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DEVELOPMENT COMPANY MANAGEMENT SYSTEM TRANSFORMATION MODELS BASED ON THE USE OF IT AND AI TOOLS

Abstract. *The article analyzes the literature on portfolio management, project management methodologies, and digitalization. The purpose of the study is formulated. The main challenges facing the management systems of development companies are identified. The characteristics of the target state of the development company management system are formulated. Three models of the development company management system are proposed. Among the proposed models are model 1 "Full digitalization", model 2 "Radical AI transformation", model 3 "Step-by-step Lean transformation". Model 1 "Full digitalization" involves the digitalization of all processes implemented by the development company management system. Model 2 "Radical AI transformation" involves not only the digitalization of all processes implemented by the development company management system, but also the use of artificial intelligence elements in all processes. Model 3 "Step-by-step Lean transformation" involves the consistent development of the development company management system using the Lean methodology. Each model in the form of "input-output" and in the plural form is presented. For model 3 "Step-by-step Lean Transformation", the use of Harold Kerzner's technological maturity model is proposed. The analysis of the proposed models was carried out and their comparison was carried out according to the following criteria: the use of AI, the complexity of the transformation of the management system within the model, the predicted effectiveness of the model and the readiness of development companies to implement the model. A SWOT analysis of the complex of proposed models was carried out. Areas of further research in the selected direction were formulated, including: detailed formalization of all artifacts of the project for the transformation of the management system of development companies; research into the use of the Gemba Kaizen model, the IPMA Delta model and other models for application within the framework of a phased Lean transformation of the management system of a development company, the use of neural networks and other elements of artificial intelligence for the development and monitoring of a project for the transformation of the management system of a development company, the development of a training system for employees of development companies on the application of a set of proposed models, practical testing of the proposed models in development companies, reengineering of models based on the results of such testing. Conclusions from the conducted research are formulated.*

Keywords: project management; development company; digitalization; artificial intelligence; management system transformation models; Lean

Introduction

Development in construction acquires extraordinary importance during the war caused by the aggression of the russian federation against Ukraine. Its importance is being institutionalized now and is also preserved during the period of post-war restoration of Ukraine. Large-scale restoration projects that need to be implemented in Ukraine require high qualifications of development companies and deep competencies of their specialists. This necessitates the development and development of innovative models and methods of management of such companies.

On the other hand, the development of digitalization in the world and in Ukraine makes it impossible to use innovative models without the use of modern IT tools and

elements of artificial intelligence. Therefore, on the one hand, development companies require new models and management methods to meet the requirements of modernity, on the other hand, such methods should use modern achievements of IT and AI.

The importance of effective management of restoration projects and development projects, thus, determines the practical value of new models and management methods for development companies. And the need to transform the management system of such companies based on new developments in IT and AI, and the corresponding need for new scientific research in this direction determine their scientific relevance.

Analysis of latest research

Development in construction is an activity that covers all stages of the life cycle - from idea and planning to operation and disposal of construction objects, and is a complex, multidimensional area that requires effective management, adaptation to market changes and the implementation of innovative approaches to project administration [1]. At the same time, development companies usually manage not one, but several projects at the same time. At the same time, these projects, as a rule, are not related to each other and have different customers. According to the classification of classical project management, it can be argued that development companies manage a portfolio of construction development projects.

Portfolio management is considered in many works by Ukrainian and foreign scientists, and the relevant developments can be used for portfolios of construction projects (construction development projects). In particular, the paper [2] outlines the methodological principles of such management, presents relevant models and methods, with an emphasis on their organizational institutionalization. The development of portfolio management has led to its standardization, in particular by leading institutions in the field of project management. For example, the Standard for Portfolio Management of the American institute PMI [3] formalizes knowledge about the Portfolio Life Cycle and six branches of knowledge (domains) of portfolio management, which we can conditionally divide into three classes: the class of institutional domains (Portfolio Capacity and Capability Management, Portfolio Stakeholder Engagement), the class of balance domains (Portfolio Value Management, Portfolio Risk Management), and the class of higher-level management domains (Portfolio Strategic Management, Portfolio Governance). In each field of knowledge, the relevant models and methods are considered.

