



INTEGRATED ENGINEERING SYSTEM FOR CONSTRUCTION PROJECT QUALITY MANAGEMENT

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ABSTRACT

This research focuses on the problem of increasing flexibility as a source of quality improvement in construction. The research aims to develop an innovative approach to quality management in construction under the conditions of the digital economy, based on industrial and manufacturing engineering. The research is devoted to an innovative approach to construction quality management in the digital economy based on industrial and manufacturing engineering. The focus is on digital tools, engineering coordination of construction processes, data-driven monitoring, and quality management mechanisms throughout the entire life cycle of a construction project. A BIM-based construction-quality case study is conducted. The novelty of the new approach lies in its provision for adapting high-technology construction projects to actual site conditions and coordinating technical processes during project implementation through engineering and technical support designed to maximize quality. The approach involves the use of advanced digital tools for construction quality management, including the Israeli solution Buildots, the US solutions Doxel and ALICE Technologies, and the UK solution Foresight, supported by industrial and manufacturing engineering. The authors' approach is unique in that it combines breakthrough digital technologies for improving construction quality, such as digital building information modeling (BIM) and digital twins, with industrial and manufacturing engineering for quality. The benefit of the new approach lies in its transfer of the engineering principles of digital control, data integration, and process standardization to construction quality management



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1. INTRODUCTION

Construction in the digital economy is increasingly organized as an integrated system of data, design solutions, technological operations, and coordination

among numerous participants. Under these conditions, the quality of a construction project depends not only on materials and artistry but also on the coherence of digital management systems, the accuracy of monitoring, and the synchronization of decisions across all stages of the project.

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Industrial and manufacturing engineering is applied in the construction industry, but only to a limited extent, particularly in the development of innovative construction materials and the design of construction projects. A major shortcoming of the established practice of implementing high-technology construction projects in the digital economy is the lack of industrial and manufacturing engineering during project execution, which reduces the quality of the structures being erected and the construction facilities being developed.

The existing approach to construction quality management in the digital economy relies on nontechnical management tools, including the development of digital competencies among engineering and construction personnel, the implementation of smart automation tools for construction processes, and the use of machine vision to monitor these processes.

The problem is that, without engineering and technical support, high-technology construction projects lack sufficient flexibility. At the planning and design stages, it is impossible to fully account for the actual conditions of the site where these projects will be implemented. As a result, during the practical implementation of high-technology construction projects, unforeseen situations frequently arise due to discrepancies between the project documentation and the actual conditions at construction sites.

Because high-technology construction projects lack continuous and interactive engineering and technical support, their adaptation to unplanned site conditions, unexpected characteristics of the structures being built (such as displacement, uneven joints, or changes in shape), and unforeseen properties of the construction materials used is carried out intuitively by construction workers themselves, which significantly reduces the quality of construction projects.

High quality of the construction industry products is one of the most important conditions for its intense development. An effective system of quality management at a production company leads to the implementation of modern methods of production, improvement of financial and economic indicators of work, an increase in the effectiveness of investments, a reduction in labor costs, etc. High-quality construction production leads to an increase in the level of the company's competitiveness. Formation of the digital economy sets a range of challenges for the adaptation of activities in the sphere of construction to new conditions, in which digital transformation is an inseparable part of innovative activities. Technology level, eco-friendliness, and inclusion, as the main trends of the digital economy in the sphere of construction, are manifested not only in technical and technological and organizational solutions but also in the tools used by construction companies and organizations to solve the issues of innovative development and search for ideas for innovations.

Digital transformation in construction changes the sector's approach to quality management. Implementing digital platforms and using the tools of monitoring of construction sites based on artificial intelligence, companies find new ways to optimize inspection, collect detailed data, minimize defects, and implement projects of higher quality with lower costs.

