Digital realities of the economic horizons in the construction industry

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Abstract. This article examines the impact of digital technologies on the development of the construction industry. The author examines what opportunities open up through the use of digital tools, such as Building Information Modeling (BIM), virtual and augmented reality, drones and others. The article provides specific examples of the use of these technologies in construction, as well as describes the advantages and disadvantages of their use.

The article shows that digital technologies have great potential to improve productivity and quality in construction, and their use will continue to grow in the coming years.

One of the key points highlighted in the article is the role of BIM technologies in modern construction. The author notes that BIM allows you to create accurate digital models of buildings and infrastructure facilities, which simplifies the design, construction and management of facilities. Thanks to BIM technologies, specialists can conduct virtual modelling of objects and check the operability of systems before the start of construction, which reduces the cost of errors and increases the efficiency of the process.

The author notes that augmented and virtual reality are also becoming increasingly popular in construction. At the end of the article, the author summarizes the results and gives recommendations so that the construction industry can maximize the potential of digital technologies.

The author advises the use of digital technologies not only in design, but also at the stages of construction and management of facilities. The article demonstrates that digital technologies are an important tool for improving productivity, reducing costs and improving the quality of work in construction. Their use will continue to grow in the coming years.

1 Introduction

Digital technologies and innovations today have a significant impact on many sectors of the economy, and the construction industry is no exception. Digital realities have already significantly changed and continue to change the ways of design, construction and operation of real estate. One of the main advantages of digitalization in construction is the improvement of project management processes and operations, reduction of time and costs for the design.*

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2 Materials and methods

3 Results
Accordingly, the construction industry plays an important role in the country's economy, providing infrastructure development, job creation, the development of innovative technologies and improving the standard of living of the population.

At the moment, the construction industry is facing a number of problems that may slow down its development. Some of them include:

1. Lack of skilled workers. In some countries, there is a shortage of labour in the construction industry, which can lead to delays in projects and increase the cost of work.

2. Increase in the cost of materials: in recent years, the prices of some construction materials have increased significantly, which can increase the total cost of projects and make them less affordable for potential investors.

3. Lack of innovation. Many companies in the construction industry continue to use traditional methods and technologies, despite the availability of new, more effective solutions. This can slow down the development of the industry and make it less competitive.

4. Lack of investment. Lack of sufficient funding can lead to delays in projects, as well as limit opportunities for the introduction of new technologies and methods.

5. Safety problems at construction sites. The construction industry remains one of the most dangerous industries, with a high rate of workplace accidents. This can lead to higher insurance costs and longer project deadlines.

6. Environmental problems. Construction can have a negative impact on the environment, including water and soil pollution, as well as gas emissions. This can lead to problems with compliance with environmental standards and requirements, as well as to a negative perception of the public.

In general, these problems can slow down the development of the construction industry, but at the same time they can also become an incentive for the introduction of new technologies and methods that can improve the efficiency and safety of processes, reduce costs, etc. One of the ways to solve the above problems is the introduction of digital technologies into the activities of construction companies.

The use of digital technologies in construction began in the 1960s, when computers began to be used for calculations in the construction industry. However, digital technologies have received the greatest development in recent years due to the widespread use of BIM technologies and other innovative solutions. The first steps in the use of BIM technologies were made in the 1970s, when software tools for building modeling began to be developed in the USA. In the 1990s, the first prototypes of programs for working with three-dimensional models of buildings were developed, but they were expensive and not widely distributed.

In the 2000s, the development of BIM technologies became more intensive, thanks to an increase in computer performance and a decrease in the cost of software. In 2004, the first open standard for data exchange between BIM systems was created — Industry Foundation Classes (IFC). Today, BIM technologies are widely used in the construction industry around the world.

In addition, the development of digital technologies is not limited only to BIM technologies. Today, drones, virtual and augmented reality, analytical technologies and many other digital innovations are successfully used in construction.

