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Effective Implementation of BIM in Kazakhstan's Construction Industry: Analysis of Challenges and Prospects

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Abstract

Global digital transformation of the construction industry has turned Building Information Modeling (BIM) into a key instrument for enhancing the efficiency of design, construction, and facility operation. In Kazakhstan, BIM adoption is gathering pace, yet encounters substantial challenges—from the need to refine the regulatory framework and train qualified personnel to technological adaptation and stronger government support. This article analyses the main international strategies for BIM implementation and explores their adaptability to Kazakhstan's context. Evidence from countries with advanced digital infrastructure (e.g., the United Kingdom, Singapore, Finland) shows that BIM can be successfully integrated at the governmental level, whereas nations with a more conservative construction sector (e.g., Italy) pursue a more gradual, adaptive pathway. Particular attention is given to Kazakhstan's digitalisation strategy for the construction industry, which encompasses drafting a modern legal framework, creating a unified construction information platform, integrating BIM technologies into public procurement processes, and modernising educational programmes. Establishing a specialist certification system and open-data standards to ensure software interoperability are also crucial. The analysis demonstrates that effective BIM implementation requires a comprehensive approach covering governmental regulation, financial incentives, educational initiatives, and technological modernisation. Introducing digital methods for design and construction management will enhance process transparency, improve construction quality, reduce costs, and accelerate project delivery. The findings underscore the necessity of a systematic rollout of BIM, which, in the long term, will boost the competitiveness of Kazakhstan's construction sector and facilitate its integration into the global digital community.

Keywords: BIM, digital construction, regulatory framework, construction sector, digital community

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Техникалық ғылымдар. Сәулет және құрылыс

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Қазақстанның құрылыс саласына ҚОАМТ тиімді енгізу: мәселелер мен перспективаларды талдау

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Түйіндеме

Мақалада жол құрылыстарының геотехникалық сейсмикалық оқшаулауына арналған демпферлік қабат ретінде қолданылатын топырақ-резеңке композиттерінің тиімділігі зерттеледі. Негізгі назар сейсмикалық толқындардың құрылыстарға әсерін азайту мақсатында іргетас пен топырақ негізінің арасына аралық қабат енгізуге аударылған. Лабораториялық эксперименттер барысында акселерометриялық талдау әдісімен кәдімгі топырақ пен резеңке үгіндісі қосылған топырақ арқылы берілетін тербеліс амплитудасы бойынша сандық мәліметтер алынды. Нәтижелер көрсеткендей, топырақ-резеңке қабаты пиковы үдеуді табиғи топырақпен салыстырғанда 33%-ға төмендетеді. Бұл зерттелген материалдың айқын демпферлік әсерін дәлелдейді. Қайта өңделген шиналардан алынған резеңке үгіндісін қолдану тек инженерлік жағынан тиімді шешім ғана емес, сонымен қатар қалдықтарды кәдеге жаратуға мүмкіндік беретін экологиялық тұрғыдан тұрақты тәсіл екені анықталды. Әзірленген әдістеме сейсмикалық қауіпті аймақтардағы сейсмотөзімді жол конструкцияларын жобалауда қолдануға жарамды. Алынған нәтижелер топырақ-резеңке қабатын инженерлік тәжірибеде қолдануға ұсынуға негіз болады және көлік инфрақұрылымының сенімділігін арттырудың экономикалық тұрғыдан тиімді жолы болып саналады.

Түйін сөздер: BIM, цифрлық құрылыс, нормативтік-құқықтық реттеу, құрылыс секторы, цифрлық қоғамдастық

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Эффективное внедрение ТИМСО в строительную отрасль Казахстана: анализ проблем и перспектив

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Аннотация

В статье рассматривается эффективность применения грунторезиновых композитов в качестве демпфирующего слоя для геотехнической сейсмоизоляции дорожных сооружений. Основное внимание уделено устройству промежуточного слоя между фундаментом и грунтовым основанием с целью снижения воздействия сейсмических волн на конструкции. В ходе лабораторных экспериментов методом акселерометрического анализа получены количественные данные об амплитуде колебаний, передаваемых через обычный грунт и грунт с добавлением резиновой крошки. Результаты показали, что слой грунта с резиной снижает пиковое ускорение на 33% по сравнению с естественным грунтом. Это подтверждает очевидный демпфирующий эффект исследуемого материала. Установлено, что использование резиновой крошки из переработанных шин является не только эффективным инженерным решением, но и экологически устойчивым подходом, позволяющим эффективно утилизировать отходы. Разработанная методика пригодна для использования при проектировании сейсмостойких дорожных конструкций в сейсмоопасных районах. Полученные результаты дают основание рекомендовать применение грунторезиновых прослоек в инженерной практике и считаются экономически эффективным способом повышения надежности транспортной инфраструктуры.

