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DIGITALIZATION OF DEVELOPMENT PROJECT MANAGEMENT SYSTEMS: POST-WAR TRIGGERS

The article analyzes the impact of digitalization on the development project management system in the post-war recovery. It is determined that the digitalization of the construction industry is a strategic direction of development, ensuring effective management of development projects and contributing to the restoration of infrastructure. It is established that the introduction of digital technologies allows optimizing the use of resources, reducing costs and increasing the accuracy of management decisions during the implementation of development projects. It is found that global trends indicate a rapid growth in investments in digital technologies in construction, while in Ukraine there is a gradual introduction of BIM technologies and specialized software tools. It is determined that the digital ecosystem of urban development contributes to increasing the transparency of processes, improving coordination between participants in construction projects and the effective use of analytical data. It is established that the volume of manufactured construction products has a high level of correlation with construction product indices, which indicates a significant impact of these indicators on the dynamics of the construction sector. It was found that the index of construction output of buildings is the main factor that positively affects the total volume of construction, while the indices of construction output of residential and non-residential buildings have a negative impact. It was determined that the developed regression model is characterized by a high level of explanatory power (RI = 0.9878), which confirms its reliability for predicting trends in the construction industry and substantiating management decisions. It was established that government initiatives for the restoration of Ukraine are aimed at ensuring the viability of society and creating the prerequisites for sustainable economic development. The priority areas are the modernization of social infrastructure, thermal modernization of buildings, adaptation of urban areas to military realities, and the development of digitalization, including the use of 3D scanning and laser analysis technologies for the restoration of architectural heritage and infrastructure.

Keywords: *digitalization, construction economics, construction management, development, post-war triggers, project management.*

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ЦИФРОВІЗАЦІЯ СИСТЕМИ УПРАВЛІННЯ ДЕВЕЛОПЕРСЬКИМИ ПРОЄКТАМИ: ПОВОЄННІ ТРИГЕРИ

У статті аналізується вплив цифровізації на систему управління девелоперськими проєктами в умовах повоєнного відновлення. Визначено, що цифровізація будівельної галузі є стратегічним напрямком розвитку, що забезпечує ефективне управління проектами розвитку та сприяє відновленню інфраструктури. Встановлено, що впровадження цифрових технологій дозволяє оптимізувати використання ресурсів, скоротити витрати та підвищити точність управлінських рішень під час реалізації проектів розвитку. З'ясовано, що глобальні тенденції свідчать про стрімке зростання інвестицій у цифрові технології в будівництві, тоді як в Україні спостерігається поступове впровадження

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BIM-технологій та спеціалізованих програмних засобів. Визначено, що цифрова екосистема розвитку міст сприяє підвищенню прозорості процесів, покращенню координації між учасниками будівельних проектів та ефективному використанню аналітичних даних. Встановлено, що обсяг виробленої будівельної продукції має високий рівень кореляції з індексами будівельної продукції, що свідчить про значний вплив цих показників на динаміку будівельного сектору. З'ясовано, що індекс будівельної продукції будівель є основним фактором, який позитивно впливає на загальний обсяг будівництва, тоді як індекси будівельної продукції житлових і нежитлових будівель чинять негативний вплив. Визначено, що розроблена регресійна модель характеризується високим рівнем пояснювальної здатності (RI = 0,9878), що підтверджує її надійність для прогнозування тенденцій у будівельній галузі та обґрунтування управлінських рішень. Встановлено, що урядові ініціативи щодо відновлення України спрямовані на забезпечення життєздатності суспільства та створення передумов для сталого економічного розвитку. Пріоритетними напрямками визначено модернізацію соціальної інфраструктури, термомодернізацію будівель, адаптацію міських територій до військових реалій, розвиток цифровізації, в тому числі з використанням технологій 3D-сканування та лазерного аналізу для реставрації архітектурної спадщини та інфраструктури.

Ключові слова: *цифровізація, економіка будівництва, менеджмент в будівництві, девелопмент, повоєнні тригери, управління проєктами.*

Problem statement and its connection with important scientific and practical tasks. Digitalization of the development project management system is an important component of the infrastructure restoration strategy after the war, as well as a key factor in increasing the competitiveness of the national economy. In this context, the relevance of the introduction of new technologies, such as BIM, is undoubted. Due to their capabilities, these technologies can significantly change approaches to project management, increasing planning accuracy, resource efficiency, and reducing the number of errors in the design and construction processes. The digitalization process requires developers to adopt new approaches to management processes, including new methods of communication and interaction with all project participants: from investors and contractors to end consumers.

In the context of post-war infrastructure restoration and reconstruction of facilities, digital technologies can significantly improve the management processes of development projects, reducing costs, increasing transparency and efficiency, and accelerating project implementation. However, despite the great potential of digital technologies, in war-torn Ukraine, there are significant difficulties in their implementation in construction practice. Low technological readiness, a shortage of qualified personnel, and the lack of uniform standards for the use of digital tools in construction design and management remain significant barriers to digitalization. In this regard, we see a need to analyze the impact of digitalization on the development project management system in the context of Ukraine's post-war reconstruction .