Quality assurance and quality control are decisive for the construction industry because they guarantee that projects conform to the established standards of safety, functionality, and durability (Toyin and Sattineni, 2025). Quality management at the company is a complex system of strategies, methods, and processes that must guarantee constant correspondence of products or services to high-quality standards, meeting customer expectations and supporting competitiveness in the market. Technologies are at the forefront of innovations in the construction sector. The COVID-19 crisis urged many companies to use new technologies to continue working and retain maximum safety. Solutions that appeared as a response to the COVID-19 crisis made way for other innovative solutions and wider implementation of new technologies. Entering a new stage of high-quality development, the digital economy, which is based on information technologies of the new generation, changes the economic structure at high speed, scale, and level of development (Li et al., 2024). Apart from technical aspects, modern quality management also covers social responsibility of the organization, its interaction with local communities, and compliance with ethical principles. Constant search for innovative solutions and uninterrupted enhancement of processes are examples of continuous development of quality management in the modern business environment.

In this research, we study new approaches to the management of quality in the construction industry in the context of the digital economy and analyze the aspects of quality control and quality assurance in construction in the conditions of digitalization of the construction sector. As an innovative solution to the identified problem, this article proposes adapting high-technology construction projects to actual site conditions and coordinating technical processes during project implementation through engineering and technical support designed to maximize quality. The research aims to develop an innovative approach to construction quality management in the digital economy based on industrial and manufacturing engineering.

2. LITERATURE REVIEW

At a fundamental level, this research is based on the theoretical concept of industrial and manufacturing engineering in the construction industry, whose scientific principles are presented in the works of such scholars as AlTawil (2026), Naghdi et al. (2026), Wang et al. (2026), and Ye et al. (2026). A scientific explanation of the existing approach to construction quality management in

the digital economy, which relies primarily on nontechnical management tools, is provided in the studies of such authors as Gao et al. (2026), Parkinson et al. (2026), Ray et al. (2026), and Ren et al. (2026).

A gap in the literature lies in the insufficient examination of the application of industrial and manufacturing engineering in the implementation of high-technology construction projects in the digital economy, which creates uncertainty regarding the significance of situational engineering and technical support for these projects in ensuring the quality of the construction facilities being developed.

The construction industry is among the basic sectors. It plays an important role in the creation and expansion of different productions, through the creation of new capacities, reconstruction, modernization, and technical re-equipment of current lines. Development of the construction industry provides a multiplier effect for the development of other industries (construction of materials and equipment, machine-building, petrochemical sector, etc.). Also, the construction industry has a vital role in solving social problems of the population and creating well-being and a quality living environment, and influences the socioeconomic development of territories.

Digital transformations of the economy create new trends in the development of innovative activities based on the technologies of the Fourth Industrial Revolution and open new possibilities for cooperation in the sphere of innovations. In the context of digital technological trends in construction, innovations provide a wide range of directions for the implementation and application of digitalization tools. Digital tools are drivers of innovative activities because they raise the effectiveness of technological processes and transform approaches to the management of resources, risks, personnel, and consumer experience. Digitalization of the construction industry means the implementation of digital technologies and tools for improving the processes of design, construction, and exploitation of buildings and objects. It may include the use of software for building modeling (building information modeling), sensors of the Internet of Things, artificial intelligence, automation of processes, and other technologies.

Scholars from all over the world have researched various aspects of quality management in the construction industry in the context of digitalization and the digital economy.

Toyin and Sattineni (2025) offer a critical overview of new digital technologies in quality assurance and control in the construction sector, analyze the modern state of the leading technologies that are used in quality assurance and control, assess the influence of these technologies on construction projects, and determine future directions for research and potential achievements in technologies of

quality assurance and control. D'Alberto et al. (2025) present an overview aiming at the study of the role of state management in the implementation of innovative technologies, such as Building Information Modeling and Digital Twin, to improve the management of the processes of construction and public procurement, and describe a range of structural gaps hindering the effective implementation of digital technologies in the operational processes of state management. Egbebi (2024) studied the effective methods of supporting high standards of quality during the entire life cycle of the project and emphasized the importance of proactive planning of quality, thorough support of quality, and effective measures of quality control. Adekunle et al. (2022) present the results of the systemic approach to the management of construction information and reveal that the advantages of information management include a company's growth, organizational effectiveness, an increase in market value, motivation of employees, and high-quality services.

