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USING DIGITAL TECHNOLOGY IN THE CONSTRUCTION INDUSTRY

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ANNOTATION: In this article, the directions of using digital technologies in the construction industry, which occupies an important place in the structure of our country's economy, the driver of the transformation that accelerates the introduction of technological innovations in the digitization of the industry, the difference in labor productivity in the industry in different countries, the use of a number of digital tools and technologies in the construction industry, in particular PLM systems (product lifecycle management) - product life cycle management and BPM systems (business process management) - aspects such as business process management are covered. Scientific and practical suggestions for solving problems in the field of construction were developed.

Keywords: analysis, digital technologies, technological innovation, capacity of fixed assets, capital construction, transformation, driver, construction objects, labor productivity, product lifecycle management, business process management, business management, capital investments, economic efficiency, socio-economic efficiency, investment, new construction, reconstruction, technical rearmament, etc.

INTRODUCTION

As humanity has learned to process large amounts of data, life is changing rapidly. At the current stage of development, the use of digital technologies in the construction industry, which occupies an important place in the structure of our country's economy, is considered important. The digitalization of the construction industry is a driver of transformation that accelerates the introduction of technological innovations.

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Labor productivity in the construction industry varies in different countries. China and South Africa show rapid growth in labor productivity, while Brazil and Saudi Arabia have lower labor productivity. Some countries (Australia, Belgium, and Israel) are achieving high levels of labor productivity and its intensive growth[1].

McKinsey experts note that construction productivity is gradually increasing, so digital technologies and new materials are a means of accelerating productivity growth.

Today, digital technology is used in various fields - from marketing to navigation. In particular, construction is not far behind in this regard. Every year, humanity produces more and more information: the forecast of the analytical company IDC is based on the fact that by 2025 the total amount of information worldwide will amount to 163 zettabytes (ZB). For comparison, in 2016 there was 10 times less information on our planet - 16 ZB, and in 2006 - only 0.16 ZB[2].

At the same time, the share of information created by commercial enterprises is increasing. According to IDC analysts, by 2025 they will produce 60 percent of the world's information (against a third in 2015). However, companies are striving not only to produce information, but also to analyze it. With the advent of big data, the prospects for this direction are increasing even more, that is, artificial intelligence is able to process not only structured, but also large volumes of various information (for example, publications on social networks and comments on news).

LITERATURE ANALYSIS ON THE TOPIC

Computers and digital technologies in construction were introduced in areas where there were large-scale calculations, primarily in economic calculations. Later, the main research direction of A.A. Gusakov was defined as: building systems engineering, as the science of creating complex automated technical systems in construction, as the application of a systematic approach to construction objects[3].

It is worth noting that today a number of digital tools and technologies are already being used in the construction industry. The most popular are PLM

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systems (product lifecycle management) and BPM systems (business process management) [2]. Within these systems, subsystems are used, for example: ERP systems (Enterprise Resource Planning). This is an information system that automates the processes of designing, accounting, controlling and analyzing all key business processes and solving business problems of a construction company. The system helps to integrate all departments and functions of the enterprise into a single system, while all departments work with a single database and they facilitate the exchange of various information with each other. ERP systems are implemented in such a way that all departments of the enterprise and all necessary functions are integrated into a single computer system that meets the current needs of the departments [4]. The ERP system increases the responsibility of individuals for the overall work, and the main motivation for introducing mobile access to ERP is to reduce operating costs. CRM-system (Customer Relationship Management) is a model of interaction between a client and a contractor, designed to meet the needs of the client. The main goal of creating and implementing CRM is to increase sales volumes, optimize marketing activities and improve the quality of customer service in an enterprise. The CRM concept allows you to integrate the client into the organization, obtain as much information as possible about customers and their needs, and on this basis create an organizational strategy that affects all aspects of the business: production, marketing, sales, services, etc. The most popular CRM systems: SAP system - a separate module of the SAP R / 3 system. Simplifies the work of enterprise departments that directly interact with the client (sales departments, websites, online stores, marketing department, service departments, subscriber services, call centers); Oracle. CRM-Oracle allows you to manage sales, service, conduct various marketing campaigns, organize a virtual call center. Among other things, Oracle. CRM-Oracle has very powerful integrated analytical tools; Microsoft Dynamics CRM – a system that increases the efficiency of employees inside and outside the organization, as well as facilitates cooperation between sales, marketing and customer service teams. BIM-technology (Building

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Information Modeling) – automates all processes on a construction site, which allows you to design not only in 3D, but also in 5-7D format.