Analysis of recent publications on the problem. Recent research in the field of development project management emphasizes the importance of effective stakeholder engagement and the use of digital technologies to optimize management processes. An important place in the study of this topic is occupied by theoretical and methodological aspects related to stakeholder management, identification of their influence, and modeling effective interaction. Thus, Melnychenko O., Lebid I.,

Tkachenko V., Luzhanska N. [1] focus on communication models of the relationship between stakeholders in educational innovative scientific projects, identifying the importance of clear communication and cooperation within complex systems. In his study [2] Ivakhnenko I.S. examines the role of stakeholders in ensuring the implementation of development in construction, emphasizing the need for proper management of interaction with all stakeholders to achieve sustainable development of projects. Myroshnychenko Y.O. and Bondar A.V. [3] propose a model of stakeholder interaction in the real sector of the Ukrainian economy, emphasizing the importance of corporate social responsibility. to ensure the sustainability of economic projects. The study by Gerasimenko Y.V. [4] focuses on the theoretical aspects of identifying enterprise stakeholders and assessing their impact on management processes, which is important for the effective management of development projects. The study by Levchenko N.M. [5] analyzes stakeholder analysis as a tool for effective project management in the context of Ukraine's integration into the European and global business space, emphasizing the importance of adapting international standards in the process of managing development projects. Korepanov G.S., Chernenko D.I., Chala T.G. [6] investigate the theoretical and methodological prerequisites for developing a conceptual model for managing stakeholder interactions, which allows for improved coordination and integration of stakeholders in project management. Shpakov A.V., Zhaldak R.Yu., Kushnir I.I. Petrukha N.M., Nikolaev G.V., Rogovchenko V.S. [7] consider the issue from the perspective of an innovative and applied basis for the structural and functional regulation of the operational management system of the leading stakeholders of a construction project and update the issue of introducing a holistic methodology and economic and analytical tools for substantiating the strategy, format and content of the operational activities of a developer enterprise in construction, which in a single economic and operational and production space carries out administrative and regulatory activities regarding the preparation and implementation of construction investment projects as part of a single investment program.

International studies (works by Bratterud H. et al. [8]), aimed at modernizing classical approaches to project management using the latest technological tools. Thus, modern publications consider the integration of digital technologies, in particular BIM, into the field of development project management as an important tool for increasing the efficiency of management decisions, in particular in the context of the post-war reconstruction of Ukraine's infrastructure.

Formulation of the article's objectives. The aim of the article is to study the impact of digitalization on the development project management system in the context of Ukraine's post-war reconstruction through an analysis of the phased management structure, a classification of models for assessing the effectiveness of interaction with stakeholders, a study of the application of BIM technologies and specialized software tools, as well as a quantitative determination of the relationship between construction product indices and the volume of products produced to forecast trends and optimize management decisions.

Presentation of the main results and their justification. Development as an integrated direction of business, real estate and construction management is a multicomponent process aimed at increasing the value of assets and optimizing financial revenues by adapting to changing market conditions, assessing risks, implementing

strategic development opportunities and effectively allocating investment resources [1]. Given the multidimensionality and systemic complexity of development, it is advisable to consider it as an independent management category in the real estate sector, which requires a comprehensive analysis of the mechanisms of interaction with key stakeholders.

The conceptual basis of development is presented by a clear step-by-step process that covers the main stages of managing development projects. Each stage has specific tasks, starting with conducting market research and strategic planning, which lays the foundation for further financial and organizational decisions. Developing a financial strategy and organizing design, taking into account legal aspects, create conditions for effective construction management and further use of the finished object. An important part is also a marketing strategy that ensures the positioning of the object in the market. All these stages are interconnected and determine the success of the project. In addition, the model includes three main stages of project implementation, which are focused on analyzing the probability of successful implementation, developing a business plan and directly implementing the strategy (Fig. 1).

