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Information Technologies for Smart Construction: Accounting and Control Aspect

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Abstract. *The formation of a digital economy in the construction sector is based on the mass introduction of information technologies for accounting and control. The complex application of such technologies provides a profound digital transformation of the information environment, while fragmentary digitalization does not allow achieving a qualitatively new level of development on the principles of smart construction. The article aims to clarify the methodical and organizational foundations of accounting and control of construction companies based on the disclosure of modern information technologies, using the principles of smart construction as a basis. An analysis of scientific publications on the topic of the study was carried out, and an abstract-graphic method was used to build a multi-level pyramid of the scientific environment, reflecting the influence of information technologies on the digitalization of accounting and control in construction. Using analysis and synthesis, as well as inductive and deductive methods, the authors identified the most promising information technologies at the highest meta-level of the scientific field, aimed at improving the information support of management, which forms the concept of smart construction. The study results show that information technologies that form the basis of the concept of smart construction are represented by three functional groups: primary data collection, information environment formation, and information interpretation. The following innovative technologies are used in the field of accounting and control of construction activities: aerovisual monitoring – to control material consumption and the presence of workers; global positioning – to track the movement of equipment; geographic information systems – to manage earthworks; Internet of Things – to control resource consumption; 3D printing – to parameterize production costs. In turn, blockchain and cloud services increase the efficiency of organizing accounting and control processes, and BIM design and virtual and augmented reality technologies contribute to the optimization of construction management. The integrated use of these technologies provides digitalized accounting and control, forming the conceptual basis of smart construction as a digital economy component.*

Keywords: *accounting, control, accounting digitalization, information technologies, smart construction, construction enterprises.*

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Інформаційні технології смартбудівництва: обліково-контрольний аспект

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Анотація. *Становлення цифрової економіки у будівельній сфері, складовою якої є смартбудівництво, базується на масовому впровадженні інформаційних технологій обліку та контролю. Комплексне застосування таких технологій забезпечує глибоку цифрову трансформацію інформаційного середовища, тоді як фрагментарна цифровізація не дозволяє досягти якісно нового рівня розвитку на принципах смартбудівництва. Метою статті є уточнення методичних та організаційних засад обліку та контролю діяльності будівельних компаній на основі розкриття сучасних інформаційних технологій та принципів смартбудівництва. Здійснено аналіз наукових публікацій за темою дослідження та використано абстрактно-графічний метод для побудови багаторівневої піраміди наукового середовища, що відображає вплив інформаційних технологій на цифровізацію бухгалтерського обліку в будівництві. Використовуючи аналіз та синтез, а також індуктивний та дедуктивний методи, автори визначили найперспективніші інформаційні технології на найвищому метарівні наукової області, спрямовані на покращення інформаційного забезпечення управління, що формує концепцію смартбудівництва. Результати дослідження свідчать, що інформаційні технології, що формують основу концепції смартбудівництва, представлені трьома функціональними групами: збір первинних даних, формування інформаційного середовища та інтерпретація інформації. У сфері обліку та контролю будівельної діяльності використовуються наступні інноваційні технології: аеровізуальний моніторинг – для контролю витрат матеріалів і присутності працівників; глобальне позиціонування – для відстеження руху техніки; геоінформаційні системи – для управління земельними роботами; Інтернет речей – для контролю споживання ресурсів; 3D-друк – для параметризації виробничих витрат. Натомість блокчейн і хмарні сервіси підвищують ефективність організації обліково-контрольних процесів, а BIM-проєктування та технології віртуальної і доповненої реальності сприяють оптимізації управління будівництвом. Комплексне використання зазначених технологій забезпечує цифровізований облік і контроль, формуючи концептуальну основу смартбудівництва як складової цифрової економіки.*

Ключові слова: *облік, контроль, цифровізація обліку, інформаційні технології, смартбудівництво, будівельні підприємства.*

INTRODUCTION

Smart construction in the construction sector, as a component of the digital economy, is based on the widespread use of information technologies. Technological changes in the construction process co-occur in the construction-technological and informational spheres. The synergistic dualism of fundamental improvement in the construction process and its accounting-control interpretation forms the paradigm of smart construction, in which all processes are mutually integrated to achieve competitive advantages in the market of construction products (works, services).