RESEARCH METHODOLOGY

In conducting the research, the methods of logical thinking, reasoning, observation, comparison, descriptive statistics, selection, generalization, grouping, dynamic change detection, statistical data analysis, induction and deduction, classification, statistical evaluation, algorithmization, programming, comparison and expert assessment were widely used. Also, scientific research by foreign and domestic scientists on the content and methods of investment efficiency and its assessment in the construction industry was thoroughly studied, and author's approaches were developed in this regard.

ANALYSIS AND RESULTS

In general, the expectations of developers when using data in the construction industry were determined by the company Sage. The survey showed that 57% of market players want to receive stable, up-to-date financial and project information, and 48% want information about important situations. 41% of enterprises hope that big data will help them predict events and avoid risks. Finally, 14% of respondents prefer to know what factors affect the growth and decline of profits[5]. Big data analytics can fully meet these expectations - because the technology is already appreciated all over the world, including by developers and designers. Most large developers implement several projects at the same time - in such a situation, it is very difficult for employees to collect, sort and study large amounts of data. Informatica company found that about 60% of working time is spent on these areas. Big data helps to save it[6].

Technology allows you to process large amounts of data at a speed that is unimaginable for humans. Programs can take over processes such as database management and report generation. Thanks to this, company specialists can focus on more important tasks that help improve business efficiency. For example,

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according to the experience of the chief specialist of GSI-Giprokachuk, as part of working with one of the largest steel structures factories, he and his colleagues were able to use big data to create an algorithm that generates a special report on bolts. The designer spends an average of three to five days on this document, and artificial intelligence - a few hours. This is not a complicated, but rather time-consuming task: working in a BIM model, you need to calculate the number of objects and bolts connecting them, and get the entire frame. The engineer manually compares one criterion with another, draws a conclusion about how the design details are attached, and generates a report. Artificial intelligence does the same thing, but it works much faster and does not make mistakes.

Digital technology opens up more prospects for combining data with other building information modeling (BIM). Applying data to 3D or 4D projects allows engineers to easily identify any errors or accurately predict them. One of the advantages of BIM is the ability to work together on the model in real time with specialists from different countries. Using data, they can quickly transfer large amounts of information to each other to make faster decisions. This fundamentally changes the way we approach project management. Previously, all the information belonged to one person or several employees sitting in one office. Today, when a designer, developer and general contractor, who may be in different countries, work together to make changes to the project at an early stage, it becomes possible to truly work as a team.

Digital data technology also allows for real-time project monitoring to improve planning, reduce construction time, and optimize budgets. Connecting data to BIM models allows you to directly enter cost data into the project to see the cost of different parts of the building and find ways to save money.

To use digital data, as well as any relevant technology in the IT world, it is first necessary to optimize the material consumption of buildings. It is possible to collect huge databases of projects and somehow draw up tables of the optimality of

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various solutions and use neural networks to find correlations between the source data and the results obtained.

Another use of digital technology data is to collect data from various metal structures and determine the real cost of production products for a large sample of projects. Data can also be used to track company assets: for example, materials, tools, equipment, etc. During the work on the object, a huge number of products need to be purchased, stored and transported, and optimizing this process will help big data integrated into the BIM model. Various assets can be combined into a single database, creating a system of alerts and reminders. Thus, all employees working on the project can track the location of materials or equipment and know when the next stage of work will begin and what assets will be involved.