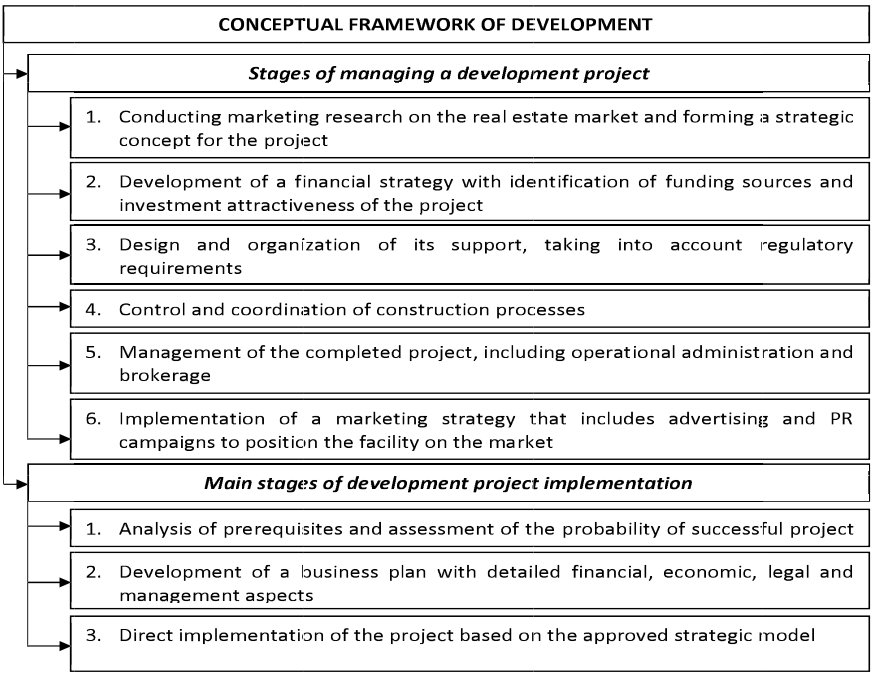

Fig. 1. **Phased structure of development project management and their implementation,** *[2–9]*

The formation of the essential characteristics of development occurs in the process of interaction with a wide range of stakeholders, which necessitates the systematic analysis of their interests and the development of strategies for harmonizing relationships. A generalized analysis of scientific sources [2–9] shows that the effectiveness of development projects directly depends on the level of integration of stakeholders' needs into man-

agement processes. In this context, assessing the prospects for interaction with key stakeholders is a priority task for development entities. Taking into account modern economic transformations, a generalized classification of models for assessing the effectiveness of interaction with stakeholders in the management of development projects has been developed based on a study of scientific approaches to the above-mentioned issues (Table 1).

The proposed classification of stakeholder interaction models in development projects reflects three strategically important areas of management. Communicative models , which are focused on ensuring effective information interaction, which is critical for harmonizing the interests of stakeholders and optimizing the decision-making process. Change management models, which are aimed at adapting to dynamic environmental conditions, which allows minimizing risks and increasing the flexibility of management processes. Interaction adjustment models, which contribute to the effective definition and analysis of the role of stakeholders, the development of interaction strategies and the resolution of potential conflict situations. The use of these models in combination provides a systematic approach to managing development projects in the context of modern economic transformations.

Table 1. **Classification of models for assessing the effectiveness of interaction with stakeholders in the management of development projects,** *[4–11]*

Model group	Model type	Characteristic
Communal models	**Performance and Evaluation Gap Model**	Determines the presence of disparities between the expected and actual characteristics of project elements (performance gap), as well as between the predicted results and the level of formation of the interaction process (assessment gap)
	Intercultural communication model	Focuses on the influence of intercultural differences in communication processes, taking into account the specifics of information perception, stereotypes, and experience of project participants
	Communication Channel Efficiency Model	It involves choosing the optimal channels for transmitting information according to its volume, level of saturation, and target audience, which ensures effective information exchange
Change management models	**Change implementation model**	Describes the processes of initiating, implementing, and monitoring transformations aimed at ensuring the sustainable development of a development project in the medium and long term
	Model of adaptation to change	Describes mechanisms for flexible response to external and internal changes in order to minimize risks and ensure the continuity of the project process
	Examples of models	Senge's system model, Bridges' model, Beckhard and Harris' model, Karnal's model, Duck's model, Kotter's model, etc.
Models of establishing interaction	**Stakeholder identification model**	It is based on the classification of stakeholders according to the criteria of influence, involvement, and legitimacy, which allows determining the priorities of interaction within the project
	- conflict model	It involves developing strategies for avoiding and resolving conflict situations between stakeholders to improve project management efficiency
	Negotiation model	Outlines methodological approaches to the negotiation process between stakeholders, identifies conflict management strategies, including compromise, consensus, cooperation, or avoidance

It is worth noting that the transition from traditional to digital models of development project management has become an important stage in the development of the modern construction industry. This process, which includes the integration of the latest information technologies, covers all stages of the construction life cycle - from the initial design to the final stage of operation of facilities. The use of digital technologies allows you to create integrated information environments that contribute to increasing the efficiency, productivity and transparency of construction processes.

One of the important aspects of digital transformation is ensuring the transparency of construction projects, which involves the openness and accessibility of information to all participants in the process - customers, contractors, investors, regulatory authorities and the public. Transparency of processes is achieved through the use of technologies such as Building Information Modeling (hereinafter referred to as BIM), cloud platforms for project management and digital document management systems, which allows monitoring of the budget, work schedules, material quality, risks and compliance with standards, which, in turn, helps reduce corruption risks and misuse of resources. BIM technology is the main tool that allows you to create digital twins of buildings, integrating data at different stages of design and construction, which makes it possible to detect technical conflicts before the start of work, which significantly reduces the cost of adjusting project documentation and reduces financial losses. In addition, project management systems (hereinafter referred to as CPMS) have become an important tool for optimizing data management processes, resource planning and monitoring the progress of work.

