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Innovative Approaches to Technical Support of Construction Projects using Digital Technologies and Automated Systems

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Abstract: The article explores the implementation of modern digital technologies in the technical support of construction projects, such as Building Information Modeling (BIM), Internet of Things (IoT), artificial intelligence (AI), and digital twins. It evaluates the benefits and challenges of applying these technologies to improve accuracy, optimize processes, and minimize risks. The article also addresses the challenges of implementation, such as standardization, integration with existing systems, and the shortage of qualified professionals. Special attention is given to process automation through PMS, QMS, ERP, and PLM systems, as well as the prospects of digital transformation in the construction industry.

Keywords: digitalization, Building Information Modeling (BIM), Internet of Things (IoT), artificial intelligence (AI), automation, construction technologies.

I. INTRODUCTION

The digitalization of the construction industry is one of the priority areas for enhancing the effectiveness of project management, rationalization, and quality assurance of the production process. Modern technologies offer great opportunities for control, analysis, and prediction in all phases of the construction project life cycle, which reduces risks, shortens the period of works, and minimizes costs.

The circle of tasks for technical support in construction is quite large: from control over the design documentation, supervision of building codes and standards observance to material quality and performance characteristics of structures assessment. Traditional labor-intensive methods based on visual inspections and paper document flow cannot provide the required level of accuracy and efficiency. Digital technologies enable the automation of key processes, integrate data into a single information environment, and increase the level of forecasting of possible deviations.

The main purpose of the study is to analyze the modern digital solutions applied to technical support for construction projects, and also to assess the efficiency and prospects for the development of those solutions. Building information modeling (BIM), the Internet of Things (IoT), artificial intelligence (AI), digital doubles, and automated systems for project management are considered in the article.

II. MAIN PART. MODERN DIGITAL TECHNOLOGIES IN CONSTRUCTION SUPPORT

In general, the construction industry needs the implementation of new technologies in conditions of digital transformation that will ensure quality control and monitoring and forecast a process with further minimization of possible risks. Among the key solutions widely used in the technical support of construction, it is possible to point out BIM, IoT, AI, and digital twins. These technologies enable not only the automation of routine processes but also a significant increase in the accuracy and efficiency of decisions.

One of the most important software tools for construction project management is BIM. The object in this system is described fully: geometry, physical characteristics, and operational parameters. The chance of design conflict is reduced in the usage of BIM. Thus, errors are identified at an early stage of design, and the integration of the BIM model into the construction process management system increases the coordination level between project participants [1].

Also, IoT technologies contribute much to the continuous monitoring of building sites. Intelligent sensors installed on key structural nodes record environmental parameters, material loads, vibration levels, and other indicators. Real-time data is transmitted to cloud platforms, where it is analyzed to identify potential deviations from standards. For example, the application of IoT systems allows for automatic monitoring of temperature and humidity conditions during concreting, which minimizes the risk of defects [2].

It is worth adding that AI is applied for the analysis of construction data in order to enhance object technical condition forecasting. AI algorithms process information arrays obtained from sensors and BIM models, identify patterns, predict the wear of the structure, and give suggestions on optimal maintenance strategies. Meanwhile, AI-based predictive analytics strongly reduces the probability of emergency cases in view of early detection of critical changes within the structure of buildings [3].

Equally promising is the development of a digital twin, a virtual clone of a constructive object. Due to IoT sensors, digital doubles interact with their physical prototypes, which enables real-time analysis of the

current state of the structure and testing of various modes of its work. This significantly contributes to achieving high accuracy of technical support because expensive inspections can be carried out much less.

Therefore, of great importance for increasing the efficiency of construction support are modern digital technologies. After all, their use reduces costs and minimizes risks, enabling more accurate design and lifecycle management of an object. Further development of these solutions, especially regarding the integration of AI with BIM and enhancing a digital twin, will open a new horizon for automation processes in construction.

III. AUTOMATED SYSTEMS AND THEIR IMPACT ON TECHNICAL SUPPORT PROCESSES

The introduction of automated project management systems (PMS) significantly changes approaches to technical support of construction, allowing to integrate various processes into a single information environment. One of the most effective tools is the use of PMS, which provide monitoring of task performance, control over resources and compliance with deadlines (fig.1).