Ключевые слова: BIM, цифровое строительство, нормативно-правовое регулирование, строительный сектор, цифровое сообщество

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Introduction

Contemporary trends in the digitalization of the construction industry highlight the growing importance of Building Information Modeling (BIM) technologies in enhancing the efficiency of design, construction, and operation processes for buildings and infrastructure assets. In the context of global digital transformation, rapid urbanization, and increasing complexity of architectural and engineering solutions, traditional construction management methods are becoming less effective—necessitating a transition to integrated digital tools.

BIM-based technologies, grounded in the concept of Building Information Modeling, significantly reduce errors during the design and construction stages, improve the accuracy of cost estimation, minimize risks, and optimize operational expenditures. The use of a digital information model ensures transparency of design decisions, enhances coordination among all stakeholders in the investment and construction process, and increases the level of automation in asset management throughout the entire life cycle [1].

For Kazakhstan, the implementation of BIM represents a strategically important direction for the development of the construction industry, as it contributes to increasing competitiveness, reducing costs, and improving the quality of built assets. However, the digitalization process requires a comprehensive approach that includes the enhancement of regulatory frameworks, technological modernization, workforce training, and active government support [2].

Global experience confirms that the application of Building Information Modeling technologies plays a pivotal role in modernizing the construction sector, enhancing efficiency at the stages of design, construction, and operation. At the same time, each country develops its own BIM implementation strategy, taking into account national regulatory frameworks, the industry's technological readiness, and the level of government support. There is no universal recipe for digital transformation: the pace and methods of BIM adoption vary depending on numerous factors, priorities, and strategic objectives. Countries adapt their approach to BIM based on their specific needs and capabilities, resulting in diverse models and rates of implementation.

For example, in the United Kingdom, construction digitalization has been declared a key instrument for increasing productivity and reducing costs. The Government Construction Strategy, adopted in 2011, set targets for transitioning to digital technologies, and since 2016, the use of Level 2 BIM has been mandatory for all public sector projects. National standards (the PAS 1192 series) formed the foundation for the international ISO 19650 standard, while the establishment of a Common Data Environment (CDE) enabled effective project information management. The outcomes were significant: in 2014–2015, the total budget savings attributed to BIM implementation amounted to approximately £0.85 billion, and the share of companies using BIM grew from 13% in 2011 to over 70% by 2020. This experience highlights the critical role of active government policy and standardization in driving the digital transformation of the construction sector [3].

Finland was one of the first countries to implement BIM at the national level. As early as the early 2000s, a nationwide construction digitalization program was launched, and in 2007, the state agency Senate Properties mandated the use of BIM in all its projects, emphasizing full life cycle management of built assets. This approach improved design accuracy and reduced subsequent operational costs. In 2016, the "BIM Roadmap 2035" was adopted, aiming for full digitalization of the construction sector by 2035. By 2022, an estimated 93% of architectural firms and 60% of engineering companies in Finland were using BIM, positioning the country among global leaders in the level of BIM adoption [4].

In contrast, Italy—where the construction sector focuses heavily on large-scale infrastructure projects and the restoration of historical buildings—has adopted digital technologies more gradually. Decree No. 560/2017 established a phased transition to BIM for public sector projects, adapting new tools to local conditions. BIM implementation is expected to reduce

construction timelines for infrastructure by improving the accuracy of design decisions and enhancing stakeholder coordination. Moreover, information models are already being used in the restoration of architectural heritage sites, increasing transparency in condition monitoring and facilitating maintenance planning [5].

Singapore stands out as one of the global leaders in construction digitalization, driven by strong government support and clearly defined regulations. The national Singapore BIM Guide and the CORENET X platform for electronic submission of project documentation have ensured standardized BIM implementation across the industry. Particular emphasis in Singapore is placed on integrating BIM with urban management systems, which enhances project transparency and automates oversight of construction execution. The adoption of BIM technologies has led to approximately a twofold increase in on-site labor productivity, a 10–20% reduction in design costs, and a significant decrease in construction errors [6].