The implementation of digital technologies, despite all its advantages, requires significant financial investments, as well as improving the skills of personnel and ensuring a high level of cybersecurity. In a global context, investments in digital technologies for the construction sector increased significantly in 2020–2022, reaching 11.5 billion USD, which exceeds the level of previous years by several times [12]. By 2030, the construction sector is expected to significantly expand its use of the Internet of Things (IoT) and analytics, which will allow for increased project management accuracy and reduced operational risks.

In Ukraine, although the pace of construction digitalization lags behind global trends, there is a gradual increase in interest in BIM technologies and specialized software tools for project management, which, in turn, creates the prerequisites for increasing the competitiveness of the Ukrainian development sector in the future. In particular, most companies are beginning to actively implement innovative technologies, which allows improving the quality of construction project management and contributes to increasing the efficiency of business processes at all stages of project implementation (Fig. 2).

Digitalization of the construction development environment in the context of post-war reconstruction is becoming a necessary condition for the successful transformation of the industry, which ensures sustainable development and contributes to the restoration of infrastructure through the integration of the latest digital solutions that optimize the use of resources and reduce the cost of construction.

It is worth noting that the digital transformation of the construction sector is based on several theoretical approaches, including the concept of ecosystem interaction and digital transformation of business processes. This paradigm involves the

gradual replacement of traditional management methods and the implementation of digital solutions that contribute to the optimization of information exchange, automation of operational processes and increased productivity. Of particular importance in this context are the technologies of the Internet of Things (IoT) and big data analytics (Big Data), which allow the collection, processing and use of data from construction sites to make informed management decisions. In particular, IoT sensors provide monitoring of the technical condition of equipment, control of the level of material use and assessment of the quality of work performed, and analytical systems allow for the prediction of risks and the effective allocation of resources.

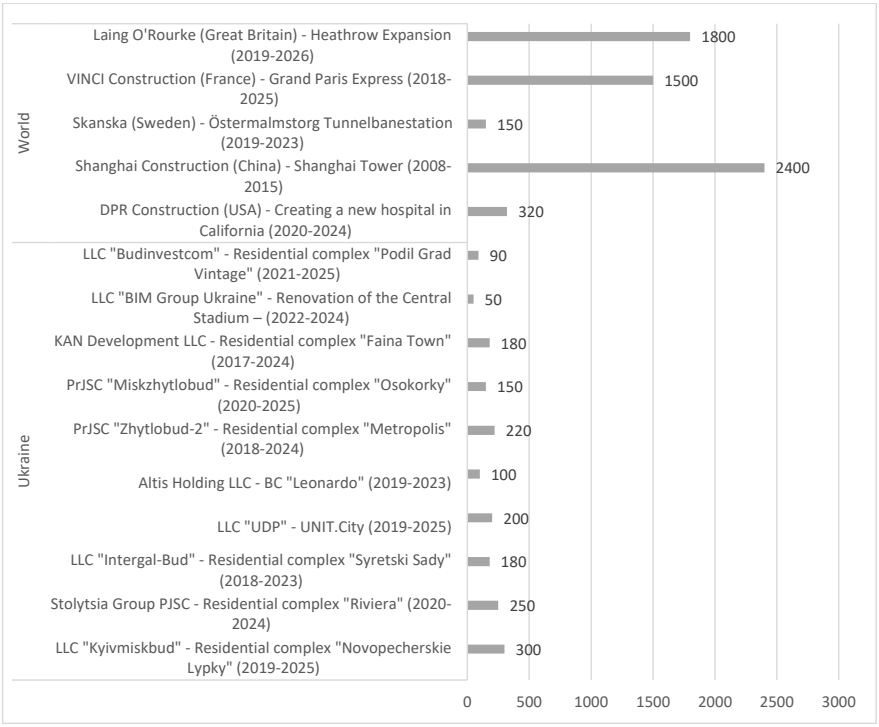

Fig. 2. **Application of BIM technologies and specialized software tools in construction project management in Ukraine and the world, *[13]***

In the construction industry, a digital ecosystem is a complex integrated system that encompasses a set of technological solutions, business processes and interaction entities united by single digital platforms. It is worth noting that the use of a digital ecosystem contributes to increased coordination between architects, engineers, contractors and customers, which ensures increased efficiency in construction project management. One of the key elements of the industry's digital transformation is the implementation of BIM, which has become the main tool for integrating design data, storing and analyzing information about all stages of the life cycle of a construction object in real time. The use of BIM technologies allows you to identify technical

errors at the design stage, which helps minimize rework and reduce costs during the project implementation process [13].

Therefore, it is worth emphasizing that the digitalization of the construction industry contributes to the formation of a new approach to managing development projects, based on the integration of innovative technologies, increasing the transparency of processes, and using analytical data for strategic planning.