Luo et al. (2022) studied the application of digital technologies and identified opportunities and problems for the use of digital technologies in construction quality management. Li et al. (2024) examine the main ways and theoretical mechanisms of the digital economy for high-quality development of the construction industry from the position of entrepreneurial innovative spirit, check the mechanism of interaction between the digital economy, entrepreneurship, and development of the construction industry, and describe how the digital economy can contribute to quality development of the construction industry. Faltein and Sukdeo (2024) consider the practices of quality management, implemented by contractors who are involved with the development of infrastructure, and focus on different stages of the construction life cycle, such as technical and economic justification, design, commissioning, etc. Olatunde et al. (2022) assessed the awareness and readiness for the implementation of technologies of Construction 4.0 in Nigeria. Afzal et al. (2022) studied the effect of the initiatives on total quality management on the execution of projects in Pakistan's construction sphere and established a connection between employee involvement and completion of projects.

Zhuman et al. (2024) use the principles of the quality management system to create the basis for implementing the practices of quality management in the construction sector, analyzing the international experience of company certification according to ISO 9001 standards, by the example of Kazakhstan. Ergashev and Saidov (2025) analyze foreign experience of improvement of the mechanisms of implementation of quality management at construction companies and consider the practices of quality management in the USA, the EU, and other developed countries.

Shaban et al. (2024) study digital processes connected with quality management within the building information

modeling projects, describe the modern practice of quality management in the construction sector, and outline new capabilities of digital systems of quality management in BIM projects. Ghansah and Edwards (2024) systematize, evaluate, and synthesize modern literature on the application of digital technologies in quality support in the construction sector and offer directions for future research. Nyqvist et al. (2024) studied the digital transformation in the construction sector by the example of three companies that strive towards changes and emphasize the key driving role of the transition to targeted technological solutions and standardization and modification of processes in the formation of the construction industry and its companies. Abkar et al. (2024) mention key factors that influence the effectiveness of construction sites by reducing waste in the construction sector of Malaysia. Sheoran and Thakur (2023) consider the latest works devoted to the improvement of quality through the implementation of total quality management in the construction industry and its use at different stages of construction projects. Pacheco et al. (2024) assess the expedience and effectiveness of implementing the BIM methodology to improve the management of construction objects in construction companies of Peru and offer ways towards higher quality of project realization, reduction of construction duration, and more effective financial management. Benčič et al. (2020) identify the specifics of building the digital economy in developed and developing countries and conclude that the basis of an economy's digital competitiveness in developed countries is a high level of integration of information and communication technologies and devices.

Riaz et al. (2023) appraise the cause-and-effect relationship and difficulties with the implementation of total quality management in the construction industries of developing countries. Cerepnalkovska et al. (2019) state that implementation and reference to standards are the simplest method of guaranteeing products' conformity to the main requirements of regulations in the context of the construction industry.

Previously published studies by Azimi et al. (2026), Guo et al. (2026), Li et al. (2026), and Nizam et al. (2026) substantiate the benefits of initial engineering and technical support for high-technology construction projects at the planning and design stages in terms of quality.

Construction influences all sectors of the economy. The need for a systemic innovative process is connected with several top-priority directions of companies' development: modernization of the main funds of the construction complex (purchase of licenses for technologies and equipment or use of domestic technological potential), improvement of energy-saving and environmental indicators during creation of innovative construction materials and technologies, and

enhancement of the qualification of engineering and technical employees of the construction sector.

3. RESULTS

3.1 Digital Engineering Tools for Construction Project Quality Management

The digital economy provided innovative opportunities for the construction industry. Technologies of smart construction raise the comfort, sustainable development, and safety of buildings due to the implementation of sensors and management systems. New technologies allow for the management of energy, control of the internal environment, and monitoring of safety. Effectiveness of energy use is raised through smart coordination of centralized energy supply with distributed energy consumption (Li et al., 2024).

