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BUSINESS PROCESS MODELS FOR COUNTER-TURBULENT PORTFOLIO MANAGEMENT IN A GENERAL CONTRACTING ORGANIZATION

Abstract. *This article analyzes research on project management, project portfolio management, and risk management. It identifies a previously unsolved part of the scientific problem. Within the type of "management processes", a set of processes for counter-turbulent management of construction project portfolios by a general contracting organization is proposed (11 such processes are identified: 1. Negotiations with the customer on the performance of the general contracting function. 2. Formation of a construction project portfolio. 3. Determination of the responsibility structure for managing the construction project portfolio. 4. Determination of subcontractors by the general contracting construction organization. 5. Monitoring the implementation of the construction project portfolio. 6. Improvement of models, methods and IT tools for monitoring the construction project portfolio. 7. Improvement of the quality management system for managing the construction project portfolio. 8. Implementation of counter-turbulent management of the construction project portfolio. 9. Assessment of the effectiveness of the counter-turbulent management system for the construction project portfolio. 10. Review of the composition of the construction project portfolio. 11. Determination of motivation for the successful implementation of the construction project portfolio.). An analysis of the applicability of models and methods of artificial intelligence and emotional intelligence (separately and together) for the proposed set of processes was conducted. The processes for which the highest AI applicability index, EI applicability index, and AI+EI combination applicability index were determined. The processes for which the lowest and highest total values of the proposed indicators were observed were also identified. Process 2 "Formation of a construction project portfolio", process 8 "Implementation of counter-turbulent management of a construction project portfolio" and process 9 "Evaluation of the effectiveness of the counter-turbulent management system of a construction project portfolio" were considered. Models of such processes were proposed and described in the BPMN 2.0 business process description notation. Within the framework of the process description, a model of weighted AI-EI portfolio composition assessment and a business process model of counter-turbulent portfolio management in a general contracting organization are proposed. Conclusions from the conducted research are formulated.*

Keywords: project and program management; project portfolio management; general contracting organization; counter-turbulence management; business process model

Introduction

The current working conditions of construction companies are extremely complex and risky. In addition to the general riskiness of construction projects, there are also risks associated with war and the need to implement construction during the threat of shelling and the threat of escalation of hostilities. However, construction remains one of the key sectors of the economy, and successful management of construction projects is a prerequisite for its growth.

General contracting organizations are one of the key players in the construction industry market, as they accumulate the efforts of many participants in construction projects, but also take on a large number of risks. Such risks must be managed to ensure greater efficiency in the implementation of construction projects.

The high turbulence of the external project environment of general contracting organizations necessitates the identification of a list of risks that may burden their construction projects and the development of a system for implementing counter-turbulent actions in order to ensure the successful implementation of projects and the sustainability of the development of such organizations.

Due to the lack of research in the field of developing counter-turbulent models for construction general contracting organizations, the topic of the study can be considered relevant.

Analysis of latest research

The fundamental principles of risk management in project management are systematized in the seventh edition of the PMBOK Guide, which presents an evolved approach to risk management with an emphasis on principles instead of rigidly defined processes [1]. The proposed approach emphasizes the importance of integrating risk management into all aspects of project activities and adapting to the specific contexts of organizations. Similar concepts are described in other leading standards in the field of project management - the Portfolio Management Standard [2] and the ISO standard for managing projects, programs and project portfolios [3]. Among the project manager's competencies, the importance of knowledge, skills and abilities in managing risks in projects, programs and project portfolios is emphasized [4]. Value-based project management, introduced by the P2M standard, also emphasizes the importance of risk management, and extends this approach to managing uncertainties and opportunities in projects and programs [5].

In general, modern research expands the traditional understanding of project risks, new categories of risks arise related to digitalization, cybersecurity and the interdependence of digital systems.

Scientists [6] in their study of portfolio management dynamics found that successful organizations practice cyclical portfolio review taking into account changes in the risk profile of projects. The authors introduce the concept of "portfolio risk velocity" – the speed of change in the portfolio risk landscape, which in the construction industry is especially high due to the influence of external factors.

The construction industry is characterized by a unique risk profile, which necessitates the need for specialized approaches to their management.

Other researchers [7] have investigated the cascading effects of risks in construction projects, finding that 73% of significant budget overruns are not caused by primary risks, but by their secondary and tertiary consequences. This highlights the need for a systemic approach to risk management, especially at the project portfolio level.

Unlike the risks of individual projects, portfolio risks have a qualitatively different nature and require specific approaches. Recent publications emphasize the role of artificial intelligence and machine learning in managing project portfolio risks, and research into the resilience of project portfolios is gaining relevance in the context of increasing uncertainty in the external environment. The study [8] proposes the concept of "portfolio resilience engineering" – proactive portfolio formation taking into account its ability to absorb shocks and recover quickly. For construction companies, this means balancing between specialization (which increases efficiency) and diversification (which increases resilience).