The evolution of computer and communication technologies has developed in parallel with scientific and technological progress in the construction industry. Smart construction represents the highest level of current technological advancement in information processing. The practical application of technologies such as artificial intelligence, blockchain, the Internet of Things, and virtual and augmented reality significantly transforms the theory and practice of accounting and control in construction enterprises. However, each technology targets a specific aspect of accounting and control in the construction sector. Only the integrated application of computer and communication technologies in construction can positively affect a company's adoption of the smart construction concept.

While the digitalization of isolated segments of accounting and control subsystems can bring certain benefits to a construction company's operations, it cannot ensure a qualitatively new level of technological transformation in construction, a requirement of the current stage of the digital economy. Therefore, it is essential to determine the impact of integrating data processing technologies on the digital transformation of an enterprise's information environment toward implementing smart construction principles.

LITERATURE REVIEW

The improvement of general theoretical principles for managing construction activities under the influence of information technologies has been the subject of numerous scientific studies. Husain and Novokhatska (2017) focused on modeling construction processes and improving software tools and enterprise management methods; Meneiliuk et al. (2019) developed variable models of construction management depending on the applied information technologies; Kyslun et al. (2020) explored the processes of creating and operating construction facilities; Ogunrinde et al. (2025) investigated construction quality management; Deneka et al. (2024) studied the formation of innovative potential as a result of digitalized management; Muravskyi (2023) analyzed the provision of economic and cyber protection of construction enterprises.

Some authors have devoted their research to examining the prospects for applying specific information technologies in the digitalization of construction management: Karacigan et al. (2025) – blockchain in managing construction contracts; Güray (2025) – geoinformation technologies and electronic mapping in managing construction projects; Ma (2025) – virtual and augmented reality in construction design; Putra et al. (2025) – Internet of Things technologies in safety management.

Most scholarly works on the use of information technologies in the construction sector are devoted to BIM design: stages of formation and prospects for development (Trach, 2017); implementation of digitalized software complexes (Kulik et al., 2020); creation of integrated information models for management purposes (Chashyn, 2022); improvement of organizational and managerial processes (Anin et al., 2023); construction safety management (Tian, 2025); prospects for green construction (Cao et al., 2025); and features of precision construction (Tang & Liang, 2025).

Only a few studies are partially aimed at refining the theory, methodology, and organization of accounting and control in construction under conditions of automation or digitalization driven by information technologies. In particular, Humenna-Derii and Humennyi (2023) systematized various types of construction resource provision in the context of automated accounting. Podkopaiev and Tsyfra (2024) improved the methodology for applying low-code systems for business process automation in construction to control settlements with counterparties. Korenga and Pryimak (2023) developed a model of accounting and analytical support for developing the construction sector in Ukraine. Koval et al. (2025) investigated the accounting system to enhance the economic security of the construction complex under the influence of digitalization and innovative technologies. Zaidan et al. (2025) established an informational relationship among cost accounting, construction project management, and the use of modern information technologies.

These studies on the digitalization of construction management form a multi-level scientific foundation for smart construction (Figure 1).