At the same time, when a development company manages its own project portfolio, the activity itself to transform its management system can be identified as a project, because 1) it is unique for each company; 2) it is limited in time; 3) it is carried out in parallel with the company's main activity. Therefore, to implement such a project, it is necessary to use project management models, methods and standards. In particular, the most famous, classic industry standard is the American PMBOK [4], which first appeared 40 years ago and which is constantly evolving and includes (in each new current edition) the most innovative and proven project management models and methods. Another interesting standard is the development of ISO [5], the use of which will unify the development company's management system, bringing it closer to well-known world standards. It is considered advisable to use elements of another classic PM standard – the British PRINCE2 standard [7]. Interesting features of this standard that should be used in the transformation project under study are the following: deviation management, a business case that is constantly updated, and the following principles that have been included in the current version of the standard – Sustainability has been added as another aspect of project performance; A digital approach to data management is now included; A focus on people (soft factor) has been incorporated throughout the methodology.

With the advent of the Agile methodology [7], the world of project management has changed. Now, project management models and methods that were previously inherent only to the IT industry are penetrating into the management systems of other types of projects. In particular, in the context of the topic that is planned to be considered, the transformation of portfolio management was also considered using Agile tools [8]. Later, Agile models and methods began to be used together with models and methods of classical project management – so-called hybrid approaches to management are being created [9], which is aimed at modernizing management systems and improving their quality.

On the other hand, comprehensive digitalization covers more and more industries, including organizational and project management systems. This, of course, also applies to development companies. The development of models and methods for digitizing organizational management systems is actively taking place in the world and in Ukraine [10]. It is advisable to use such development in the studied project of transformation of the management system, in particular through reengineering of the processes of such a system. Models and methods of such reengineering based on digitalization are studied, for example, in [11], and in a study using cognitive models [12]. After all, the culmination of digitalized systems at the moment is the use of developments in the field of artificial intelligence, which is actively used in projects of transformation of production management systems [13].

However, it is worth noting that in modern scientific research, models and methods for transforming

development company management systems based on the use of IT and AI tools are not sufficiently developed. The works of the authors [14; 15] only begin research in this direction. This proves the relevance of scientific development of the research topic.

Purpose of the article

The purpose of the article is, based on an analysis of modern research on project management, to identify problematic issues in the management systems of development companies (in particular, in project and project portfolio management systems), to develop models for the transformation of management systems of development companies, and to conduct their comparative and SWOT analysis.

The main material of the article

Based on the results of the research, we propose three models of the development company management system:

– Full digitalization;
– Radical AI-transformation;
– Phased Lean-transformation.

We will describe each of the models in detail. The inputs of each model are a hypothesis about the generalized characteristics of the state of the development company management system. The main challenges are identified as follows:

– Unsystematic management processes with fragmented use of IT;
– Insufficiently integrated project management into the company's management system;
– Subjective decision-making system based on the manager's intuition.

On the other hand, we will consider the target state of the system to be one that can be described by the following characteristics:

– Systematized management processes;
– Integrated project management in the company management system;
– Improved decision support system.

The inputs and outputs of each of the three proposed models are similar. We will describe other features of the models below.

The "Full Digitalization" model

This model (Fig. 1) involves the digitalization of all processes implemented by the development company's management system. These processes include the main processes, auxiliary processes, supply processes, HR processes, IT processes, and, importantly, all project management processes of the development company.

Thus, the project to transform the management system of a development company can be represented by a formal figure eight:

$$P = <S, M, R, E, H, I, O, D>, \quad (1)$$

where P – transformation project; S – management system of the development company; M – methodology for managing the transformation project of the management system of the development company; R – project artifacts; E – project participants and their characteristics; H – project stakeholders and their characteristics; I – project inputs (in particular, the challenges that are the reason for the initialization of the project); O – outputs of the project (in particular, the target characteristics of the management system that it should have after the completion of the transformation project); D – models, methods and tools of digitalization.