The process of digitalization and modernization of the construction and urban development system in Ukraine is a strategically important direction of development, contributing to increased transparency, efficiency and accessibility of data for all stakeholders. On December 5, 2024, a professional event "Digitalization of urban development activities in Ukraine. Current status and next steps for transparent recovery" was held, which was attended by representatives of relevant ministries, state bodies, international partners and industry experts. The main goal of the event was to improve the construction industry, which is extremely important in the context of war realities and the further recovery of the country. Among the key initiatives for the digital transformation of urban planning activities is the creation of the Urban Planning Cadastre of Ukraine, which involves the integration of seven information systems and registers, in particular:

- register of urban planning documentation;
- a single state electronic system in the field of construction;
- register of buildings and structures;
- address register;
- register of administrative-territorial units;
- electronic pricing system;
- building energy efficiency databases.

The introduction of modern mechanisms for processing, storing and analyzing data allows for the introduction of conceptually new approaches to their use, ensuring effective access, search and interaction between stakeholders. The comprehensive integration of digital systems contributes not only to accelerating the country's recovery processes, but also to increasing the level of data openness for citizens, developers and authorities, which is especially important for internally displaced persons.

At the same time, the implementation of digital initiatives in the field of urban planning demonstrates the need to process significant amounts of information, which requires a comprehensive approach to data management, their structuring, and regulated access both within national information systems and at the international level. An example of successful digital integration is the bilateral Memorandum of Understanding (MoU) concluded between the State Customs Service of Ukraine and the Customs Department under the Ministry of Finance of the Republic of Lithuania within the framework of the EU4Digital program, where this pilot project aims to eliminate geographical barriers, improve customs data exchange and improve the quality of communication. Its implementation is an important milestone in the process of harmonizing Ukraine's customs procedures with the EU customs policy, which is of key importance for the country's integration into the European Economic Area.

The development of digital technologies in the construction industry will be promoted by a bill registered in the Verkhovna Rada, which provides for the creation of a Unified State Digital System for the Recovery and Development of Ukraine [17].

This system is focused on automating the processes of managing territorial planning, development, implementation of construction projects, infrastructure development, as well as regional and local government. In addition, it will provide processing, publication and monitoring of statistical data, which will contribute to increasing the transparency and efficiency of management decisions.

At the same time, the implementation of digital initiatives in the construction sector demonstrates the need for further improvement of data verification mechanisms in the Unified State Address Register of Ukraine. Expanding the functionality of the Urban Planning Cadastre, as well as introducing electronic tools for territorial communities. A comprehensive approach to the digitalization of the industry will contribute to increasing the level of control over urban planning processes, optimizing management decisions, and creating a transparent environment for developers, government agencies, and the public [14].

According to the data in Figure 3, during 2024, there is a steady positive dynamics of the volume of construction products produced in Ukraine, which indicates a stable growth of the construction sector. In particular, the total volume of construction recorded a significant increase, reaching UAH 204,730.1 million in December. The highest indicators of the volume of products produced are observed in August, which is the month with the maximum values (UAH 131,356.1 million), which confirms the intensification of construction works in the middle of the year.

The buildings segment turned out to be the most powerful among the categories of construction products. In the volume of buildings, products related to residential buildings demonstrate gradual growth, although the growth rate significantly decreases by the end of the year. In particular, the volume of products produced in the residential buildings sector at the end of the year is UAH 26,641.7 million, which indicates high demand for housing, but with a decrease in the pace of development.

In contrast, the non-residential building category shows steady growth at all stages of 2024, reaching UAH 57,717.7 million in December. This indicates growing demand in the commercial real estate and infrastructure segment, which is a sign of economic development and increased investment in the business environment.

The volume of products produced in engineering structures, including pipelines, electronic communication network lines, as well as complex industrial facilities, also shows steady growth. This emphasizes the importance of infrastructure projects and the need to expand engineering infrastructure to support the national economy.

Therefore, the general conclusion of the analysis of the table indicates a stable and gradual development of the construction industry in Ukraine, where the highest growth rates are observed in the infrastructure and commercial sectors, while residential construction also continues to grow, albeit with some slowdown by the end of the year.

Construction output indices by type in Ukraine in 2024 indicate a gradual decrease in the growth rate of construction activity compared to the previous year. The overall construction index in the first quarter shows stable growth, starting from 118.1% in January, reaching a maximum value of 143.8% in April, after which a downward trend is observed, and by December the index decreases to 115.5%. This indicates a slowdown in the growth rate of construction output in the second half of the year, probably due to changes in economic conditions and fluctuations in demand for construction services.