Let's look at some examples of the introduction of digital technologies in different historical stages of the development of the construction industry:

– 1960s — the first computer programs for calculations in construction;
– 1970s — the beginning of the use of BIM technologies in the USA. Computer programs began to be used for building modeling and structural calculations;
– 1980s — the spread of computer technology in construction. Using CAD (Computer Aided Design) and CAM (Computer Aided Manufacturing) systems to create drawings and control the production process;
In the 1990s, the development of the first prototypes of programs for working with three-dimensional models of buildings. But due to the high cost and complexity of use, these programs have not been widely distributed. In the 2000s, there was intensive development of BIM technologies due to an increase in computer performance and a decrease in the cost of software. Creation of an open standard for data exchange between BIM systems — Industry Foundation Classes (IFC). In the 2010s, there was widespread dissemination of BIM technologies around the world. The introduction of virtual and augmented reality, analytical technologies, the use of drones, mobile technologies and 3D printing in construction.

At different historical stages of the introduction of digitalization in construction, various problems arose: – at the initial stage (in 1980-1990), the main problem was the high cost of digital technologies and the lack of qualified personnel. In addition, data standardization was not sufficiently developed, which made it difficult to exchange information between different programs and systems; – in the period from the 1990s to the early 2000s, the main problems were the incompatibility of programs and data formats, which made it difficult to exchange information between various project participants. In addition, the lack of a single standard at the national level made it difficult to work with digital technologies; – in the period from the 2000s to the present, the main problems are related to the lack of qualified personnel, lack of investment in the development of digital technologies and insufficient degree of automation of processes in construction. In addition, many industry participants are not ready for changes in their work and do not want to master new technologies.

However, the prospects for the use of digital technologies in construction are huge and continue to grow every year. Some of the most significant prospects include: – increase productivity and efficiency. Digital technologies can significantly increase productivity and efficiency in construction. This allows you to speed up projects, reduce production costs and improve the quality of the final product; – reduction of risks and errors. The use of digital technologies allows to reduce risks and errors in the construction process; – improvement of project management. Digital technologies make it possible to improve project management. They allow you to speed up data collection and processing, simplify the coordination of work, increase transparency and timeliness of information for all project participants; – creation of innovative products. Digital technologies allow us to create new innovative products and services that can meet different customer needs; – reducing the impact on the environment. Digital technologies can help reduce the impact of the construction industry on the environment; – improving working conditions: Digital technologies can improve working conditions for workers on the construction site.

Thus, digital technologies play an important role in the development of the construction industry. They can significantly improve the efficiency and quality of construction, reduce costs and reduce the impact on the environment.

4 Discussion

In the era of digitalization of the construction industry, there are several main directions of development that allow the use of digital technologies to improve processes and work results. The main digital technologies that are used in the construction industry are presented in Table 1.
Table 1. The main digital technologies that are used in the construction industry

<table>
<thead>
<tr>
<th>Name of the technology</th>
<th>Characteristic</th>
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<tbody>
<tr>
<td>The use of BIM technologies</td>
<td>These technologies allow you to create accurate digital models of buildings and infrastructure facilities, which simplifies the design, construction and management of facilities.</td>
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<tr>
<td>The use of virtual and augmented reality</td>
<td>Augmented reality can be used for interior design, and virtual reality allows you to visualize objects in different conditions, which helps to reduce the number of errors and improve the quality of work.</td>
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<tr>
<td>Application of IoT technologies.</td>
<td>Internet of Things (IoT) technologies allow you to manage objects and improve safety on construction sites. For example, IT technologies can be used to monitor energy consumption and control lighting and air conditioning systems on construction sites.</td>
</tr>
<tr>
<td>The use of drones</td>
<td>Drones are used to monitor construction sites, which reduces monitoring costs and improves data accuracy.</td>
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<tr>
<td>Development of mobile technologies</td>
<td>Mobile technologies, such as mobile applications and portals, make it possible to simplify the management processes of the construction site and improve communication between various project participants.</td>
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<tr>
<td>Development of 3D printing.</td>
<td>3D printing can be used to create rapid prototyping of objects and elements, which reduces design time.</td>
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<tr>
<td>Application of analytical technologies.</td>
<td>Analytical technologies are used to process large amounts of data and analyse information about projects, which allows you to manage risks and make informed decisions in real time.</td>
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<tr>
<td>The use of robotics.</td>
<td>The works can be used to perform routine and dangerous work on construction sites, which makes it possible to increase the safety and efficiency of work.</td>
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<tr>
<td>Development of environmental technologies.</td>
<td>Environmental technologies are used to create environmentally friendly buildings and infrastructure, which contributes to sustainable development and economic growth.</td>
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<tr>
<td>The use of blockchain technologies.</td>
<td>Blockchain technologies are used to manage the supply chain and improve the transparency and security of transactions in the construction industry.</td>
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In general, the development of digital technologies in the construction industry makes it possible to increase the efficiency and quality of work, reduce costs and risks, and create a more sustainable and environmentally friendly infrastructure. Let's look at these technologies in more detail.