Analyzing many similar projects using digital technology in construction is an opportunity to predict possible problems during the construction process and their impact on costs at the design stage.

The analysis conducted in our study showed that the digitalization of construction should be considered as a tool for managing business activities and construction resources. However, there are a number of problems associated with the introduction of digital technologies: the problem of compatibility, which prevents effective information exchange in the information environment. Compatibility means the ability of products or systems with completely open interfaces to interact with other products or systems without limiting access and use [7]; the problem of the lack of specialists with the necessary competencies for the effective use of digital technologies in the construction sector; lack of awareness of the benefits of digital technologies among construction industry participants. Despite a number of shortcomings that lead to serious problems in the use of digital technologies in construction, it is necessary to highlight the most important promising areas for the development of digitalization in the studied area: 3 and 5D printing. Currently, there are “printers” that allow “printing” brick buildings and other objects (for example, printing from concrete) on the basis of trucks. The most

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promising area is low-rise construction; the use of BIM technology. This is a computer model of a building with all the necessary coordinated information. When one parameter changes, the same happens with others. Creating such a project makes it possible to assess the interior and exterior of the building and understand how much money, materials and work will be needed for construction, what equipment will be used, how the construction process is organized; Visualization using 3D glasses, which allows you to create an augmented reality effect and thus see the planned projects; Introduction of integrated building condition sensor systems that allow monitoring the condition of the building, energy efficiency and infrastructure networks; Widespread use of robotics.

Every company has to deal with bad materials, unpredictable weather conditions, and other problems. Using data, it is possible to create virtual scenarios of events in order to take preventive measures. For example, by analyzing many similar projects, it is possible to find out which materials often lead to budget overruns.

In the construction industry, digitalization is carried out in a constantly changing economic environment[8] using the following technologies. Digital Twins (DT) are distinguished as a unifying element for almost all “digital” technologies. For the user, it is necessary to use the product and regularly support it, receive updates, and constantly adapt to new requirements and conditions. Customers understand the need for a “digital connection” between physical and virtual products. A digital twin is a key stage in the development of technologies that are supplemented with information about the operation of a real object and display its functional state in real time (based on the BIM model). It is designed to create a model of the interaction of an object with its environment (BIM is used only to create a digital model). The model collects information about materials, design features, operations performed, tests, allows you to identify defects and carry out repairs, predict the condition of the object and make decisions on future operating modes (increasing the safety and efficiency of systems, reducing production cycles).

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Creating a DT involves developing a matrix of multi-level goals and resource constraints (temporary, financial, technological, production, etc.), which behaves with a high degree of adequacy like a real object at all stages of its life. A real physical object (no need for expensive scientific research, natural tests with material objects). Virtual copies have become convenient for users. Access to the DT is constantly synchronized with the real object, which allows you to analyze options for performing construction work, assess their effectiveness, cost and choose the best solutions. Digital intelligence helps to avoid costly mistakes in the life cycle of a construction object and increase the competitiveness of the construction industry.

The presence of a DT for the object being created ensures an increase in the efficiency of all project participants. There are the following problems in the implementation of the technology: the observed processes are not always fully taken into account; the customer does not assess the economic efficiency of the DT. The assessment should be carried out taking into account the initial investments and operating costs (staff, software, updating technical equipment, etc.); the complexity of the created models; the lack of responsibility for the DT at the enterprise; the reverse sequence of the impact of changes (there should be initial information about the state of the DT production).

The aspects required for the implementation of the DT: development of project indicators and budgeting taking into account the payback period; appointment of a person responsible for the implementation of functionality and subsequent support; creation of a compact disc; Development of standards for the implementation of DT; first making changes to DT, and then at the construction site; control over the use of regulatory documents throughout the entire life of the facility[9].