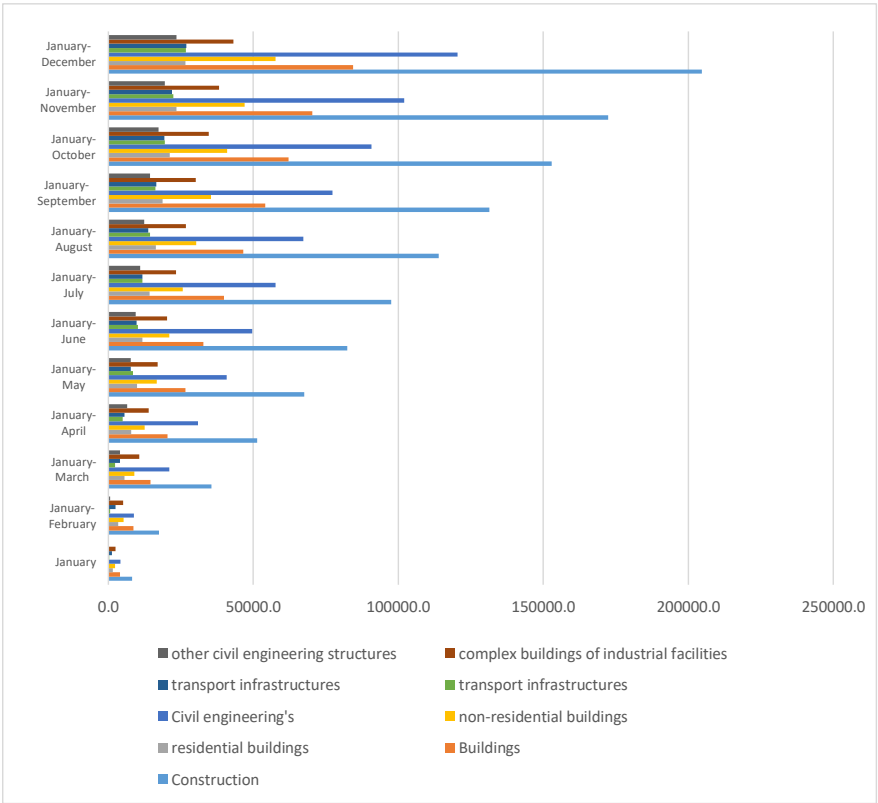

Fig. 3. **Volume of manufactured construction products by type in 2024 (million UAH),** *[15]* *

Notes: * - these figures are given without taking into account the territories temporarily occupied by the Russian Federation and parts of the territories where hostilities are (were) being conducted .

As for the category "Buildings", the growth index in January is 122%, which indicates a positive dynamics in the construction of this type of product. However, during the year, this indicator has decreased, and in December it is 119.8%. This trend is more pronounced in the subcategory of residential buildings, the index of which gradually decreases from 112.1% in January to 107.6% in December, which may indicate a gradual slowdown in the pace of housing construction. The category "Non-residential buildings" has seen a high level of growth in the first half of the year, with a maximum index of 141.4% in February, after which it gradually decreases, reaching 126.2% in December. It is worth noting that this dynamics indicates a temporary increase in demand for the construction of non-residential facilities, with a subsequent adjustment in the growth rate. The construction output index in the category "Engineering structures" also shows some seasonal fluctuations, starting at 114.5% in January and reaching a maximum value of 151.4% in April. After that, there is a decrease to 112.5% in December, which indicates an increase in activity in the con-

struction of engineering structures in the first half of the year with a further slowdown in the growth rate in the second (Figure 3).

Thus, the results of the construction product indices indicate an overall decrease in the growth rates of the construction industry in Ukraine in 2024, with a particular decrease in the residential construction category. However, the stability of growth rates in the non-residential buildings and engineering structures segment may indicate significant fluctuations in demand and supply for different types of construction products depending on the economic situation.

Given the importance of accurate data for effective management of the construction industry, the next stage of the analysis focuses on quantifying the relationship between various construction product indices and the volume of construction products produced. Table 2 presents the results of regression modeling, which allows us to determine the relationship between the volume of construction products produced and construction product indices by main categories (residential buildings, non-residential buildings, engineering structures) in 2024. This modeling provides the opportunity to quantitatively assess the impact of individual indices on the total volume of construction production, which is necessary for forecasting trends in the construction sector and optimizing management decisions:

$$\text{Volume of construction products produced} = 473866{,}971 + 35506{,}57317 * X_1 + \\ +108904{,}6618 * X_2 - 50022{,}42122 * X_3 - 77496{,}2519 * X_4 - 20079{,}12245 * X_5$$

The correlation coefficient (Multiple R) for the model is 0.9939, which indicates a very strong positive correlation between the volume of construction and the indices of construction output. This means that changes in the indices of construction output largely determine the variation in the volume of construction output . The coefficient of determination (R Square), equal to 0.9878, indicates that the model explains 98.78% of the changes in the volume of construction output, which is a high indicator for the regression model and indicates its high accuracy. The adjusted coefficient of determination (Adjusted R Square), equal to 0.9777, confirms the reliability of the model, since it takes into account the number of variables in the model and their influence on the result.