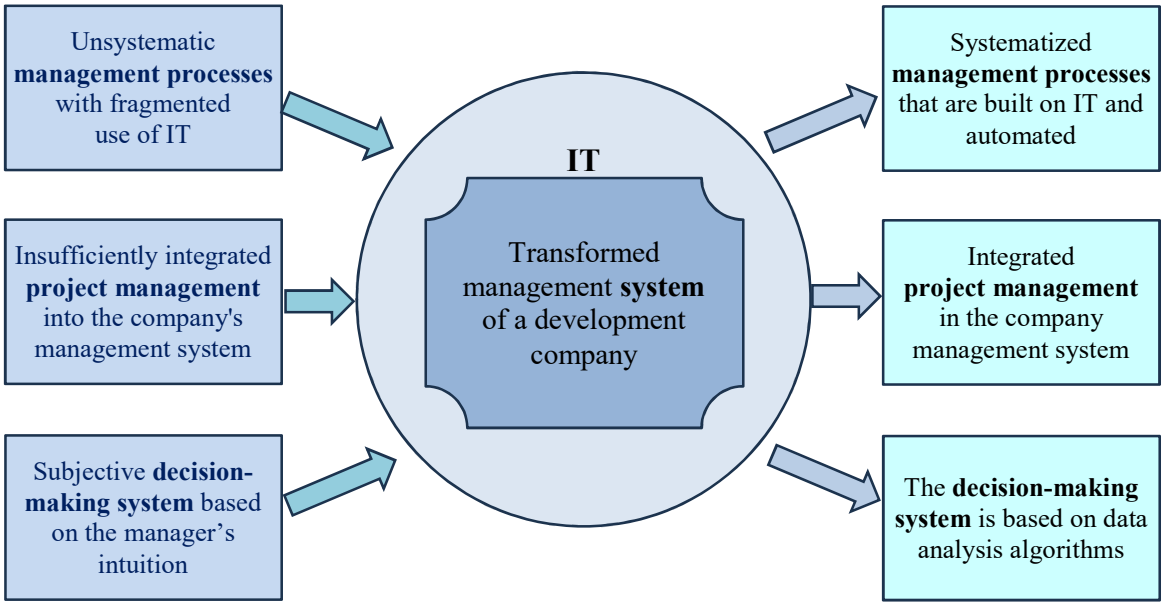

Figure 1 – Model 1 "Full digitalization"

The "Radical AI Transformation" model

This model involves not only the digitalization of all processes implemented by the development company's management system, but also the use of artificial intelligence elements in all processes (Fig. 2).

Moreover, such elements are being improved, along with the development of artificial intelligence, and are heading towards full AI control with minimal human participation in the management process. The only thing left for humans to do is make decisions – in the context of "Decision-making systems" (Fig. 2). While "Systematized management processes built on IT, automated and using AI" and "Synergistically integrated through AI project management into the company's management system" can be fully controlled by artificial intelligence.

Human participation in the two specified artifacts (management processes and project management) can be foreseen through certain reference points. Such reference points can be established in those elements of these artifacts where it is necessary to make significant decisions regarding them. Therefore, an IT interface should be organized in these two artifacts, which will ensure such decision-making by specialists of the development company – respectively, process management and project management.

Thus, the project of transformation of the management system of the development company (formula 1) can be expanded by one additional element:

$$P = <S, M, R, E, H, I, O, D, A>, \qquad (2)$$

where A – models, methods and tools of artificial intelligence used in the management system of the development company.

The model "Step-by-step Lean Transformation"

This model involves the sequential development of the management system of the development company using the Lean methodology (Fig. 3). In this case, the management system is consistently improved, such improvement occurs incrementally. Each new stage of the development of the management system involves the achievement of a certain set of improvements – both in the context of digitalization and in the context of the use of artificial intelligence elements.

This development never stops and can be compared to the sequential, managed evolution of the development company management system. Therefore, the number of development stages can be limited only by the life cycle of the company itself.

One variation of this model could be one that uses Harold Kerzner's Project Management Maturity Model (PMMM) [16] for the development stages of the development company management system.

Based on the results of comparing the levels of the PMMM model with the development stages of the development company management system according to Model 3, we obtain the following.

Level 1 "Common Language". The development company develops and approves a dictionary of terms for the use of IT models, methods and tools and elements of artificial intelligence. The transformation project team itself uses uniform terms, and also instills a culture of their use in all divisions of the company.

Level 2 "Common Processes". Processes that use new IT and AI models, methods and tools are described and engineered. The described processes are then automated and integrated into a single IT system of the development company. The transformation project team organizes training in the company's divisions on the use of new automated processes.