Specifics of the construction industry, with its wide range of production processes and importance for all sectors of the national economy, determine the relevance of implementing digital technologies in its management. Digitalization becomes the key factor in the transformation of innovation management in the construction sector, contributing to an increase in the effectiveness and competitiveness of companies. Digitalization influences different aspects of modern life and is considered an important factor in economic, technological, educational, social, cultural, and other changes in society. It is also a necessary condition for raising the competitiveness, flexibility, and adaptability of modern companies. Companies work under the conditions of quick changes, which lead to new challenges, risks, and demands.

Recently, digitalization has become a strategic global priority in the construction sector, aimed at raising operational effectiveness, stimulating sustainable development, and increasing transparency in the processes of project management (D'Alberto et al., 2025). Quality control in construction projects is a process of checking, testing, and evaluating construction materials, products, and work, to ensure their correspondence to the established standards and specifications. It involves monitoring and correcting processes at all stages of the project. Quality control is aimed at early detection and resolution of potential problems.

The level of construction quality is assessed through the level of correspondence of the objects to design solutions and regulations. Quality must be formed at all stages of construction: design, production, construction, installation, and exploitation. Management of construction quality is a complex problem, which depends on all stakeholders: public authorities, customers, design and construction contractors, manufacturers of construction materials, transport organizations, etc. Creation of a rational system of

quality management is decisive for the success of a business. Tough competition in the world market makes companies raise the quality of their products and services. Satisfying consumer demands, companies can increase customer satisfaction and their loyalty. An effective system of quality management allows optimizing internal operations, which leads to cost-effectiveness and growth of profitability.

Quality control in construction projects is a continuous process that requires the commitment and cooperation of all stakeholders. Prioritizing quality and adhering to the structured approach, it is possible to raise customer satisfaction and strengthen the company's reputation. Implementation of a quality management system is a complex and labor-intensive process, which includes different tasks and influences numerous aspects of the company (Zhuman et al., 2024). In the conditions of growing competition and dynamic changes in the global economic environment, construction companies must pay special attention to the implementation of innovative approaches. Using innovative technologies and effective managerial approaches is vital for raising the competitiveness of construction companies and strengthening their technological and intellectual potential. Innovative policy in the construction sector covers a wide range of tasks, in particular, development and employment of modern construction technologies, improvement of material and technical basis, application of digital solutions, and adaptation to new environmental standards.

The duration of the realization of construction projects slows down the process of technological upgrade in this sphere. One construction project may take up to several years, which limits the company's capabilities to quickly implement innovations. This is further complicated by the long period of reformatting of production and business processes in construction due to the absence of a clear understanding of economic effects at all horizons of planning. Construction cycles are still connected to the existing technological solutions, which are determined at the design stage. The specific feature of construction production is the long-term term of object exploitation. For most construction objects, average exploitation periods are more than fifty years, and exploitation periods for dams and bridges could be more than one hundred years. Sectors with long production cycles and long periods of exploitation are less susceptible to the effects of innovations.

Introduction of digital solutions allows raising the effectiveness of the realization of construction projects, ensuring transparency of management, reducing costs and terms of construction, and optimizing the processes of exploitation of construction projects. The modern construction industry uses a lot of leading digital technologies. However, the employment of the latest technologies in construction is a difficult process due to the high requirements for objects. These

requirements include safety, compliance with regulatory and legal norms, standardization, and economic purpose. Successful implementation of any technology requires the appropriate design, quality control, and personnel training. However, growth of cities and population, as well as new forms of interpersonal interactions in the digital age, development of the economy, and an increase in population's well-being, have led to the acceleration of the construction industry, which has become more dynamic in the implementation of innovations and technological solutions.