The United States does not have a unified national BIM policy; however, major construction corporations and federal agencies—such as the General Services Administration (GSA) and the U.S. Army Corps of Engineers (USACE)—widely implement digital technologies. The National BIM Standard (NBIMS), developed by the National Institute of Building Sciences (NIBS), serves as a reference framework for BIM use across different industry segments. In the private sector, Building Information Modeling is primarily aimed at improving productivity, reducing errors, and enhancing project team coordination. Significant attention is also given to integrating BIM with advanced technologies—such as virtual and augmented reality, artificial intelligence, and Internet of Things (IoT) sensors—to automate design, construction, and asset management processes. By 2021, an estimated 74% of architectural firms in the U.S. were using BIM, and adoption among large firms reached approximately 90%, indicating widespread uptake across the market [7].

Australia, similar to the United States, has not introduced a federal mandate for mandatory BIM adoption; however, its implementation is actively promoted at the level of individual regions and organizations. In several states—such as New South Wales and Queensland—BIM use is already mandatory for public infrastructure projects, which is accelerating the digital transformation of the construction sector. Professional associations and government clients are encouraging the transition to BIM by integrating digital requirements into project standards and contractual frameworks [8].

Global experience demonstrates a variety of approaches to BIM implementation, yet all emphasize the importance of strategic government support for digitalization. In line with these trends, Kazakhstan is developing its own strategy for the digital transformation of the construction sector. This strategy includes the development of a modern regulatory framework, the creation of a unified information platform for construction data management, the integration of BIM technologies into public procurement processes, and the modernization of educational programs to train a new generation of professionals. Other key components include the establishment of a national BIM certification system and the adoption of open data formats to ensure interoperability between software solutions [9].

The aim of this study is to analyze the challenges and prospects of effective BIM implementation in Kazakhstan’s construction industry by examining international experience and national specificities, and to propose strategic approaches for a successful digital transformation of the sector.

Methods

A comprehensive approach was applied in this study to examine Kazakhstan’s BIM implementation strategy in the construction sector, taking into account the regulatory, economic, technological, and organizational aspects of digitalization.

An analysis of the regulatory framework of the Republic of Kazakhstan was conducted, covering current legislative and technical documents related to the implementation of information modeling. In particular, the Concept for the Implementation of BIM Technologies in Industrial and Civil Construction (approved in 2017) was reviewed, along with the potential for adapting international standards for information management—such as the ISO 19650 series—to national practices. In addition, the study examined existing domestic technical regulations governing digital construction and reflecting emerging technological requirements.

To identify effective mechanisms for BIM implementation, international experience in the digitalization of the construction sector was analyzed across several countries, including the United Kingdom, the United States, Finland, Singapore, China, South Korea, Australia, and others. The analysis focused on national BIM development strategies, legislative initiatives, and the economic efficiency of digital technology adoption in the construction industries of these countries.

Based on the analysis conducted, the key barriers to BIM implementation in Kazakhstan have been identified—namely, technical, organizational, human resource, and regulatory challenges. A set of systemic recommendations has been proposed to support a sustainable transition to digital methods in the construction sector. Furthermore, drawing on international experience, a preliminary digitalization roadmap for Kazakhstan's construction industry for the period 2025–2030 has been developed. It outlines the stages of BIM implementation and assesses the impact of regulatory changes, educational programs, government incentives, and technological innovations on the digital transformation process.

Results

The process of BIM implementation in Kazakhstan is actively progressing; however, its widespread adoption is hindered by several factors. In recent years, interest in digitalization has increased: the Concept for BIM Implementation was adopted in 2017, and efforts have begun to adapt international ISO 19650 standards to national practice. Nevertheless, the use of BIM remains fragmented—there are no mandatory requirements for BIM in public sector projects, and digital design is applied selectively, mainly in large-scale infrastructure developments. Companies' readiness to transition varies significantly due to disparities in equipment, workforce qualifications, and financial resources.

Key Barriers to BIM Implementation:

- The absence of mandatory regulations slows down digitalization, as organizations postpone the transition due to concerns over additional costs. Legislative amendments are needed to grant legal status to information models and to establish clear deadlines for mandatory BIM adoption in public sector projects.
- High costs for software, training, and process restructuring, especially for small and medium-sized enterprises (SMEs). There is a need for subsidies, concessional loans, and grant support. The current cost adjustment coefficient in project estimates only partially offsets expenses, so the financing system should be expanded.
- Shortage of qualified personnel. Updating university curricula, expanding professional development courses, and promoting international certification will help build a professional community of BIM specialists.
- Weak market incentives. Effective measures include tax benefits, tender preferences, advisory support, and co-financing programs.