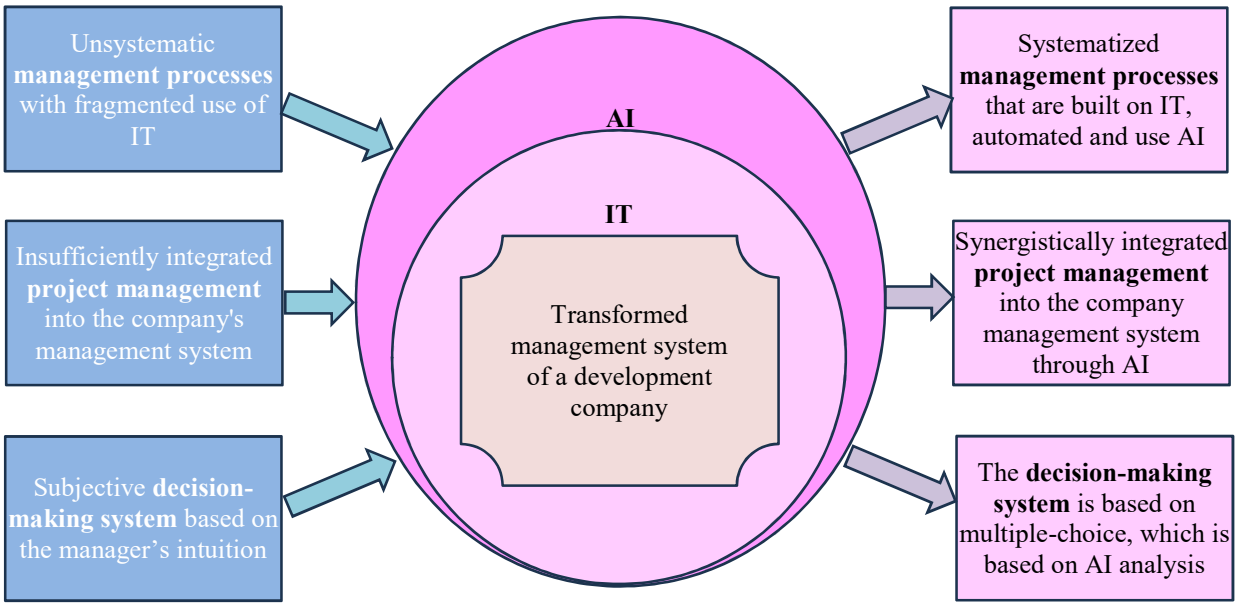

Figure 2 – Model 2 "Radical AI transformation"

Level 3 "Single Methodology". At this level, all processes of the development company's activities are described and automated. The processes that were described and automated at the previous level are reengineered to be consistent with other processes. At the company level, a single corporate methodology is developed and approved. Part of it is the methodology for managing projects and project portfolios in the company. Each artifact of the corporate methodology is supported by an appropriate IT tool using the appropriate AI element.

Level 4 "Benchmarking". At this level, which can be compared with the concept of measured processes, the characteristics of all described and automated processes are measured. Among such characteristics are the time of process implementation, the cost of process implementation, the complexity of process implementation, the quality of the process result, the level of use of AI elements, etc. In addition, this level is characterized by borrowing the best techniques and models for increasing the efficiency of processes – from one process (which shows the best results) to another – in the context of benchmarking.

Level 5 "Continuous Improvements". At this level, processes are constantly reviewed and improved in terms of their main characteristics, including, in addition to those mentioned above, the level of process consistency, the absence of duplication of functions, the identification of missing functions, the constant transfer of best practices from one process to other processes, and the increase in the use of IT tools and AI elements.

In general, it is worth noting that Kerzner's PMMM model corresponds well with the model of phased Lean transformation of the development company management system. Therefore, PMMM can be successfully integrated into it, but it is not the only model that can ensure continuous Lean development. As other models, one can consider, for example, the Gemba Kaizen model, the IPMA Delta model and others, which can be considered as one of the directions in the context of the prospects for further research.

Thus, the project of transformation of the development company management system (formula 2) can be expanded to include one more additional element:

$$P = <S, M, R, E, H, I, O, D, A, L>, \quad (3)$$

where L is the formalized model of the development levels of the development company management system.

We will analyze the proposed models and compare them according to the following criteria: the use of AI, the complexity of the management system transformation within the model, the predicted effectiveness of the model, and the readiness of development companies to implement the model (Table 1.)

According to the results of the analysis, the following conclusions can be drawn: Model 2 is determined to be the most difficult to implement in development companies, the greatest predictive effectiveness is expected from the implementation of Model 3, the highest level of readiness of development companies to implement management system transformation models can be predicted for Model 3.

In general, it can be stated that the most relevant to the development of management systems in development companies are Models 2 and 3, as they received the highest overall score.