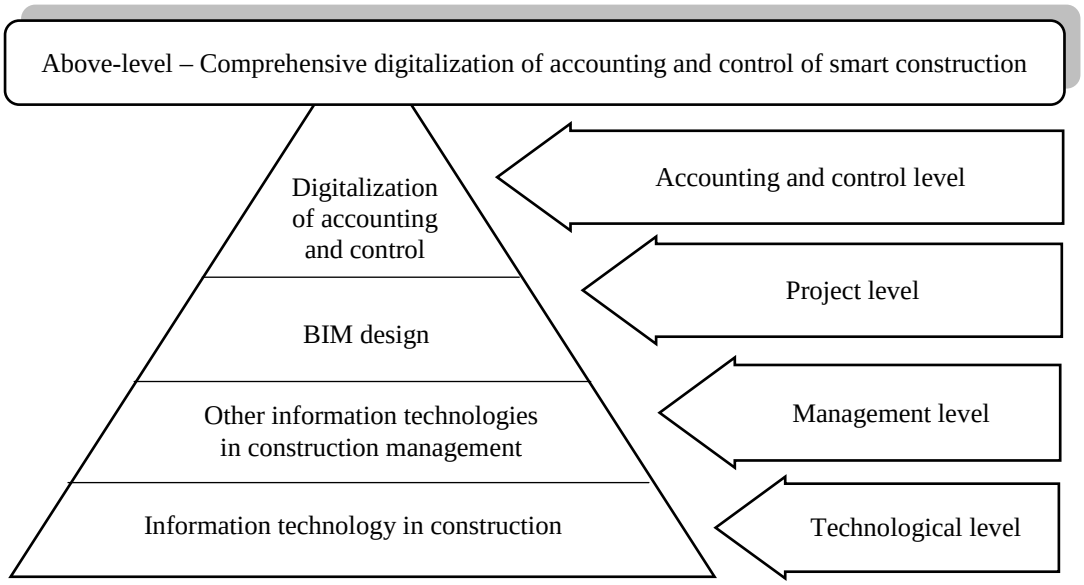

Figure 1. Multi-level pyramid of scientific substantiation of the concept of smart construction

Source: formed by the authors.

The lower technological level of scientific support for smart construction is associated with the prospects of applying information technologies in the construction sector. This level of the scientific paradigm of smart construction includes studies of the functional capabilities of individual technologies in management (management level), among which BIM research dominates, and their role in fostering smart construction development (project level). The higher level of the scientific environment relates to using information technologies to improve accounting and control in the construction industry (accounting-control level). However, such studies are fragmented and address only certain aspects of the digitalization of accounting and control support for construction management. They also remain insufficiently adapted to the requirements of smart construction as an element of the digital economy. Therefore, the next promising research stage involves the comprehensive digitalization of accounting and control in smart construction.

The article aims to clarify the methodical and organizational foundations of accounting and control of construction companies based on the disclosure of modern information technologies, using the principles of smart construction as a basis.

RESEARCH METHODOLOGY

Using the scientific publication aggregator ResearchGate, we selected and empirically evaluated studies based on the key search phrases “information

technologies," "digitalization of accounting," and "construction." Based on the analysis of diverse academic works containing these keywords, an abstract-graphic method was employed to construct a multilevel pyramid of the scientific environment reflecting the impact of information technologies on the digitalization of accounting in construction.

Using analysis and synthesis, as well as inductive and deductive methods, we identified the most promising information technologies at the highest meta-level of the scientific domain aimed at improving information support for management, which shapes the emerging concept of smart construction. The systematic approach allowed us to develop a comprehensive framework for accounting transformation, emphasizing the necessity of the integrated use of various information technologies to achieve positive effects from the transition to smart construction principles in the operations of construction companies.

RESULTS

Information technologies used in smart construction can be classified into data collection, information environment formation, and information interpretation, depending on their functions and use in accounting and control. Primary data collection employs geoinformation systems, global positioning, aerial drone monitoring, the Internet of Things, and 3D printing. Blockchain and cloud services integrate and accumulate accounting data, while BIM design and virtual/augmented reality technologies are used for data interpretation in accounting and control. All these technologies are closely interconnected.

Most accounting data is automatically collected at its source. It must be accumulated and processed after identifying the semantic parameters of accounting information. Effective two-way data transmission is essential since construction sites are often geographically distant from company headquarters. Raw accounting information is sent to centralized management units, while processed data and managerial decisions are returned. Given the large number of employees involved in collecting and transmitting accounting data, real-time synchronization among all construction process participants is crucial. In other words, primary or secondary data processing results should be instantly accessible to responsible staff members. Installing specialized software on every workstation cannot ensure effective communication within an automated accounting and control system. Decentralized data collection from construction sites combined with centralized processing becomes inefficient when using standardized networks of individual automated workplaces.