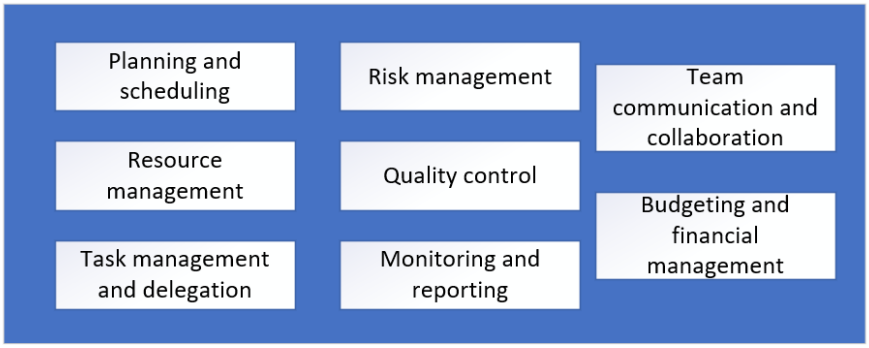

Fig. 1. PMS model [4]

These systems allow for highly accurate tracking of work stages, minimization of human error, and improvement of overall project productivity [5]. For example, PMS systems integrated with BIM models allow for tracking of changes in design documentation and prompt adjustments to the work plan, if necessary.

Quality Management Systems (QMS) play an important role in the automation of quality control of construction work. It allows collecting and analyzing data on the quality of materials, compliance with building codes and standards, as well as the efficiency of technology use (fig.2).

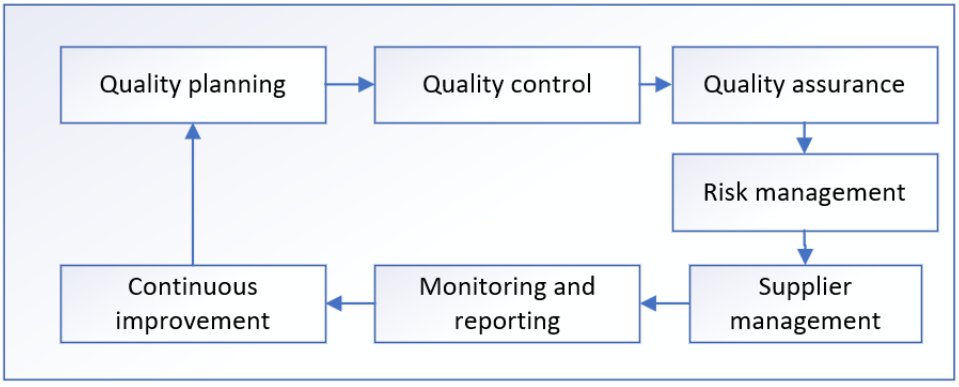

Fig. 2. QMS model [6]

The implementation of automated solutions allows for the acceleration of compliance verification processes, automation of testing and analysis of indicators, which leads to a reduction in the time required to perform control procedures. Thus, QMS systems provide a high degree of confidence in the quality of work performed and allow for the minimization of the risks of defects at operational stages.

Another important tool is the integration of automated systems with Enterprise Resource Planning (ERP) and Product Lifecycle Management (PLM) systems, which allows managing not only design and construction but the whole cycle of operation of the facility. These systems also support the integration of the following functional areas: accounting, purchasing, inventory, and production processes. At the same time, ERP systems allow tracing financial flows in real time, and PLM systems enable the life cycle monitoring of design documentation and design solutions. The integrated working of these with PMS and QMS yields one flow of

information that noticeably improves the interaction between all participants of the project and allows reduction of the cost of management. For example, automation of procurement and supply of materials through the ERP system optimizes logistics processes and reduces delay times in construction works [7].

The introduction of automated systems in technical support of construction helps to improve the quality of design and management, increase the accuracy of execution and reduce errors associated with the human factor. In addition, the automation of processes allows to significantly reduce operating costs, optimize resources and speed up the project completion time. It is important to note that the successful implementation of such systems requires proper training of personnel and appropriate infrastructure, which is a key factor in the implementation of digital solutions in construction.

IV. PROBLEMS OF IMPLEMENTATION AND PROSPECTS OF DIGITAL TRANSFORMATION IN CONSTRUCTION

Digitalization of the construction industry is a complex and multifaceted process that faces a number of organizational, technological and financial challenges. Despite significant advances in digital technologies, their successful implementation in construction practice remains difficult due to many factors. One of the main obstacles is the lack of maturity of the IT infrastructure at many construction companies. It is important to note that many companies face the problem of integrating new digital solutions into existing systems, which requires significant costs for equipment modernization and personnel training.