3.2 BIM-Based Construction Engineering Case

One of the key directions for digital transformation in the sphere of construction is integration and cooperation based on data, which is realized through the use of modern digital tools, among which an important place belongs to building information modeling (BIM). BIM technologies are an integrated digital platform that allows creating and managing the information model of a building or object, including geometrical, physical, engineering, and exploitation characteristics. BIM allows for centralized cooperation of all participants of the construction process: architects, designers, engineers, contractors, and customers in a unified digital space. They have joint access to relevant information in real-time, which allows eliminating repeated actions, avoiding mistakes and conflicts, and reducing time and resource costs. Also, BIM contributes to the optimization of work processes, ensuring precise planning of construction, effective management of material and technical resources, control of the terms of project realization, coordination at the construction site, and monitoring of the execution stages. An important aspect here is the possibility to use the BIM model data for predictive analysis – assessment of potential risks, rational distribution of resources, planning of technical maintenance, and upgrade of infrastructure at the stage of exploitation of the object.

Functioning of the construction industry is associated with a high level of risks in the sphere of labor protection, negative impact on the environment, control of materials' quality, defects of construction products, and violation of terms of construction projects' realization. Because of these risks, construction companies face image and economic problems, which eventually may lead to a reduction in competitiveness or bankruptcy. Digital innovations are supposed to prevent these consequences. They also contribute to sustainable development in the conditions of various risks. Let us analyze the most effective and promising digital innovative solutions used for quality management in construction.

Table 1 contains a description of digital innovations that ensure the planning and optimization of construction projects. Precision, uniqueness, and innovativeness of these digital tools influence the quality of construction objects.

Table 1. Digital tools for managing the planning and optimization of construction projects using industrial and manufacturing engineering

	Digital tool using industrial and manufacturing engineering	Advantages and positive effects of industrial and manufacturing engineering on quality
1	Buildots (digital platform for management and optimization of construction projects using industrial and manufacturing engineering). Owned by Buildots (Israel)	Functions of industrial and manufacturing engineering: provision of access to data, data exchange, and communication for all participants of the projects; analysis of the efficiency of management of construction objects (trends of productiveness and rates of construction), based on which decisions on optimization are made; forecasting of delays with execution of works and modelling the options to eliminate them; monitoring of more than 80 stages of construction (cameras with 360-degree view, which are installed on employees' helmets, transfer data to the management system). Factual results of the effectiveness of implementing the innovation: - Reduction of construction costs by 50%. - Reduction of costs of construction delays. - Increase in labor safety. The positive effect on quality is manifested in support of the standards of construction products and the price-quality parameter.
2	Doxel (a digital platform for construction project management and optimization supported by industrial and manufacturing engineering). Owned by Doxel (USA)	Functions of industrial and manufacturing engineering: similar to Buildots. Uniqueness: This digital solution ensures a high level of cost-effectiveness. Influence on quality management within the parameters: 1) Cost-efficiency: - Reduction of personnel costs in the sphere of monitoring and data transfer on the execution of construction projects by 95%. - Total monthly reduction of costs of mid-term and long-term projects by 11%. 2) Speed of execution of construction projects – an increase of 11%. 3) Improvement of labor safety.
3	ALICE Technologies (digital platform for planning and management of construction projects using industrial and manufacturing engineering). Owned by ALICE Technologies Inc. (USA)	This is a construction simulator for developing millions of possible construction projects according to the input data; it supports joint work and reporting of the project's participants and optimizes resource use at all stages of the project; it is integrated with digital systems of 4D modeling; and ensures analysis of the scenarios of project changes in real-time. Digital technologies that are used in this innovation include generative AI, machine learning, big data analytics, and neural modeling. The effect on quality management of construction using industrial and manufacturing engineering is manifested within the following indicators: - Cost-effectiveness: reduction of equipment cost (12%); reduction of labor resources' costs (14%); reduction of project completion terms (17%).
4	Foresight (a digital platform for forecasting the results of construction project stages and managing them using industrial and manufacturing engineering). Owned by Foresight (UK)	Functions of industrial and manufacturing engineering: similar to Buildots, Procure, and Doxel. The uniqueness lies in ensuring the possibility of forecasting project changes in real-time. Influence on quality management is manifested within the following parameters: 1) The precision of forecasting construction projects is two times higher compared to traditional forecasting. 2) Cost-effectiveness: - Detection of possible delays in construction leads to the reduction of costs by 30%. - Reduction of personnel costs for positions dealing with the preparation of reports – 40 hours each month.