The standard error of the model, equal to 9336.49, is quite low, indicating a small difference between the observed and predicted values of the volume of construction products produced, which in turn emphasizes the accuracy of the regression model. The results of the analysis of variance (ANOVA) indicate the statistical significance of the model, since the F-statistic is equal to 97.42, which is a significant value for testing the adequacy of the model. The Significance F value (1.16609E-05) is very small, indicating a high significance of the model in the context of the analysis of the volume of construction products produced .

The regression coefficients that determine the impact of each index on the volume of construction output demonstrate different levels of significance. The intercept of the model is 473866.97, which indicates the expected volume of construction output with zero values of all independent variables. The index of construction output of buildings (X_2) has the largest coefficient, equal to 108904.66, which indicates a significant positive impact of this index on the volume of construction. The P-value for

this coefficient (6.01792E-05) is very small, which confirms the statistical significance of this parameter.

Table 2. **Results of regression modeling,** *authors' own calculations*

Regression Statistics								
Multiple R	0.994							
R Square	0.988							
Adjusted R Square	0.978							
Standard Error	9336,486							
Observations	12							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	5	4.25E+10	8.49E+09	9.74E+01	1.17E-05			
Residual	6	5.23E+08	8.72E+07					
Total	11	4.30E+10						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	473866.97	162475.71	2.92	0.03	76303.22	871430.72	76303.22	871430.72
X_1	35506.57	29960.65	1.19	0.28	-37804.50	108817.64	-37804.50	108817.64
X_2	108904.66	10963.82	9.93	0.00	82077.16	135732.16	82077.16	135732.16
X_3	-50022.42	4157.49	-12.03	0.00	-60195.43	-39849.41	-60195.43	-39849.41
X_4	-77496.25	6924.66	-11.19	0.00	-94440.29	-60552.22	-94440.29	-60552.22
X_5	-20079.12	16559.17	-1.21	0.27	-60597.96	20439.71	-60597.96	20439.71

Notes: construction output index (X_1); construction output index of buildings (X_2); construction output index of residential buildings (X_3); construction output index of non-residential buildings (X_4); construction output index of engineering structures (X_5).

Residential construction output index (X_3) and the non-residential construction output index (X_4) have a negative impact on the volume of construction, since their coefficients are -50022.42 and -77496.25, respectively. This indicates that an increase in the residential and non-residential construction output indices leads to a decrease in the total volume of construction. The P-values for both coefficients are very small (1.99978E-05 and 3.03832E-05), which indicates their statistical significance.

The index of construction output (X_1) has a coefficient of 35506.57, but its P-value (0.2808) is large, indicating statistical insignificance of this parameter. This means that the index does not have a significant impact on the volume of construction output , unlike the indices of construction output of buildings. The index of construction output of engineering structures (X_5) also has a negative coefficient (-20079.12), but its P-value (0.2708) indicates statistical insignificance, confirming the absence of a significant impact of engineering structures on the volume of construction output. The value of the coefficient of determination indicates that the model explains 98.78% of the relationship between the volume of construction products produced and construction product indices. This indicates that there are still a small number of other influencing factors that were not included in the model, but their influence is not critical to the overall result.

Thus, the results of the regression analysis indicate that the volume of construction output is most dependent on the index of construction output of buildings, in particular the index of construction output of buildings as a whole, which has the greatest positive impact. At the same time, the indices of construction output of residential and non-residential buildings have a negative effect on the volume of construction output.

These results confirm the need to adapt investment policy and government initiatives to the real conditions of the construction services market, which will contribute to the stability of the industry. In the context of infrastructure restoration It is important to introduce new approaches in planning and implementing construction projects, focusing on minimizing risks and maximizing economic efficiency.

Government initiatives to restore Ukraine are focused on ensuring the viability of citizens, families, cities and the state as a whole. Uncertainty about a comprehensive strategic recovery in the short term has become one of the main changes compared to the end of 2022 - beginning of 2023. The 10-year Recovery Plan for Ukraine, presented to foreign donors and investors, is currently being implemented with short-term goals, focusing on the defense, housing and infrastructure sectors. The vision of this recovery is to create a strong European state that will become an attractive center for foreign investment. The main goal is to accelerate sustainable economic development, with an emphasis on the implementation of National Programs aimed at achieving key results. The Recovery Plan for Ukraine is based on five main principles: 1) immediate start of recovery with gradual development; 2) increasing fair welfare for the population; 3) integration of Ukraine into the EU; 4) restoring the country to a higher level on a national and regional scale; 5) stimulating the attraction of private investment.

Projects included in the national program for the restoration and modernization of social infrastructure include a number of initiatives, such as replacing gas boilers with heat pumps in autonomous heating systems of insulated public buildings, conservation of damaged facilities that are not a priority for restoration, as well as large-scale thermal modernization of public buildings. In addition, the installation of heat pumps for heating and cooling of public buildings, the development of capable networks of public service facilities, as well as the development of industrial parks are envisaged. Considerable attention is paid to the creation of public-private partnership programs with advantages for private investors and the creation of space for youth development. Particular importance is given to the thermal modernization of the most energy-intensive buildings and the restoration of damaged public service facilities. The projects of the national program for the restoration and modernization of housing and infrastructure in the regions include more than 100 initiatives aimed at significantly improving housing conditions and modernizing infrastructure facilities in the entire regional context, which aims not only to restore, but also to improve existing living conditions.