Today, it is difficult to imagine the future without data. IDC experts predict that company revenues from the use of this technology will increase from $ 130 billion in 2016 to $ 203 billion by 2020. According to World Oil, the use of digital technologies can reduce company costs by almost 20%. It is clear that every year

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there are more and more advantages of introducing data into construction processes. Using data in conjunction with BIM platforms allows companies to avoid paper costs and work, as well as workflow, and especially the main problems of production, namely, violation of construction deadlines, budget overruns and slow decision-making. Developers will be able to optimize business processes and achieve a new level of efficiency.

The use of digital technology data is no longer a surprise today. Technologies are constantly developing and moving forward, opening up new and new opportunities for various sectors of the economy and business. The large-scale understanding of data in the real estate sector is not yet the norm. However, developers are already working on the first steps that will simplify and automate the work.

Digital technology data allows you to combine all the information about advertising campaigns - that is, from social networks, advertising agencies, collective systems, from outside, from offline data (for example, surveys), etc. As a result of processing this data, specialists can get a very clear idea of the client for various projects - to create a detailed portrait of him, for example, how successfully the advertising campaign is working.

Data center technology that provides automated monitoring of equipment and material usage, waste tracking, worker movement around the construction site, more efficient resource management, and emergency response teams. Using digital data to make construction safer—using the virtual world to save lives in the real world. Steelcase used Azure Digital Twins to create the SteelcaseWorkplace Advisor and Find Space mobile apps to help business leaders see how space is being used and create new jobs. Steelcase cites an example of working with a client—a rapidly growing company that was struggling to organize its workspace to accommodate its employees. An optimization project found that the company’s workspace utilization rate was only 35 percent.[10].

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The advantages of cloud technologies widely used in construction include: high mobility; unlimited amount of data in the cloud; quick access to information of project participants; ability to control the management of several construction sites; reduction of the cost of large offices; maximum data protection. Cloud technologies allow solving problems from the first stages of design to the commissioning of the facility. By minimizing possible delays in the work process, high performance is achieved and leads to an overall increase in construction efficiency. Enterprises using cloud solutions reduce construction time by half and ensure standard security of project documentation[11]. “Internet of Things, IoT” is a set of executive devices (“smart” objects) with built-in sensors that communicate via certain communication channels using software (“things”, devices and communication channels, platforms). It also allows the use of cloud technologies designed to collect, transmit and process data, and make decisions based on their analysis. The official definition of the Internet of Things is given in the Recommendation of the International Telecommunication Union, according to which the Internet of Things, IoT, is a global infrastructure of the information society that provides advanced services by organizing communication between things (physical or virtual). The technological ecosystem known as the “Internet of Things” combines hardware, software, communication infrastructure, as well as “connected” devices participating in the process of data exchange. To implement this technology, devices and connected systems are used to collect data: geolocation modules, vibration, motion, pressure sensors, cameras, radars, gyroscopes, barometers, magnetometers, etc. Thanks to various sensors on the construction site, project management becomes more efficient and safer. Experts believe that by 2024, the market share of the Internet of Things (IoT) in construction will reach $16.8 billion.

Construction companies often build objects in different places. Sensors collect data that is processed by programs on the construction site and provide information to the contractor about the state of work. This technology helps to manage large projects, reduces the time and cost of resolving problems. Currently,

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the number of objects that can be included in the IoT is much greater than the number of people. According to the real-time Internet of Things Connections Counter (Cisco System's Internet of Everything Connections Counter), the number of installed devices connected to the Internet at the beginning of 2015 was 14.7 billion, and by 2020 it will be 14.7 billion. The number of such devices can increase to 50 billion [12].

Building Information Modeling (BIM) is based on the joint creation, filling and use of information about the model, which is the basis for decision-making throughout the entire life cycle of the object. The technology digitally represents the physical and functional characteristics of the object. With the help of BIM, a 3D model of the building and a database of technical, technological, economic, engineering and construction solutions are obtained, which allows solving the problems shown in Figure 3.5.

At all stages of the design process, the project is developed in a single information model. Architects create a 3D model, in which the designers perform calculations for each part of the project and transfer them to the architects for correction.