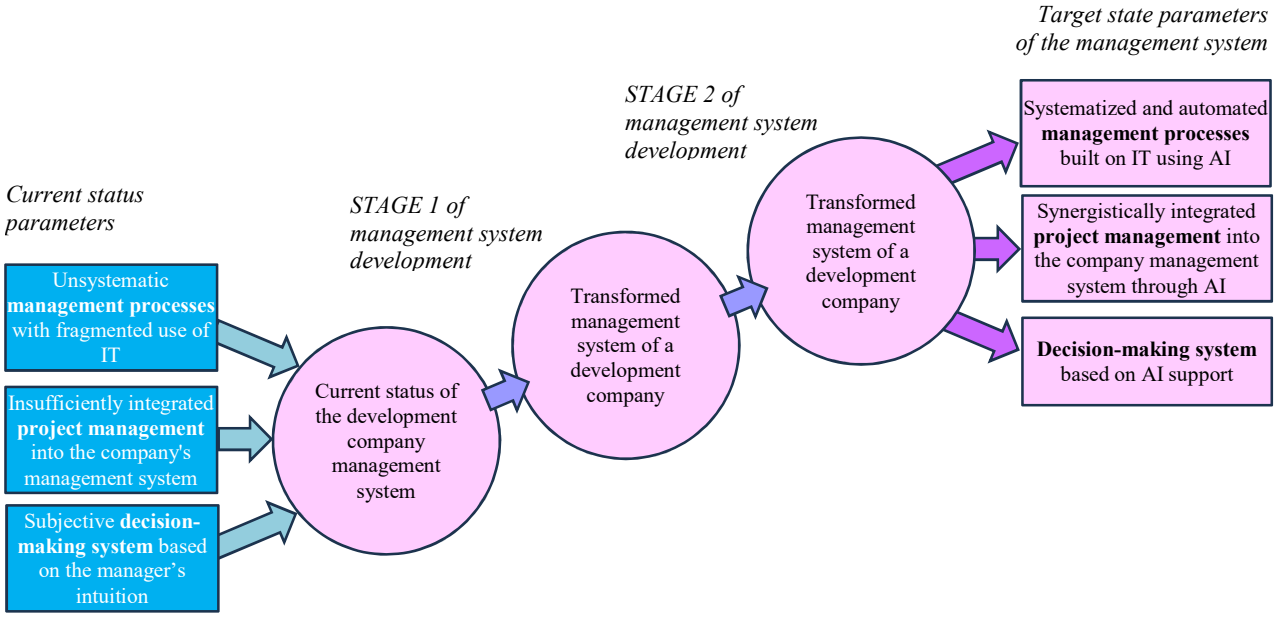

Figure 3 –Model 3 "Step-by-step Lean transformation"

Table 1 *– Comparison of development company management system models*

№	Model name	AI usage	Complexity of transformation	Predictive performance of the model	Readiness of companies to implement model
1.	Model 1. Full digitalization	–	+	+	++
2.	Model 2. Radical AI Transformation	+++	+++	++	+
3.	Model 3. Step-by-step Lean Transformation	+	++	+++	+++

We will conduct a study of the obtained results in the form of a SWOT analysis.

Strengths.

– ensuring the continuous development of the management system of development companies;

– digitalization and use of artificial intelligence elements;

– flexibility of models, their ability to adapt to the company and scale.

Weaknesses.

– insufficient formalization of the artifacts of the project for transforming the management system of development companies;

– the unreadiness of the management of development companies to implement large-scale projects for the transformation of the management system;

– the high cost of the project for the transformation of the management system of the development company.

Opportunities.

– preservation and strengthening of the competitive position of the development company due to the functioning of a modern, adaptive and updated management system;

– timely application of new elements, models and developments of artificial intelligence as soon as they appear;

– the possibility of simultaneously effectively managing a larger number of projects in the portfolio of the development company.

Threats.

– the ongoing war may shift the priorities of development companies towards the use of familiar models, methods and tools;

– non-acceptance of the proposed models by the middle management of development companies and corresponding resistance to implementation;

– the new management system will not take root due to complexity or for other reasons.

Based on the results of the SWOT analysis, it can be concluded that the complex of proposed models has high potential in the context of increasing the efficiency of management systems of development companies. The weaknesses of the models and the threats that can potentially accompany their implementation can be minimized by using their strengths and using the opportunities they provide.

Let us formulate the prospects for further research in the chosen direction based on the results of the research:

1. Detailed formalization of all artifacts of the project for the transformation of the management system of development companies.

