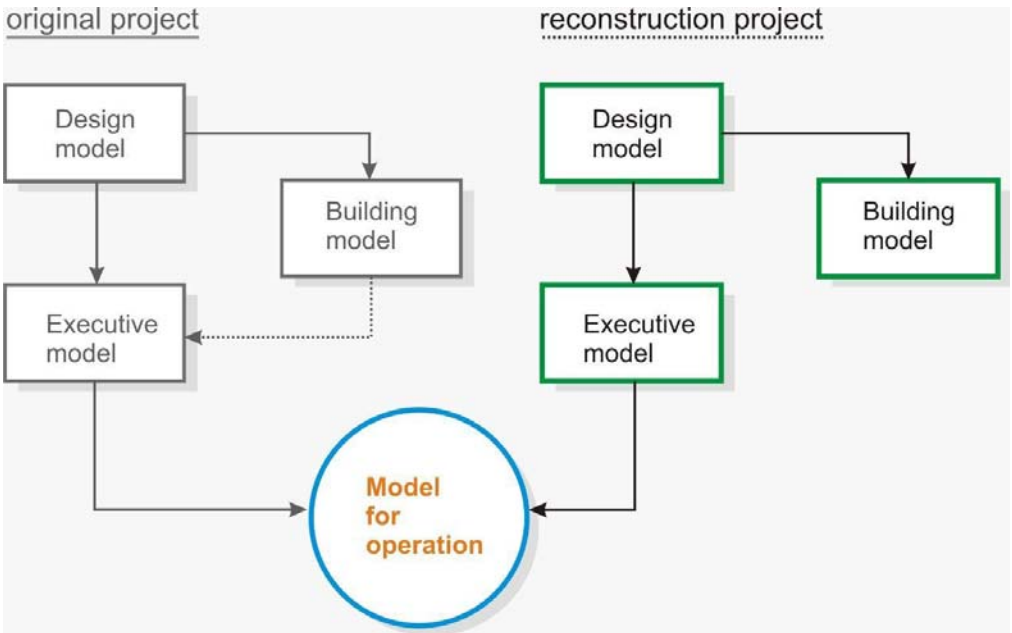

Fig. 2. Scheme of the organization of work on the reconstruction of an object using BIM technologies

The key definition of the relationship between DAM (Digital Asset Management) and complex business systems already in use in the manufacturing world consists in an almost structural delay of the two reference worlds: the world of construction and Real Estate, by definition is at levels of slower acceptance of innovation [27] than in the manufacturing world. In [28] we analyze the characteristics of the process of choosing to undertake the path of digitization in the DAM sector by studying its drivers: greater efficiency in the organization of work flows [29], in particular the direct effects of choice would be indicated in the information sharing function that would lead to an increase in revenue in the short-medium term for the company [30]. The definition at a strategic level is to be considered as equally important as the IT and technical definitions since the purchase decision, following the approval by the companies, determines their diffusion and success. In an interconnected world, the success of technology is determined by the adoption rate. Greater adoption translates into an advantage in terms of assistance, development, research for the whole sector and in a sector such as construction the aforementioned slow reaction can translate into an advantage, exploiting the progress achieved by early adopters in other sectors [31] and, often, in the phases preceding the development of technologies and solving problems and bugs in unconventional environments such as specialized forums for restricted environments which represent a great form of development.

It is important to note that in this case we are talking about «digital asset» management and not about digital «asset management», which can often be read in two ways in English (Digital Asset Management).

3.2 Application structure

Like any web application, the developed service consists of a client and a server part.

Frontend - the client side. Implements the processing of 2d drawings or 3d models, rendering of the UI (user interface), all kinds of operations with elements of the loaded information model, such as highlighting the necessary elements, etc. Events from the client are also processed here. Ultimately, a DOM tree is generated and the page is rendered in a browser using the HTML hypertext markup language.

Backend is a server part built in the node js language. Responsible for receiving requests from the client, processing them and then generating a response, for example, in the form of an HTML page. Here authorization and user authentication is implemented, files are read from directories.