Source: Compiled by the authors based on (ALICE Technologies Inc., 2025a; ALICE Technologies Inc., 2025b; Doxel, 2025; Foresight, 2025; LinkedIn, 2024a; Procure Technologies, 2025)

Development and implementation of smart digital innovations lead to an increase in product quality management in the construction industry (Table 2).

Table 2. Effects of the implementation of digital innovations on quality management in construction: industrial and manufacturing engineering implication

	Parameters of quality management that can be improved through industrial and manufacturing engineering	Value
1	Safety of construction (number of accidents in the sector) has improved through industrial and manufacturing engineering	1. UK (high level of digitalization of safety with the use of digital platforms and tools for monitoring this parameter): 2020–2021 – 40 cases, 2024–2025 – cases. 2. USA (increase in the scale of using digital platforms that involve monitoring of safety and are connected to digital cameras on employees' helmets). Reduction of accidents in construction due to the growth of the use of digital innovative solutions: 25% over the period of 2020–2024.
2	Level of the use of digital building information modeling (BIM), % (in the world)	2020 – 59% 2024 – 89%
3	Impact of digital Building Information Modeling (BIM) on the reduction of construction time, optimized through industrial and manufacturing engineering, % (worldwide)	25% in 2020–2024
4	Influence of the use of building information modeling (BIM) on the reduction of total construction costs, optimized using industrial and manufacturing engineering, % (in the world)	A decrease of 10–20% due to optimization of planning, reduction of the scale of defects and errors, improvement of quality assurance, and growth of supply management.
5	Optimization of construction projects' quality due to digital building information modeling (BIM) using industrial and manufacturing engineering, including the following:	32% – over the period of 2022–2024, in large construction companies that use platforms for digital building information modeling (BIM)
5.1	Digital twins technology in the planning of construction projects and their correction through industrial and manufacturing engineering	World market of digital twins in construction: 2023 – \$1.49 billion 2032 (forecast) – \$18.87 billion
6	Influence of digital twins on the indicator of construction objects' exploitation	35% in 2023–2033, due to the improvement in building management
7	Effect of the digital twins technology on the eco-friendliness of construction, improved through industrial and manufacturing engineering (reduction in CO ₂ emissions into the atmosphere), %	50% in 2023–2033
8	% of construction industry employees with skills in digital technologies (in the world)	2023 – 26% of the total number 2025 – 37% of the total number
9	Growth of inclusiveness of the construction industry due to an increase in digitalization (growth of female employees), optimized through industrial and manufacturing engineering, % (in the world)	22% in 2021–2025

Source: Compiled by the authors based on (Dash Flow Solutions, 2025; Hexagon, 2025; LinkedIn, 2024b; UKATA, 2025)

Implementation of digital innovations allows raising quality parameters in the construction industry and ensuring the growth of products and services' value-added. Growth of the number of digital technologies, including in the structure of platforms (systems or applications), allows covering a larger number of stages and processes of construction, which helps reduce the time required for project completion and costs, and increase eco-friendliness and safety.

Based on an analysis of the latest international experience in the real-time management and optimization of high-technology construction projects using digital tools supported by industrial and manufacturing engineering,

with examples from Israel, the United States, and the United Kingdom, it was established that the use of industrial and manufacturing engineering in implementing digital innovations significantly improves the quality of construction projects.