A successful digital transformation requires a comprehensive ecosystem that includes unified regulations, financial mechanisms, technological solutions, and a skilled workforce. A key condition is the introduction of mandatory BIM requirements in public procurement, along with the adaptation of international standards such as ISO 19650 and IFC. The development of domestic

BIM platforms will reduce dependence on foreign software, while support for startups will accelerate innovation.

Financial instruments will yield returns through increased productivity and reduced costs. Government support for digital construction—such as tax incentives, software subsidies, and project co-financing—will accelerate the transition to BIM among companies. A phased implementation through pilot projects on significant facilities will help identify barriers and refine methodologies, after which solutions can be scaled up. The use of digital models during design and operation stages will enhance transparency, reduce expenses, and facilitate the prediction of asset conditions.

Thus, regulatory reforms, economic incentives, the development of national IT solutions, and systematic workforce training will create the necessary conditions for widespread BIM adoption and enhance the competitiveness of Kazakhstan's construction industry.

Discussion

BIM implementation in Kazakhstan is only achievable through a comprehensive program that encompasses the entire cycle of digital transformation, including sequential phases, clear distribution of responsibilities, and a transparent system for monitoring outcomes. International practice shows that a sustainable transition to BIM technologies is achieved when regulatory frameworks, technical solutions, and educational initiatives are aligned and mutually reinforcing. The national roadmap is structured in two phases (2025–2030): first, a pilot stage to test technologies and identify bottlenecks; second, the scaling up of digital tools across the entire construction sector.

The central element of the program is a unified digital environment. Kazakhstan is already deploying the Unified Construction Platform (UCP), designed to consolidate data on all projects, automate information exchange, and increase transparency in construction processes. Similar ecosystems, which have proven effective internationally, help shorten design timelines, reduce errors, and save resources.

To accelerate the transition of companies to BIM, pilot projects have been launched. These serve as testing grounds for methodologies, help identify implementation barriers, and generate recommendations for the industry. The experience gained from these pilot projects is also being extended to the private sector.

A powerful driver of adoption is the mandatory use of information modeling in public procurement. Updated tender requirements that include BIM criteria improve project quality, reduce risks, and enhance the transparency and accountability of public spending. International experience shows that when governments enforce digital requirements, private companies are more likely to invest in new technologies.

The promotion of BIM is supported by industry conferences, seminars, exhibitions, and collaboration with international organizations. These activities help build a professional community and disseminate best practices.

The development of R&D and support for local BIM software developers will reduce dependence on imported solutions, enhance technological autonomy, and open up opportunities for export.

BIM enhances project transparency and manageability by providing a unified model accessible to clients, designers, contractors, and regulators, thereby minimizing uncoordinated changes and data duplication. Automated compliance checks, clash detection, and specification generation reduce errors and rework. The digital model facilitates accurate quantity take-offs, resource planning, and site logistics, helping to reduce waste and unplanned costs. For the government, BIM provides early risk detection and precise control over timelines and budgets.

During the operation phase, the digital asset passport simplifies maintenance and upgrades, reduces failure rates, and lowers operational costs.

Conclusions

The implementation of Building Information Modeling (BIM) technologies is a strategically important direction for the modernization of Kazakhstan's construction sector. The consistent execution of a comprehensive set of core and supporting measures will enable a full transition to digital technologies, enhance project management efficiency, reduce costs, and minimize errors during the design and construction stages.

Key measures—including the update of a unified industry-wide digital platform, improvement of the regulatory and technical framework, modernization of educational programs, and implementation of pilot projects—will provide a solid foundation for the mandatory and widespread adoption of BIM. Additional efforts, such as the promotion of digital technologies through conferences and awareness campaigns, support for scientific research and domestic software development, and collaboration with international organizations, will accelerate the implementation process and facilitate the adaptation of global best practices to Kazakhstan's specific context.

The expected outcomes of BIM implementation will be reflected in key indicators of successful digital transformation within the construction sector. These include the development of an appropriate regulatory framework, an increase in the share of projects delivered using BIM, improved transparency in stakeholder collaboration, and the upskilling of professionals through international certification systems.

The comprehensive implementation of the proposed strategy will lead to the creation of an efficient and competitive construction sector aligned with international standards. Large-scale adoption of BIM technologies will improve construction quality, reduce costs and project timelines, and enhance life cycle management of buildings and infrastructure. In the long term, this will contribute to the sustainable development of Kazakhstan's construction industry, strengthen its competitive position, and facilitate integration into the global digital economy.

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