BIM (Building Information Modeling) is one of the key technologies that are used in the construction industry today. BIM technology allows you to create a digital model of a building that contains information about all its elements and properties, including geometry, construction, materials, structure, systems, etc. The use of BIM technologies in construction makes it possible to improve the processes of design, construction and operation of buildings. In particular, thanks to BIM technologies, it is possible to reduce the time for design and construction, reduce the number of errors and inconsistencies, improve interaction between project participants and increase the transparency of the entire process. One of the key advantages of BIM technologies is the ability to create a virtual model of the building, which allows for virtual testing and optimization of all systems and elements of the building, even before the start of its construction. This reduces the risks of errors and...
inconsistencies that may occur during the construction phase, and also reduces the cost of materials and resources [7].

In addition, BIM technologies can be useful when planning the operation of a building, since the building model contains information about all its elements and systems, which helps to improve the management and maintenance of the building. Thus, the use of BIM technologies is becoming increasingly popular in the construction industry, and is one of the directions of its development. However, like any new technology, BIM requires investments in training and equipment, as well as coordination between various project participants and standardization [8].

Virtual and augmented reality is another direction of development of the construction industry. These technologies can be used at various stages of the design and construction of buildings, as well as in training and interaction with customers. Virtual reality (VR) allows you to create three-dimensional models of buildings and premises that can be explored in virtual space. This can help visualize concepts and ideas, improve decision-making, and provide a more accurate idea of what the end result will look like. Augmented reality (AR) can be used to enrich the real environment with additional information. For example, using AR, you can place a digital model of a building on a construction site and get information about its elements and systems in real time. AR can also be used for training and interaction with clients, allowing them to interact with 3D models of buildings and premises.

Virtual and augmented reality can also be used to train personnel and improve safety on the construction site. For example, with the help of VR, you can conduct training in case of emergencies, and with the help of AR, you can get information about the safety and location of hazardous areas on the construction site [9].

Thus, the use of virtual and augmented reality is an important direction in the development of the construction industry. However, as in the case of BIM technologies, the introduction of these technologies requires investments in training and equipment, as well as coordination between various project participants.

The Internet of Things (IoT) is another direction of development of the construction industry. It provides opportunities for automation and optimization of the processes of construction, operation and management of buildings. IoT sensors and devices can be installed in buildings to collect data on temperature, lighting, noise level, air quality, energy consumption and other parameters. This data can be analysed and used for building management in order to improve efficiency and comfort, as well as reduce operating costs. IoT can also be used to manage the construction process by monitoring performance, equipment condition, material costs and other parameters. This can help speed up the construction process, reduce costs and improve the quality of work. Moreover, IoT can be used to create "smart" buildings that automatically respond to changes in external conditions and user needs. For example, such buildings can regulate the level of lighting, temperature and ventilation depending on the presence of people, time of day and other factors [10].