2. Research into the use of the Gemba Kaizen model, the IPMA Delta model and other models for application within the framework of the phased Lean transformation of the management system of a development company.

3. Application of neural networks and other elements of artificial intelligence for the development and monitoring of the project for the transformation of the management system of a development company.

4. Development of a training system for employees of development companies on the application of the complex of proposed models.

5. Practical testing of the proposed models in development companies, reengineering of models based on the results of such testing.

Conclusion

The task of increasing the effectiveness of development company management systems in the scientific field is to formulate new models and methods of their functioning and formalize the transformation project – the transition of the existing management system to a new management system.

This article identifies the main challenges facing development company management systems and formulates. characteristics of the target state of the development company management system.

On this basis, three models of the development company management system are proposed: “Full digitalization”, “Radical AI transformation” and “Step-by-step Lean transformation”. Each model is presented in the form of “input-output” and in the plural form, in the context of the “Step-by-step Lean Transformation” model, the use of Harold Kerzner's PMMM technological maturity model is proposed. The proposed models were analyzed and compared according to certain criteria, according to the results of such analysis, it was determined that the most relevant to the development of management systems of development companies are models 2 and 3 as those that received the highest overall score. A SWOT analysis of the complex of proposed models was also conducted, which proved their high potential for the development of management systems of development companies. Areas of further research in the chosen direction were also formulated. In general, it can be stated that the proposed complex of models is only the beginning of the study of projects for the transformation of management systems of development companies, and the development of scientific tools for such projects is a practically significant and relevant scientific task.

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Use of Artificial Intelligence. The authors confirm that no artificial intelligence tools were used in the creation of this work.

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МОДЕЛІ ТРАНСФОРМАЦІЇ СИСТЕМИ УПРАВЛІННЯ ДЕВЕЛОПЕРСЬКОЮ КОМПАНІЄЮ НА ОСНОВІ ВИКОРИСТАННЯ ІТ ТА ШІ ІНСТРУМЕНТІВ

Анотація. *У статті проаналізовано літературу щодо портфельного управління, методологій управління проєктами та діджиталізації. Сформульовано мету дослідження. Визначено основні виклики, що стоять перед системами управління девелоперських компаній. Сформульовано характеристики цільового стану системи управління девелоперською компанією. Запропоновано три моделі системи управління девелоперською компанією. Серед запропонованих моделей – модель 1 «Повна діджиталізація», модель 2 «Докорінна AI-трансформація», модель 3 «Поетапна Lean-трансформація». Модель 1 «Повна діджиталізація» передбачає діджиталізацію всіх процесів, які реалізує система управління девелоперською компанією. Модель 2 «Докорінна AI-трансформація» передбачає не лише діджиталізацію всіх процесів, які реалізує система управління девелоперською компанією, а й використання в усіх процесах елементів штучного інтелекту. Модель 3 «Поетапна Lean-трансформація» передбачає послідовний розвиток системи управління девелоперською компанією з використанням методології Lean. Кожна модель представлена у вигляді «вхід-вихід» та у множинному вигляді. Для моделі 3 «Поетапна Lean-трансформація» запропоновано використання моделі технологічної зрілості Гарольда Керцнера. Здійснено аналіз запропонованих моделей та проведено їх порівняння за такими критеріями: використання AI, складність трансформації системи управління в межах моделі, прогнозована ефективність моделі та готовність девелоперських компаній до впровадження моделі. Проведено SWOT-аналіз комплексу запропонованих моделей. Сформульовано галузі подальших досліджень у обраному напрямі, серед яких: детальна формалізація всіх артефактів проєкту трансформації системи управління девелоперськими компаніями; дослідження використання моделі Гемба кайдзен, моделі IPMA Delta та інших моделей для застосування в межах поетапної Lean-трансформації системи управління девелоперською компанією; застосування нейронних мереж та інших елементів штучного інтелекту для розробки і моніторингу проєкту трансформації системи управління девелоперською компанією; розробка системи навчання для працівників девелоперських компаній щодо застосування комплексу запропонованих моделей; практична апробація запропонованих моделей в девелоперських компаніях; коригування моделей за результатами такої апробації. Сформульовано висновки з проведених досліджень.*

Ключові слова: управління проєктами; девелоперська компанія; діджиталізація; штучний інтелект; моделі трансформації системи управління; Lean

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