Cloud computing technology is applied to maintain continuous information synchronization. Cloud services can function without a unified hardware-software network for accounting data processing. Information processing in the cloud environment can occur through various platforms, applications, or even standard web browsers. Cloud systems integrate accounting data for storage and processing online. This enhances personnel mobility, allowing work to be done directly on-site and ensuring operational control over the construction process. Accounting and management staff can perform their duties remotely, reducing costs for workplace organization and specialized equipment.

Although periodic expenses for cloud service providers may arise, these are offset by savings from organizational optimization and reduced penalties for inadequate in-house accounting and control. Moreover, cloud operators can offer outsourcing services to construction companies, further supporting efficient digital transformation in the sector.

Developing the "smart construction" management concept involves integrating blockchain technology into the developer's cloud-based information environment. Accumulating accounting data in a blockchain structure ensures efficient processing, cybersecurity, distributed access, and transparency. Blockchain technology integrates all construction process participants into a unified information space with an effective system of responding to user information requests. Smart construction is oriented toward storing accounting data in unified databases with automatic transmission to stakeholders according to their informational interests, access rights, and positions within the managerial hierarchy. Accounting data generated through blockchain can reach end users in real time and in the optimal amount necessary for effective decision-making. The blockchain structuring of accounting data helps prevent information deficiency and redundancy, affecting management efficiency.

Blockchain technology can also be used to minimize the influence of negative information threats on the developer's accounting and control system. Through data recovery mechanisms, duplication of datasets among users, and hierarchical records that monitor unauthorized changes, the actions of internal and external violators become much more difficult. Consequently, using blockchain reduces potential enterprise losses caused by cyber risks, inefficient management due to low-quality data, and data manipulation aimed at distorting reporting indicators, thereby protecting the company's reputation.

The digitalization of design work in construction has enabled the formation of accurate electronic building projects using BIM technology. The electronic model allows determining the full range and volume of necessary construction materials, structures, and related works. Accounting personnel can prepare a reliable construction budget based on a detailed digital version of the building. At the same time, controllers can continuously compare the actual state of completed work with the planned scope according to the project. Significant deviations in expenses serve as a basis for internal investigations to identify causes and responsible parties.

BIM technology can prevent excessive direct costs and losses caused by unlawful actions of internal or external individuals. BIM systems are also complemented by virtual and augmented reality technologies designed to enhance the ergonomics of construction design. With the help of these systems, all design tasks can be performed

in a human-oriented computer interface that supports intuitive data processing. Such technology is also valuable for accounting and control professionals, as it allows visual representation of accounting information and detailed interpretation of complex technological processes and financial indicators of construction activities. Visualization of technological and economic processes contributes to a better understanding of accounting indicators related to the construction company's operations.

Geoinformation technologies that employ various informational layers of satellite imagery are a prerequisite for BIM modeling. GIS collects information on terrain relief, climate, existing buildings, engineering communications, and territorial restrictions. Together, these elements form the construction conditions of the building site.

Among the most widely known geoinformation systems are electronic cadastral maps. Construction enterprises use digital mapping data to define site boundaries, automate land accounting, and inventory non-current land assets. Geocadastral maps are also applied in earthwork planning, terrain modification, and foundation preparation. Using geoinformation technologies, construction units can accurately plan expenses during the initial preparation stage, minimizing unforeseen and excessive costs.

The Global Positioning System (GPS) is used to determine the location of construction and transportation equipment accurately. Navigation is based on continuous data exchange between specialized moving machinery and low-orbit satellites. Information on the location and movement of equipment can be transmitted to navigation devices or a centralized accounting unit. Initially, GPS data were used to calculate the distance traveled by construction machinery, serving as a basis for recording fuel and lubricants.