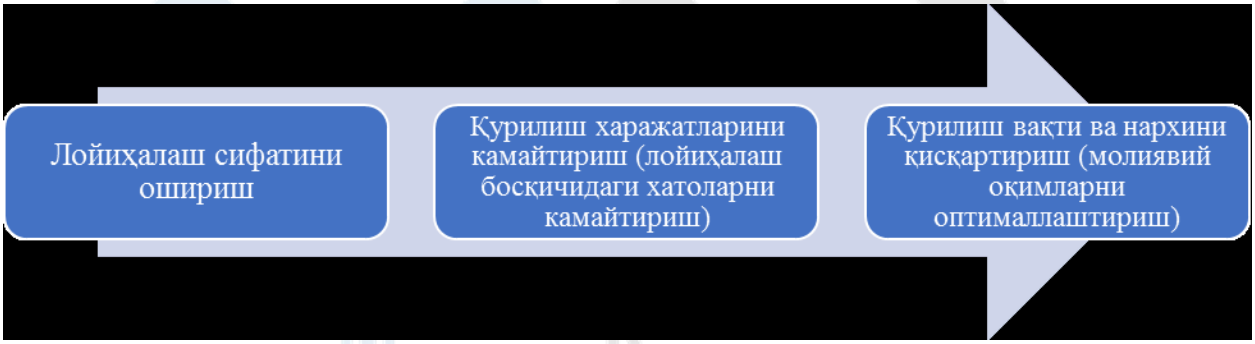

Figure 3.5. Tasks of using BIM technologies

Source: author's development

The use of digital technology data is an excellent tool for forecasting. Each project has specific goals in terms of planned construction costs, related expenses and sales revenue. Initially, the amount of knowledge about the project may be minimal, but the project and working documentation is gradually being

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supplemented, tender procedures for selecting contractors, purchasing materials are being carried out. Based on the collected data, the possibility of achieving the set tasks is calculated, appropriate adjustments are made to the expected result of the work. At the same time, it is possible to constantly work with market data, monitor changes in real time. The use of data in the field of real estate management also has very good prospects. Here, relevant technologies can be used not only in the field of business management, but also in the operation of buildings. These are sensors that collect all kinds of information about the condition of the object.

Gadgets can record the occurrence of technical problems, warn about the occurrence of pre-emergency situations in communication systems, measure pressure, temperature, environmental parameters, load intensity, work activity, etc. And all this information is valuable not only for the management company, but can also be very useful for the developer for planning future facilities.

Understanding and applying modern technologies, integrating them into business tasks, thinking flexibly, seeing trends, feeling and anticipating the needs of your client - this is one of the tasks of a modern and experienced developer. The integration of digital information technologies into various areas of economic activity optimizes and increases the efficiency of business processes.

When using big data to forecast real estate demand, it is possible to collect information about user interactions with real estate agencies and construction company websites, survey results, city population statistics, economic reviews, urban development plans, and transportation systems, and predict the future needs of different types of real estate customers[13].

Machine learning for personalized apartment advertising. By analyzing existing customer data and supplementing it with open sources, including social media data, it is possible to create a very detailed portrait of each consumer: their interests, financial capabilities, expectations, and needs. After that, it is recommended to launch personalized marketing campaigns for real estate advertising: an individual parking space for someone who brags about a new car on