As mentioned earlier, the service is built using Autodesk Forge, a set of cloud APIs on which a web application is built. The user can upload the desired model (more than 60 formats are supported), and the conversion to the Viewer format will automatically occur. The information model is loaded by calling the launchViewer method, which is passed the urn parameter. After successful loading, the onDocumentLoadSuccess callback function is called, in which you can access the tree of model elements, get the id of all elements, and so on.

```
function launchViewer(urn) {
  var options = {
    env: 'AutodeskProduction',
    getAccessToken: getForgeToken
  };

  var dataInfoTable = {};

  getInformationDocument();
```

```
    Autodesk.Viewing.Initializer(options, () => {
        viewer = new Autodesk.Viewing.GuiViewer3D(
            document.getElementById('forgeViewer'),
            {extensions: ['MyAwesomeExtension', 'CustomPropertyPanelExtension']}
        );
        viewer.start();
        var documentId = 'urn:' + urn;
        Autodesk.Viewing.Document.load(documentId,                    onDocumentLoadSuccess,
onDocumentLoadFailure);
    });
}
```

Fig. 3. Code Element

3.3 Categories

The internal structure of Revit includes categories. In the developed application, they are stored in a json file.

```
"Инженерные сети": [
    "Revit Осветительные приборы",
    "Revit Кабельные лотки",
    "Revit соединительные детали кабельных лотков",
    "Revit Выключатели",
    "Revit Электрические приборы",
    "Revit короба",
    "Revit Сантехнические приборы",
    "Revit воздухораспределители"
  ],
  "Монтируемое оборудование": [
    "Revit ограждение",
    "Revit пандус"
  ],
```

Fig. 4. Internal structure

With js, categories are automatically generated as a side menu on the page. The click event handler, customizable for each category, allows you to organize the highlighting of the necessary elements. The viewer.impl.highlightObjectNode method is responsible for this.

```
categoryUI.addEventListener("click", () => {
    for (let val of Object.values(all_category)) {
        for (let key in val) {
            if (key === categoryUI.innerHTML) {
                val[key].map(id => {
                    viewer.impl.highlightObjectNode(
                        viewer.model, id, true, false);
                })
            }
        }
    }
})
```

Fig. 5. Code element

3.4 Table

For the convenience of work, a tool has been created for linking a web service with data from the Revit specification in excel format. The xlsx libraries provide conversion of excel to json. This process is carried out on the server side.

```
function transformToJSON(FILE_PATH) {
   let workbook = XLSX.readFile(FILE_PATH);
   let sheet_name_list = workbook.SheetNames;
   const sheet = workbook.Sheets[sheet_name_list[0]];
   return XLSX.utils.sheet_to_json(sheet,{defval:""});
 }
```

Fig. 6. Code element

After sending json data from the backend to the frontend, a table is formed using the js code, which is available for editing directly on the web service page. This changes the data, both on the page and in the original excel file.

```
function createTable(data) {
   let elem = document.querySelector('.table');
   let table = document.createElement('table');
   for (let i = 1; i < data.length; i++) {
      let tr = document.createElement('tr');
      for (let key in data[i]) {
            var td = document.createElement('td');
            td.classList.add(key);
            td.innerText = data[i][key];
            tr.appendChild(td);
      }
      table.appendChild(tr);
   }
   elem.appendChild(table);
}
```

Fig. 7. Listing. Generating a table from a specification

At the initial stage, three types of user were created with different levels of access to the information model. In the future, it is planned to adjust the access level depending on belonging to a certain group.

4 Conclusions

In this study, a preliminary analysis of a digital asset as an inseparable part of real estate management is carried out. The first experimental prototype of the BAM web service for managing a digital asset was developed, tested on the example of a real object and a model created by laser scanning.

Sources analysis has shown that there are a number of BIM applications in building operations and lifecycle management. At the same time, the greatest value of a digital asset is achieved through the integration and convergence of various IT solutions.

The development of the market for information modeling technology in construction means the emergence of an institutional arrangement for buyers and sellers to deliver information about relative prices, conditions of supply and demand. Thanks to the information modeling technology in a heterogeneous environment of different economic agents implementing one investment project, an additional system-forming factor arises as an information model throughout the life cycle of an object. [32]

At the project management level, it is necessary to take into account the different levels, studying the problem at a more operational level: the identification of stakeholders must precede the market analysis of the available commercial product, in order to then come to the definition of integration needs with existing systems. These aspects are inherent characteristics at the level of strategic and operational management of the implementation of a digital asset management system in a company or organization.

At the moment, the concept of digital «asset management» is more common in the literature, which can often be read in two ways in English (Digital Asset Management). Further research involves an ontological analysis of similarities and differences, and most importantly the object of management in the cases of digital «asset management» and «digital asset» management.

In the case of industrial capital construction, it is necessary to include in the digital asset both information models of buildings and structures (BIM) and information models of equipment (DT).

Software complexes allow to fully implement the process of real estate object management. The use of web technologies allows for cross-platform functionality.

Further areas of research imply a detailed study of the entire functionality of the digital asset of the real estate object. It is planned to integrate existing solutions into the developed web service.

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