Currently, GPS functionality has expanded to include monitoring machinery performance, such as crane operations, material loading, or mixer work. These data allow accounting departments to determine employee wages, control idle time, and monitor efficiency. GPS technology also enables the detection of deviations from set parameters and technological limitations to ensure the effective use of the enterprise's fixed assets.

Global satellite positioning is complemented by the use of unmanned aerial vehicles (drones) to monitor construction processes visually. Drones transmit visual information in real time to processing centers. In construction, drones are primarily used for safety control — monitoring workers and detecting unauthorized persons on site. In case of intrusion, drones can automatically notify internal and external security units.

The economic use of drones extends further. They can create electronic terrain models of construction sites, reducing preparation costs and facilitating initial site organization. Drones can also record the arrival of personnel and machinery, as well as determine the degree of project completion, which is crucial for expense planning and revenue recognition under construction contracts.

Construction projects are increasingly individual in nature, requiring unique structural elements. Producing separate molds or casting blanks for single-use components is economically inefficient. 3D printing offers an optimal method by layering materials within defined spatial dimensions. Industrial 3D printers can produce construction elements of any size or complexity from standard templates or self-created electronic designs.

3D printers record the materials and energy resources used in manufacturing each element, allowing step-by-step determination of production cost. After installation, printed components can be automatically included in the total building cost. Self-production of structural elements compared to external procurement can reduce overall construction expenses, and savings from 3D printing can offset the cost of printers and maintenance.

In most of the technologies mentioned, data transmission occurs through the Internet. The ability to instantly transfer information led to the emergence of the Internet of Things (IoT), which enables real-time data collection and transmission through various sensors. In construction, IoT is integrated into automated control systems of technological processes.

The most widespread IoT-based application is smart energy metering. When installed in different construction site areas, smart meters can differentiate energy consumption by activity type. Unlike traditional meters that collect aggregate data, smart meters provide detailed accounting information for each building, floor, or unit. They can also be installed on production equipment to track resource consumption for each batch of materials or construction unit. Such data accumulation ensures accurate cost determination without relying on generalized overhead distribution.

The use of the aforementioned information technologies in the digitalization of accounting and control in smart construction contributes to optimizing construction companies' costs. Various information processing technologies differentially affect cost behavior in the construction sector (Table 1).

There is a direct relationship between groups of information technologies and the types of costs that are minimized through their use in accounting and control. Data collection technologies enable the precise calculation of the cost of construction products (works, services) and reduce production and overhead costs in construction companies. These technologies ensure more comprehensive cost recognition and efficient allocation when forming cost indicators in construction. Conversely, information technologies that form the information environment are primarily aimed at optimizing administrative expenses. Implementing the smart construction concept is intended to reduce costs associated with maintaining administrative facilities and personnel. Meanwhile, data interpretation technologies help optimize the use of working time by responsible specialists, minimize losses caused by professional misconduct, and reduce the risk of sanctions imposed by government institutions.

Table 1. Use of Smart Construction Information Technologies in Accounting and Control

No.	Information Technology	Use in accounting and control	Impact on financial results
1.	Geographic Information Systems	Conducting preparatory earthworks and inventorying the territory of construction sites	Planning and minimizing costs for land management design work, preparatory land works
2.	Aerovisual Unmanned Monitoring	Consumption of materials (structures) and the presence of workers on the construction site	Identification and minimizing production costs related to materials and wages
3.	Global Positioning	Movement of vehicles and construction equipment	Identification and minimizing costs for operation, maintenance, and depreciation of movable non-current assets
4.	Internet of Things in Smart Meters	Consumption of energy and utilities	Determination and allocation of energy costs
5.	3D Printing	Consumption of materials	Recognition and minimizing most costs as direct
6.	Blockchain	Formation of centralized databases with distributed access. Information protection.	Minimization of costs due to the preservation of commercial secrets and related economic losses
7.	Cloud Services	Remote processing of accounting information, formation of integrated cloud environments	Minimization of administrative costs for maintaining premises and personnel
8.	BIM Design	Forecasting of company activities, planning of construction costs	Formation of a construction budget, planning costs, and comparison with actual indicators
9.	Virtual and augmented reality	Visualization and ergonomics in processing accounting information and making management decisions	Reduction of losses of working time of responsible specialists, and costs of involving third-party institutions in data interpretation

Source: compiled by the authors.