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Instagram, larger apartments for those expecting a baby, and covered courtyards with children's playgrounds for families with small children, etc. Data technologies can analyze their behavior on social media and identify those among newlyweds who are most likely to divorce in the next two years. Each of the divorced spouses will need a new home, as will people who have been living together for a long time and may be thinking about children and expanding their living space[5]. To learn the behavior of people thinking about buying an apartment, it is recommended to show the marketing offer only to those who are as close as possible to the purchase using machine learning models[14]. This will give high results and reduce the cost of the advertising budget. Similarly, it is possible to form advertising campaigns for commercial real estate. For example, by collecting information about companies in open sources and social networks (number of employees, occupied territories, information about vacancies from job search sites, information about opening branches and regional expansion, etc.), you can create a list of potential consumers. A point marketing campaign aimed at these developing enterprises can lead to high sales conversions and save advertising budgets due to the narrow specialization of the target audience[15]. In addition to the content of the advertising offer, Big Data can be used to increase the effectiveness of marketing campaigns due to the hidden aspects of business indicators arising from external conditions. For example, if Machine Learning models reveal that the intensity of calls to real estate agencies and construction companies depends on the season and weather, it makes sense to increase the share of advertising banners during this period. And if a correlation is found between the number of search queries and the time of day, it is recommended to increase conversion by buying morning or, conversely, evening screenings[15].

Machine Learning and Big Data help to provide a personalized marketing offer for an apartment at the right time and in the right place for the client.

Using the Internet of Things to manage smart buildings. "Smart" homes, where you can set a comfortable temperature or prevent burglary through a mobile application, are gradually becoming the standard in the construction of new

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buildings. Sensors and detectors monitor the consumption of electricity, water and gas in order to detect leaks in time or optimize resource consumption.

The introduction of Internet of Things technology into buildings can reduce energy costs by analyzing utility usage and connecting efficient energy storage during peak hours. In addition, energy consumption can be significantly reduced thanks to a system of led lamps that provide advanced lighting control that corresponds to the time of day or approximately[15][4]. Reducing the financial costs of operating buildings, energy optimization also has a positive impact on the environment.

Big data, machine learning and the Internet of Things allow you to combine local "smart houses" into a common single infrastructure for integrated and remote management. In particular, if a heating pipeline suddenly breaks in one of the houses, the backup water supply system will automatically turn on so that residents are not left without water and heat. Also, a large power capacity will be allocated so that the electrical network can withstand the increased load from the use of household electric heaters. At the same time, all services involved in the processes of eliminating the accident and its consequences will be notified. In order to organize safe repairs, the principle of the road network will change this quarter, for example, posters installed along the road will show the scheme of bypassing the emergency site.

Despite generally positive global trends, a number of factors influence and complicate the process of digital transformation of the construction industry: an acute shortage of qualified personnel to work with new equipment and digital solutions, including BIM software; the timing of restructuring production and business processes, which is complicated by a lack of clear understanding of economic benefits in short-term planning; the absence of generally accepted standards for the use of digital solutions and their low interoperability with the existing fleet of machinery and equipment; the difficulty of integrating information

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models created by several teams using different software tools (this is partially solved within the framework of the OpenBIM concept, which involves the interaction of large teams without being tied to a specific software); the complexity of coordinating various participants in complex projects to create CIM, populate data layers, and develop mechanisms for their exchange (data marketplace); different levels of digital maturity of large construction companies, subcontractors, and small and medium-sized enterprises. In our country, the construction sector is dominated by localized small and medium-sized enterprises in regional markets. Due to the lack of investment resources, qualified personnel and direct incentives for digitalization, most of them are actually at a low technological level.

CONCLUSIONS AND SUGGESTIONS

Summing up the prospects for digitalization of construction, it should be noted that digitalization helps to make management decisions based on reliable and up-to-date information. As a result, it is possible to monitor the actual state of construction projects, analyze critical moments and check the implementation of technology. At the same time, digitalization is not only a goal for the development of the construction industry, but also a means of improving the quality of objects under construction and the profitability of the construction process. An analysis of the advantages and problems associated with the digitalization of the construction industry shows that this process is inevitable and rational for construction organizations in the conditions of the widespread integration of modern technologies into business. Digitalization in the construction industry is developing in response to the requirements of today's market, as construction efficiency and cost reduction become a priority. Therefore, construction is becoming "smart" not only in computer design, but also in the direct process of creating an object. Digital technologies have a significant impact on the profitability of the construction industry, which is aimed at optimizing and increasing the efficiency of the implementation of project stages, from engineering research to the operation of the constructed object.

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