One of the important aspects of the reconstruction process in Ukraine is the adaptation of urban areas to new war realities, in particular through the development of underground infrastructure. Cities located near the front line, such as Kharkiv and Zaporizhzhia, are responding to the challenges of war by creating underground spaces that not only serve as shelters, but can also be used as social, educational, and cultural centers. As the front stabilizes, temporary shelters are transformed into permanent places for living and holding public events. For example, in Kharkiv, school classrooms have been moved to metro stations, and shelters are used as concert halls and theater venues. Such use of underground facilities is important for maintaining security and the functioning of social institutions in conditions of constant military threat. Similar initiatives are reminiscent of the experience of Finland, where a large-

scale system of bomb shelters was created, which were designed to ensure safety in conditions of potential military threats.

Another important trend in Ukraine's reconstruction is digitalization, in particular the use of 3D scanning technology to preserve and reconstruct the architectural heritage damaged by military operations. This allows not only to record historical buildings in digital format, but also to ensure accurate reconstruction of damaged objects. Projects like "Skeiron" in Lviv focus on the preservation of UNESCO architectural monuments, and demonstrate how modern technologies can contribute to cultural restoration. In addition to Lviv, similar initiatives are being implemented in Chernivtsi and Kyiv, including projects aimed at collecting digital evidence of damaged objects in Mariupol, using crowdfunding to create 3D models of destroyed structures.

Of particular importance is the use of laser scanning technologies in the Institute of Forensic Expertise to assess and record damage to buildings, which allows for accurate monitoring and significantly speeds up the process of expert assessments. A separate project is worth noting, which includes the development of a digital platform for the reconstruction of deoccupied regions, which provides users with instructions on the restoration of housing, taking into account local architectural features.

The use of innovative technologies in restoration also includes the recycling of building materials, which has not only economic but also environmental significance. One such innovation is 3D printing of cement, which allows for the rapid construction of buildings with high precision and at reduced costs. This technology has enormous potential for the accelerated restoration of damaged objects, as well as for the creation of complex architectural forms. In Lviv, for example, it is planned to use 3D printing for the rapid construction of a new school building, which will save time and resources, as well as reduce the amount of construction waste. This construction method promotes the efficient use of recycled materials and can become the basis for a more environmentally friendly approach to urban development in Ukraine.

Global experience also demonstrates the successful application of 3D printing in construction. In the Netherlands, the Milestone Project in Eindhoven was implemented, where residential buildings were built using 3D printers, and in the USA, ICON built the world's first 3D-printed residential district for low-income families. In Dubai, the Dubai Future Foundation office center was built, and in Italy, the TECLA environmental project was implemented, where 3D printing from natural materials was used to create environmentally friendly houses. In Ukraine, 3D printing and digitalization technologies are opening up new horizons for the country's recovery, creating opportunities for not only rapid reconstruction, but also long-term sustainable development [17].

Conclusions and prospects for further research. Based on the study, it can be concluded that development in the field of real estate and construction is a multifaceted and complex process that includes effective management of financial flows, optimization of asset value and minimization of risks in an unstable market environment. It was established that within the framework of the conceptual model of development, the key stages are marketing research, strategic planning, development of a financial strategy, organization of design and implementation of construction, taking into account legal aspects, which are interconnected and have a significant impact on the success of

the project. It was found that the use of the latest digital technologies, such as BIM and CPMS, is an important step in increasing the efficiency of development project management, allowing for improved control over costs and quality, as well as reducing operational risks, however, the implementation of such technologies requires significant investments in infrastructure and personnel qualifications, as well as ensuring an adequate level of cybersecurity. The results of the analysis of the construction output indices for 2024 indicate a decrease in the growth rate in residential construction, which indicates negative economic trends, while the stability in the non-residential building segment indicates the industry's adaptation to changes in demand and supply. Regression modeling showed that the construction output index of buildings has the greatest impact on the volume of output, while the negative impact of the growth of the residential and non-residential building indices may be the result of economic factors, such as unstable demand in war conditions. Therefore, to ensure sustainable development of the construction industry in Ukraine, it is necessary to adapt investment policy to current economic conditions, take into account the needs of individual market segments, and implement effective risk management strategies.

The practical significance of the research is that the conclusions and recommendations formulated by the author can be effectively applied to adapt the construction industry to new economic and market conditions, in particular, they can contribute to the optimization of management processes, increasing the efficiency of the implementation of development projects, and reducing risks arising from economic uncertainty. Further scientific research in this area should be focused on developing new models of development project management that take into account dynamic changes in the economic environment and the integration of innovative technologies, such as digital management models, BIM technologies, and project management systems (CPMS).

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