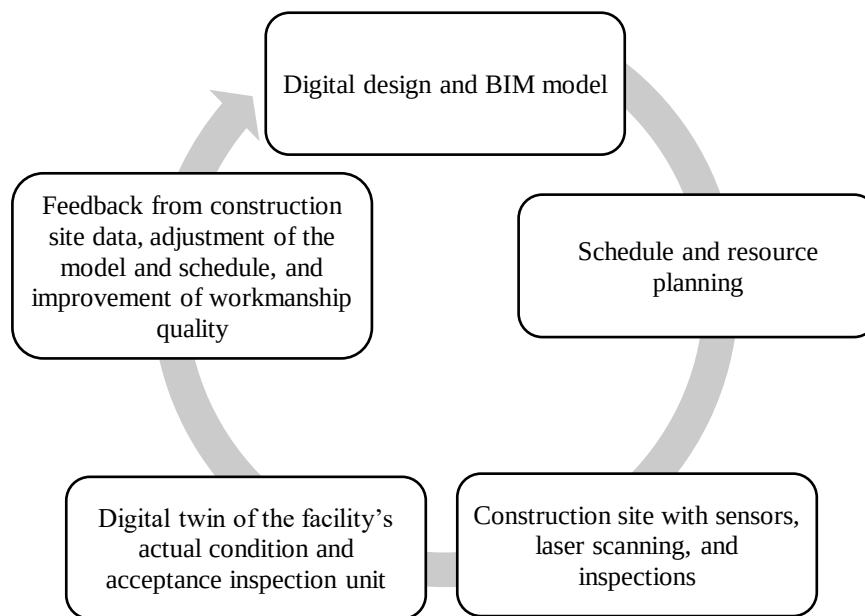
3.3 Systematic Review BIM-Based Quality Assurance

The use of BIM models and digital twins is considered an engineering tool for quality management throughout the life cycle of a construction project. Based on data on project timelines, defects, and the costs of correcting

nonconformities, the operational effects of implementing such tools are assessed.

In construction under the conditions of the digital economy, project quality is regarded as the outcome of an integrated engineering system that includes digital design, planning, resource management, construction control, and operational monitoring. Digital technologies, including BIM, project management systems, and sensor-based monitoring, form a data loop that enables continuous monitoring of quality parameters at all stages of the project life cycle.

The engineering model describes key quality indicators, including reductions in rework, compliance with schedules and budgets, structural resilience, and operational reliability, and links them to the configuration of the project's digital and organizational architecture. The use of a case-based format specifying initial quality problems, solution architecture, and measured outcomes makes it possible to consider the proposed approach as an applied implementation of industrial and manufacturing engineering principles in the construction sector. The BIM-oriented digital quality loop for a construction project is schematically presented in Figure 1.



Source: Compiled by the authors

Figure 1. BIM-oriented digital quality loop for a construction project

The first block in Figure 1 presents digital design and the BIM model; the second shows schedule and resource planning; the third represents the construction site equipped with sensors, laser scanning, and inspection systems; and the fourth depicts the digital twin of the facility's actual condition and the acceptance inspection unit. The feedback loop connects data from the construction site with adjustments to the model, schedule, and artistry quality. The authors' framework emphasizes the engineering nature of digital construction quality management.

In the United Kingdom, Singapore, and Scandinavian countries, BIM and digital inspections have already become standard practices for complex infrastructure and civil construction projects. In practice, these technologies make it possible to identify clashes before construction begins, monitor the actual geometry of structures, and reduce the volume of rework. International experience demonstrates that construction quality is increasingly regarded as the result of continuous digital coordination among the design, actual site conditions, and management decisions.

4. DISCUSSION

The research extends the literature by AlTawil (2026), Naghdi et al. (2026), Wang et al. (2026), and Ye et al. (2026) and further develops the theoretical concept of industrial and manufacturing engineering in the construction industry by providing a scientific explanation of the nature and benefits of situational engineering and technical support for quality management in high-technology construction projects in the digital economy.

In contrast to Gao et al. (2026), Parkinson et al. (2026), Ray et al. (2026), and Ren et al. (2026), evidence from Israel, the United States, and the United Kingdom demonstrates that nontechnical management tools alone are insufficient to ensure high quality in high-technology construction projects. This substantiates the limitations of the established approach to construction quality management in the digital economy and the need to supplement it with industrial and manufacturing engineering.