In general, the use of IoT technologies is an important direction in the development of the construction industry. However, as with other technologies, this requires investments in equipment, sensors and software, as well as coordination between the various project participants. In addition, for the successful implementation of IoT projects, it is necessary to ensure data security and protection from hacker attacks.
construction process. They can take photos and videos from a height, which allows you to observe the construction process from all sides. This helps project managers and engineers quickly identify problems that may arise during construction and make decisions to eliminate them.

Drones can also be used to deliver materials and tools to the construction site. This can reduce the delivery time and improve the efficiency of work at the facility. In addition, drones can be used to create 3D models of buildings and structures. They can take photos and videos from different angles, which can be used to create an accurate and detailed 3D model of the object.

In general, the use of drones is an important direction in the development of the construction industry, which allows improving the efficiency of construction processes and facility management. However, as with other technologies, this requires investments in hardware and software, as well as training of personnel to work with drones. In addition, it is necessary to take into account the legislative and regulatory restrictions associated with the use of drones [12].

The use of mobile technologies is another important area of development of the construction industry. Mobile devices such as smartphones and tablets can be used to improve communication and coordination between project participants, increase productivity and reduce the time spent on tasks.

One example of the use of mobile technologies is the use of project management applications. Such applications can help in the organization of tasks, time planning, budget management and monitoring of work. The apps also allow team members to share information and communicate with each other, which can improve communication and improve work efficiency.

Mobile technologies can also be used to manage inventory and materials on the construction site. With the help of mobile applications, you can track stocks of materials and tools, as well as manage orders and deliveries. This allows you to speed up the procurement process and reduce the time spent waiting for the delivery of materials. In addition, mobile technologies can be used for training and staff training. With the help of mobile applications, it is possible to provide access to training materials and resources that can be used to improve the skills of personnel and improve their productivity [13].

The use of mobile technologies can also help reduce the cost of paper documentation. Instead of using paper forms and documents, you can use mobile applications to create and store digital documents. This can reduce paper costs and reduce the time spent searching and processing paper documents. In general, the use of mobile technologies provides a large number of opportunities to improve the processes of construction and management of facilities. However, as with other technologies, this requires investments in hardware and software, as well as training of personnel to work with mobile devices.

The use of 3D printing is one of the most promising areas of development of the construction industry. This technology allows you to quickly and efficiently create three-dimensional models of objects, as well as produce construction parts, facade elements, furniture and other structural elements. One of the main advantages of 3D printing is the ability to quickly produce parts, as well as the possibility of an individual approach to each project. This allows you to create unique objects that can meet specific customer requirements [14].

In addition, 3D printing can be used to create models of buildings and complexes, which can help architects and engineers better understand the project and visualize it in three-dimensional space. It can also help customers better understand the project and make more informed decisions. 3D printing can be used to create various elements, such as walls, windows, doors and other structural elements. This reduces the cost of production and reduces the time spent on construction.
At the same time, it must be borne in mind that 3D printing has its limitations. For example, printing large objects may require considerable time, as well as large amounts of material. In addition, the print quality may depend on the type of material used in the process. Nevertheless, the use of 3D printing in construction has great potential to increase efficiency and reduce production costs, as well as to create more unique and individual projects [15].

The use of analytical technologies is an important direction in the development of the construction industry, as it allows for more accurate and efficient project management, as well as improving production processes and resource management. One of the examples of analytical technologies that are used in the construction industry are Project Management Systems. These systems allow you to track the progress of a project, control the budget and manage resources such as materials, equipment and personnel. Analytical technologies can also be used to improve production processes, for example, to optimize production chains, inventory management and improve product quality. This may include the use of statistical analysis, machine learning and artificial intelligence methods to predict production results and optimize processes [16].

In addition, analytical technologies can be used to improve risk management in the construction industry, for example, to assess the likelihood of certain risks and develop strategies to minimize them. Finally, analytical technologies can be used to collect and analyse data on the real estate market, for example, to assess demand for various types of real estate, determine prices and predict market trends.