The identified relationship between technology groups and areas of operational optimization in construction enterprises is not rigid or absolute. Systematic use of various innovative information processing technologies in accounting and control provides a comprehensive positive impact on the financial performance of construction enterprises, constituting a key prerogative of smart construction.

CONCLUSION

The development of the smart construction concept involves the integrated use of diverse information technologies in accounting and control. Information processing technologies can be classified into three groups: data collection (geoinformation systems, global positioning, aerial drone monitoring, the Internet of Things, and 3D printing); information environment formation (blockchain and cloud services); and information interpretation (BIM design and virtual/augmented reality technologies).

The application of innovative information technologies in smart construction ensures digitalized accounting and control. In particular, the following innovative technologies are used in the field of accounting and control of construction activities: aerovisual monitoring – to control material consumption and the presence of workers; global positioning – to track the movement of equipment; geographic information systems – to manage earthworks; Internet of Things – to control resource consumption; 3D printing – to parameterize production costs.

At the same time, blockchain and cloud technologies are focused on the optimal organization of accounting and control processes, which contributes to minimizing administrative costs. Using BIM design systems and virtual/augmented reality technologies allows for the optimization of specialists' working time and improvement of construction management efficiency. Achieving positive results in the construction industry is possible only through the comprehensive application of diverse information technologies in accounting and control – a conceptual foundation of smart construction.

4 References

Anin, V. I., Pastukhova, S. V., Bilov, Yu. O., & Metelenko, N. H. (2023). Innovative information technologies as an improvement of organizational construction processes. *Mosty ta tuneli: teoriia, doslidzhennia, praktyka*, 23, 5–16. https://doi.org/10.15802/bttrp2023/281073 [in Ukrainian].

Cao, S., Li, Y., & Zhu, S. (2025). The application of BIM technology in green construction management of building projects. *Applied and Computational Engineering*, 156, 29–34. https://doi.org/10.54254/2755-2721/2025.MH25085

Chashyn, D. Yu., Rakhmanin, O. A., & Khil, D. V. (2022). Implementation of BIM technologies as a basis for creating complex information models in construction management. *Ukrainskyi zhurnal budivnytstva ta arkhitektury*, 1, 63–70. https://doi.org/10.30838/J.BPSACEA.2312.220222.63.834 [in Ukrainian].

Deneka, V., Fenyc, V., Torbych, A., & Kryvulia, R. (2024). Management of innovation potential of construction enterprises in the context of digitalization. *Akademichni vizii*, 27, 1–9. https://doi.org/10.5281/zenodo.10715019 [in Ukrainian]

Güray, T. (2025). Functional mapping of Industry 4.0 technologies in construction project management. *Journal of International Architectural Sciences*, 2(1), 01–08. https://doi.org/10.5281/zenodo.15908037

Humenna-Derii, M. V., & Humennyi, P. V. (2023). Automation of financial resource accounting in construction. *International Scientific Journal "Internauka". Series: Economic Sciences*, 4. https://doi.org/10.25313/2520-2294-2023-4-8822 [in Ukrainian].

Husain, N. M. Y. M., & Novokhatska, D. V. (2017). The role of information technology in the management of construction projects. *Upravlinnia rozvytkom skladnykh system*, 29, 103–109. Retrieved from: https://urss.knuba.edu.ua/ua/zbirnyk-29/article-1006 [in Ukrainian]

Karacigan, A., Caglayan, S., Tezel, A., & Ozorhon, B. (2025). Strategic roadmap to achieve successful implementation of blockchain technology in construction contract management. *Journal of Construction Engineering and Management*, 151, 04025185. https://doi.org/10.1061/JCEMD4.COENG-17040

Korenga, A., & Pryimak, S. (2023). Accounting and analytical support for modern trends in the development of the construction industry in Ukraine. *Zeszyty Naukowe Wyższej Szkoły Technicznej w Katowicach*, (17). https://doi.org/10.54264/0076

Koval, S. D., Ustymenko, A. M., & Moholivets, A. A. (2025). The impact of digitalization and innovative technologies on improving the economic security of the construction complex. *Zdobutky ekonomiky: perspektyvy ta innovatsii*, 19. https://doi.org/10.5281/zenodo.15649907 [in Ukrainian].