Global trends in the economy, especially in the conditions of economic instability, emphasize the key role of technologies and innovations in all sectors. The construction industry is one of the drivers of the development of any national economy. The most successful participants of the construction sector are companies that employ technological innovations at all stages of the production cycle.

The construction industry is one of the sectors that is characterized by low innovative activity of companies. However, digitalization discloses new directions for the acceleration of innovations in construction. Support of high standards of quality control in the construction industry is very important for the success of projects and customer satisfaction. Quality control guarantees construction's compliance with the adopted standards and helps in risk management, reduction of costs, and prevention of costly delays. Since projects become increasingly complex, the integration of reliable practices of quality control acquires even larger importance. Effective quality control covers different aspects, including problem management, lists of deficiencies, precision of data, and safety. Construction projects are complex measures that involve many stakeholders and often have strict deadlines. Quality support in these projects is decisive for their success and customer satisfaction.

Digitalization processes are a defining factor in the formation of an effective technological economy. They contribute to the development of innovative activities, growth of macro-economic productivity, and effectiveness of production. The application of digital technologies in the construction sector allows for automation and optimization of the processes of design, planning, and management of construction production. This reduces time and expenditures for the execution of works and raises the quality and safety of construction objects.

4. CONCLUSION

Based on the BIM-based construction-quality case study research results, an innovative approach to construction quality management in the digital economy has been developed based on industrial and manufacturing engineering. The novelty of this approach lies in adapting high-technology construction projects to actual site conditions and coordinating technical processes during project implementation through engineering and technical support designed to maximize quality. The approach provides for the use of advanced digital tools for construction quality management, including the Israeli solution Buildots, the US solutions Doxel and ALICE Technologies, and the UK solution Foresight, supported by industrial and manufacturing engineering. Quality management plays a vital role in the achievement of successful results in construction projects, for it directly influences the project execution, customer

satisfaction, and general reputation of the project (Egbebi, 2024).

The construction industry is constantly developing, and digital technologies play a significant part in the improvement of various aspects of the management of construction quality. Implementing software for construction management, companies can improve their abilities in quality assurance in different ways. Advantages of transition to digital technologies include a reduction in the number of errors and an enhancement of cooperation and communication between members of the construction team. General trends of digital economy development show the main spheres of implementation of innovations, which are manifested in construction activities. For construction, these are additive technologies, construction materials based on nanotechnologies, green technologies, planning of construction objects based on eco-friendliness, circularity, and autonomy, robots, unmanned technologies, BIM technologies, digital twins, the Internet of Things, digital platforms, and open innovation models.

Digitalization of managerial processes in construction contributes to the creation of a transparent, controlled, and adaptive environment. The use of BIM technologies, digital passports of objects, and systems of smart monitoring and management allows ensuring a high level of precision, predictability, and coordination of work. Automated collection of data on the quality of materials, processes, and final products opens new opportunities for quick decision-making and minimization of risks.

In the construction industry, digitalization rates are slower compared to other sectors of material production. This is due to the complex multi-level structure of construction projects, high labor intensity of construction works, insufficient level of digital competencies, and significant capital intensity of construction objects. The processes of digital transformation of the construction industry create a range of challenges and threats to companies. One of the most serious challenges, which restrains the processes of digital transformations in the construction sector, is the low level of digital competence of employees and the absence of skills with digital equipment and solutions. Also, digitalization processes in the construction industry are hindered by companies' opposition to digital changes, which includes the absence of a clear understanding of the economic benefits of digitalization. Digital transformations in construction are also slow due to the absence of generally accepted standards for the use of digital solutions and their low compatibility with the current technological basis.

The new approach is unique in that it combines breakthrough digital technologies for improving construction quality, such as digital building information modeling (BIM) and digital twins, with industrial and manufacturing engineering for quality. The practical

value of the authors' approach to construction quality management in the digital economy lies in the fact that its implementation will help enhance the safety, inclusiveness, and environmental efficiency of high-

technology construction projects, thereby comprehensively improving the quality of the construction facilities being developed through the application of industrial and manufacturing engineering.

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