The lack of standardization and regulations remains a significant challenge for the effective implementation of digital technologies in construction. While various national and international standards exist – such as ISO 19650, BS 1192 (UK), and IFC (Industry Foundation Classes) – there is still no universally accepted framework for the use of BIM, digital twins, or other digital tools. This fragmentation leads to difficulties in data exchange between different project participants. Although some countries have introduced regulatory requirements for BIM implementation, approaches to modeling, data monitoring, and software compatibility still vary, reducing work efficiency, increasing the risk of errors, and extending project timelines. Therefore, the development of harmonized and widely adopted standards for digital solutions in construction is a crucial step toward improving interoperability, regulatory compliance, and industry-wide efficiency.

Another significant challenge is the shortage of skilled digital professionals. The construction industry has historically been less digitalized than other sectors, resulting in a shortage of professionals with the necessary knowledge and skills to work with new tools and systems. Personnel training and competence development are becoming key factors in the successful implementation of innovations. However, solving this problem requires significant investment in training and retraining of workers [8].

The level of digital maturity in construction companies varies significantly, ranging from traditional manual processes to fully integrated intelligent management systems. Understanding these different stages helps assess the current state of digitalization and identify the necessary steps for its further advancement. Table 1 presents a structured overview of these stages, highlighting their characteristics, expected benefits, and associated challenges.

Table 1. Levels of digital transformation in construction

Stageofdigitaltransformation	Description	Expectedbenefits	Implementationchallenges
Initiallevel (traditionalapproach)	Paper-based documentation, minimal process automation. Visual inspections, manualcalculations.	Low digitalization, high dependence on human factors.	Errors in design, slow processes, data management difficulties.
Partialdigitalization	Implementation of individual digital tools (BIM, ERP, QMS) without full system integration.	Improved coordination, cost reduction, increased accuracy.	Software compatibility issues, high transition costs, personnel resistance.
Comprehensivedigitalization	Integration of BIM, IoT, AI, and digital twins. Process automation and advanced data analytics.	Increased efficiency, risk minimization, reduced costs.	Requires personnel training, significant investments, and data standardization.
Intelligent management (full digital transformation)	Fully integrated digital ecosystems, big data analysis, predictive modeling, autonomous construction processes.	Maximum transparency, lower operational costs, early risk detection.	High implementation costs, shortage of skilled professionals, technical complexity.

Despite these challenges, the prospects for digital transformation in construction remain very significant. IoT, blockchain technologies and AI are actively growing. It will not only improve the accuracy and efficiency of construction, but also improve the safety and quality of facilities.

V. CONCLUSION

Digitization is expected to enhance construction efficiency and quality by optimizing all stages of a project's life cycle. The integration of BIM, IoT, AI, and digital twin technologies will revolutionize design, monitoring, and project management. However, digital transformation faces challenges such as a lack of standardized regulations, a shortage of skilled professionals, and high implementation costs. Despite these obstacles, advancements in automation and emerging technologies are driving significant improvements. Overcoming these barriers and integrating digital systems will foster the industry's growth, making construction processes more efficient, cost-effective, and transparent.

REFERENCES

[1] A. R. Radzi, N. F. Azmi, S. N. Kamaruzzaman and R. A. Rahman. A framework of attributes for as-built BIM models: A systematic review, *Journal of Information Technology in Construction (ITcon), 29(28),* 2024, 612-634.

[2] J. Brozovsky, N. Labonnote and O. Vigren. Digital technologies in architecture, engineering, and construction, *Automation in Construction, 158,* 2024, 105212.

[3] H. K. Musa, C. Agupugo, A. Manuel and H. Manuel. The impact of AI on boosting renewable energy utilization and visual power plant efficiency in contemporary construction, *World Journal of Advanced Research and Reviews, 23(2),* 2024, 1333-1348.

[4] Y. Arefazar, A. Nazari, M. R. Hafezi and A. H. Maghool. Prioritizing agile project management strategies as a change management tool in construction projects, *International Journal of Construction Management, 22(4),* 2022, 678-689.

[5] A. Malikov. Digital transformation and its impact on the structure and efficiency of modern business, *Annalid'Italia, 62,* 2024, 112-115.

[6] J. Rosak-Szyrocka. *Quality management, value creation, and the digital economy* (Routledge, 2024).

[7] Y. Yarov. Modern architectural approaches to building design: integrating eco-friendly solutions and advanced technologies, *New science: from idea to result, 11,* 2024, 139-147.

[8] E. Fomicheva. SEO strategies development for development projects effective promotion, *Znanstvenamisel journal, 96,* 2024, 24-26.