In general, the use of analytical technologies has great potential to improve efficiency and management in the construction industry, and can help organizations become more competitive and adaptive to changing market conditions.

The use of robotics is an important direction in the development of the construction industry, as it allows you to automate certain processes, improve the quality and accuracy of work, as well as improve safety at construction sites. One example of robotics in the construction industry is the use of robots to perform various tasks on a construction site, such as welding, cutting and processing materials, as well as the installation and assembly of components. This makes it possible to reduce the time of work and reduce the likelihood of errors and defects [17].

In addition, robotics can be used to perform dangerous and time-consuming work, such as dismantling and demolition of buildings, as well as cleaning and repair of sewer systems and other utilities. This increases the safety of employees and reduces the time required to complete tasks. Robotics can also be used to create and install modular structures and components, which speeds up the construction process and improves the accuracy and quality of work. In addition, robotics can be used to create autonomous building management systems that can monitor and optimize the operation of heating, ventilation, air conditioning and lighting systems. This increases energy efficiency and reduces the cost of building operation [18].

Accordingly, the use of robotics has great potential for improving the efficiency and safety of work, as well as improving quality and accuracy in the construction industry. However, the successful implementation of this direction requires a high level of technological and organizational training, as well as the introduction of appropriate standards and regulatory mechanisms.

The development of environmental technologies in the construction industry is one of the important areas of development that minimizes the negative impact of construction on the environment and ensures a more sustainable and efficient use of resources. One example of environmental technologies in construction is the use of materials and technologies that pollute the environment less. For example, the use of UV lamps for glue polymerization instead of traditional varnishes and adhesives containing harmful chemicals, as well as the use of biodegradable materials and materials obtained from recycled waste.
environmental technologies also include the use of energy-saving systems and technologies, such as the installation of solar panels, wind turbines and heat pumps, as well as the use of energy and water management systems [19]. An important element of environmental technologies in construction is the ecological design of buildings, which takes into account the impact of the building on the environment and includes elements such as the use of natural lighting and ventilation, organic materials and waste management systems. Also, environmental technologies in construction may include the use of recycled materials and products, as well as reducing the use of water and other natural resources in the construction and operation of buildings.

It can be concluded that environmental technologies in construction have a huge potential to reduce the negative impact of construction on the environment, improve the efficiency of resource use and create more sustainable and environmentally friendly buildings.

The use of blockchain technologies is one of the new directions of development of the construction industry. Blockchain is a distributed database that stores a chain of blocks linked together in chronological order and protected by cryptographic methods. The use of blockchain technologies in the construction industry can increase the transparency, efficiency and security of processes. For example, blockchain can be used for accounting and tracking materials and equipment on a construction site, quality control of construction materials, as well as to reduce time and costs for documentation and project approval.

One example of the use of blockchain technologies in the construction industry is the use of smart contracts. A smart contract is a computer protocol that allows you to automate the processes of contract execution and reduce the costs of their implementation [20]. In construction, smart contracts can be used to automate the process of concluding contracts, monitoring the performance of work and paying for them. Blockchain can also be used to create decentralized platforms for financing construction projects, which will reduce the cost of attracting investments and increase accessibility for small and medium-sized enterprises.

Blockchain technologies can improve the efficiency and security of processes in the construction industry, which in turn can reduce costs and speed up the implementation of projects.

5 Conclusion

The advantages of using digital technologies in the construction industry are obvious. But it is necessary to take into account that at the initial stages of the introduction of digital technologies, some problems may arise related to the high cost of implementation, the need for staff training and adaptation to new processes. Also, at different historical stages, their own problems and limitations appeared. Despite this, digital technologies have great potential and are a promising area for the development of the construction industry. They can help reduce construction time and costs, improve the quality and safety of the process, and make construction more environmentally friendly. In the future, there is likely to be an even wider introduction of digital technologies into construction, which will improve its efficiency and quality.

References


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