Kulik, M. V., Kulish, S. O., & Ishchenko, S. S. (2020). Implementation of modern digitalized software complexes based on BIM technologies in Ukrainian construction. *Naukovyi visnyk budivnytstva. Seriia Budivnytstvo*, 2, 301–306. https://doi.org/10.29295/2311-7257-2020-100-2-301-306 [in Ukrainian].

Kyslun, O. A., Parkhomenko, Yu. M., Skrynnik, I. O., & Dariienko, V. V. (2020). IT in the processes of creation and operation of construction objects. *Tsentralnoukrainskyi naukovyi visnyk. Tekhnichni nauky*, 3(34), 218–225. https://doi.org/10.32515/2664-262X.2020.3(34).218-225 [in Ukrainian]

Ma, S. (2025). Research on construction management based on BIM-AR/VR technology. *E3S Web of Conferences*, 606, 04007. https://doi.org/10.1051/e3sconf/202560604007

Meneiliuk, O. I., Nikiforov, O. L., & Makarov, S. O. (2019). Development of construction management models using information technologies. *Visnyk Kharkivskoho natsionalnoho avtomobilno-dorozhnoho universytetu*, 86(1), 7–14. Retrieved from: https://dspace.khadi.kharkov.ua/handle/123456789/2760 [in Ukrainian]

Muravskyi, V. (2023). Accounting and cybersecurity. Ternopil: ZUNU. [in Ukrainian]

Ogunrinde, O., Idrissi Gartoumi, K., Osuizugbo, I. C., Hatamleh, M. T., & Oyeyipo, O. (2025). Construction 4.0 technologies for advancing quality management processes. *Engineering, Construction and Architectural Management*, 1–20. https://doi.org/10.1108/ECAM-01-2025-0007

Podkopaiev, D., & Tsyfra, T. (2024). Low-code systems for business process automation in construction. *Prostorovyi rozvytok*, 9, 349–360. https://doi.org/10.32347/2786-7269.2024.9.349-360 [in Ukrainian].

Putra, W. D., Latief, R. U., & Arifuddin, R. (2025). Conceptual Framework Integration of Building Information Modelling (BIM) and Internet of Things (IOT) Technology in the Application of Construction Safety Management Systems in Construction Projects. In: *International Conference on Civil Engineering* (pp. 280–294). Singapore: Springer Nature Singapore. https://doi.org/10.1007/978-981-96-8990-3_25

Tang, S., & Liang, X. (2025). Research on fine management of construction engineering based on BIM technology. *Academic Journal of Science and Technology*, 15, 22–26. https://doi.org/10.54097/mx34d678

Tian, K. (2025). Application of BIM technology in safety management of construction projects. *Journal of Architectural Research and Development*, 9, 58-63. https://doi.org/10.26689/jard.v9i4.11529

Trach, R. V. (2017). Information modelling in construction (BIM): essence, stages of formation and development prospects. *Hlobalni ta natsionalni problemy ekonomiky*, 16, 490–495. Retrieved from: http://global-national.in.ua/archive/16-2017/99.pdf [in Ukrainian]

Zaidan, M., Maeni, A., & Qasim, A. A. M. (2025). The impact of technology, cost, time, and stakeholders on construction project management performance in Iraq. In: *5th International Conference on Architectural and Civil Engineering Sciences (CIC-ICACE'25)* (pp. 308–320). https://doi.org/10.24086/icace2025/paper.1713