Other works by scholars on portfolio management emphasize the risks associated with the organizational structure of portfolio management [9], the risks of information technologies used in portfolio management [10], and the risks in relations with stakeholders of construction project portfolios [11]. Scholars also emphasize the importance of accumulating data on project portfolios [12], proposing a holistic portfolio management methodology taking into account risk management [13], taking into account the Agile methodology for project portfolio management [14], and taking into account the specifics of project portfolio implementation in the public sector [15]. An important aspect of portfolio management, which involves the use of risk management, is also the described business processes of such management [16], and the emotional intelligence of its participants, which also significantly affects the probability of success in the implementation of construction portfolios and the mitigation of their risks [17].

Despite the significant volume of literature, important gaps remain. First, there is a lack of empirical research on the effectiveness of different risk management models specifically at the level of a construction project portfolio – most publications focus on individual projects or consider portfolios in other industries. Second, the integration of risk management with other aspects of portfolio management (financial planning, resource management, strategic alignment) is not sufficiently explored. Third, there is a limited number of studies that consider risk management through the prism of an organization's business processes, rather than as an isolated function. These gaps identify space for further scientific exploration in this topic.

Purpose of the article

The purpose of the article is, based on an analysis of modern research on project portfolio management, to identify a set of processes for counter-turbulent management of construction project portfolios by a general contracting organization, to analyze the applicability of models and methods of artificial

intelligence and emotional intelligence to construction project portfolio management, and to formalize the corresponding processes.

The main material of the article

Counter-turbulent portfolio management can also be described through a system of processes that are implemented within it. According to scientific research in this area, the upper level of the process classification model can be represented by the following types: main processes, auxiliary processes, management processes, development processes, support processes, IT processes.

Within the type of "management processes", we will propose a set of processes for counter-turbulent management of construction project portfolios by a general contracting organization:

1. Negotiations with the customer on the performance of the general contracting function.
2. Formation of a construction project portfolio.
3. Determination of the responsibility structure for managing the construction project portfolio.
4. Determination of subcontractors by the general contracting construction organization.
5. Monitoring the implementation of the construction project portfolio.
6. Improving models, methods and IT tools for monitoring the construction project portfolio.
7. Improving the quality management system for the management of the construction project portfolio.
8. Implementing counter-turbulent management of the construction project portfolio.
9. Assessing the effectiveness of the counter-turbulent management system for the construction project portfolio.
10. Reviewing the composition of the construction project portfolio.
11. Determining the motivation for the successful implementation of the construction project portfolio.

Let us analyze the applicability of AI and EI models and methods separately and together (Table 1) for the proposed set of processes.

Table 1 – ***Applicability analysis of AI and EI methods in portfolio management processes***

№	Process	Applicability of AI	Applicability of EI	Applicability of AI + EI
1	Negotiations with the customer on the performance of the general contracting function	+	+++	++
2	Formation of a construction project portfolio	+++	+	++
3	Determination of the responsibility structure for managing the construction project portfolio	++	++	++
4	Determination of subcontractors by the general contracting construction organization	+++	+	++
5	Monitoring the implementation of the construction project portfolio	+++	+++	+++
6	Improving models, methods and IT tools for monitoring the construction project portfolio	+++	+++	+++
7	Improving the quality management system for the management of the construction project portfolio	+++	+	++
8	Implementing counter-turbulent management of the construction project portfolio	+++	++	+++
9	Assessing the effectiveness of the counter-turbulent management system for the construction project portfolio	+++	+++	+++
10	Reviewing the composition of the construction project portfolio	+++	+++	+++
11	Determining the motivation for the successful implementation of the construction project portfolio	++	++	++

Based on the results of such an analysis, the following conclusions can be drawn:

1. The applicability index of AI is the highest for processes 2 and 4-10.
2. The applicability index of EI is the highest for processes 1, 5, 6, 9, 10.
3. The applicability index of the combination of AI+EI is the highest for processes 5, 6, 8, 9, 10.
4. The lowest total value of the indicators is observed for processes 1, 3, 4, 7, 11.
5. The highest value of all indicators is observed for processes 5, 6, 9, 10.

In general, it can be argued that all processes are suitable for the application of both AI and EI and their combination (AI+EI). The low level of AI applicability for process 1 regarding negotiations can be explained by the need for communication skills and the application of emotional intelligence in the negotiation process, which at this stage of AI development is not provided by it.

At the same time, the low level of possibility of applying EI to the relevant processes can be explained as follows: process 2 on portfolio formation can be well formalized and in general does not require empathy for the projects included in the portfolio; when EI is included in process 4 on determining subcontractors, it may carry corruption risks; process 7 on improving the quality management system should also be taken outside the scope of EI to minimize subjective influence and due to the possibility of its detailed formalization.

Let us consider process 2 "Formation of a portfolio of construction projects", process 8 "Implementation of counter-turbulent management of a portfolio of construction projects" and process 9 "Evaluation of the effectiveness of the counter-turbulent management system of a portfolio of construction projects". We will propose and describe models of such processes in the notation of business processes description BPMN 2.0 (Business Process Model and Notation).

The process model 2 "Formation of a portfolio of construction projects" is shown in Fig. 1.

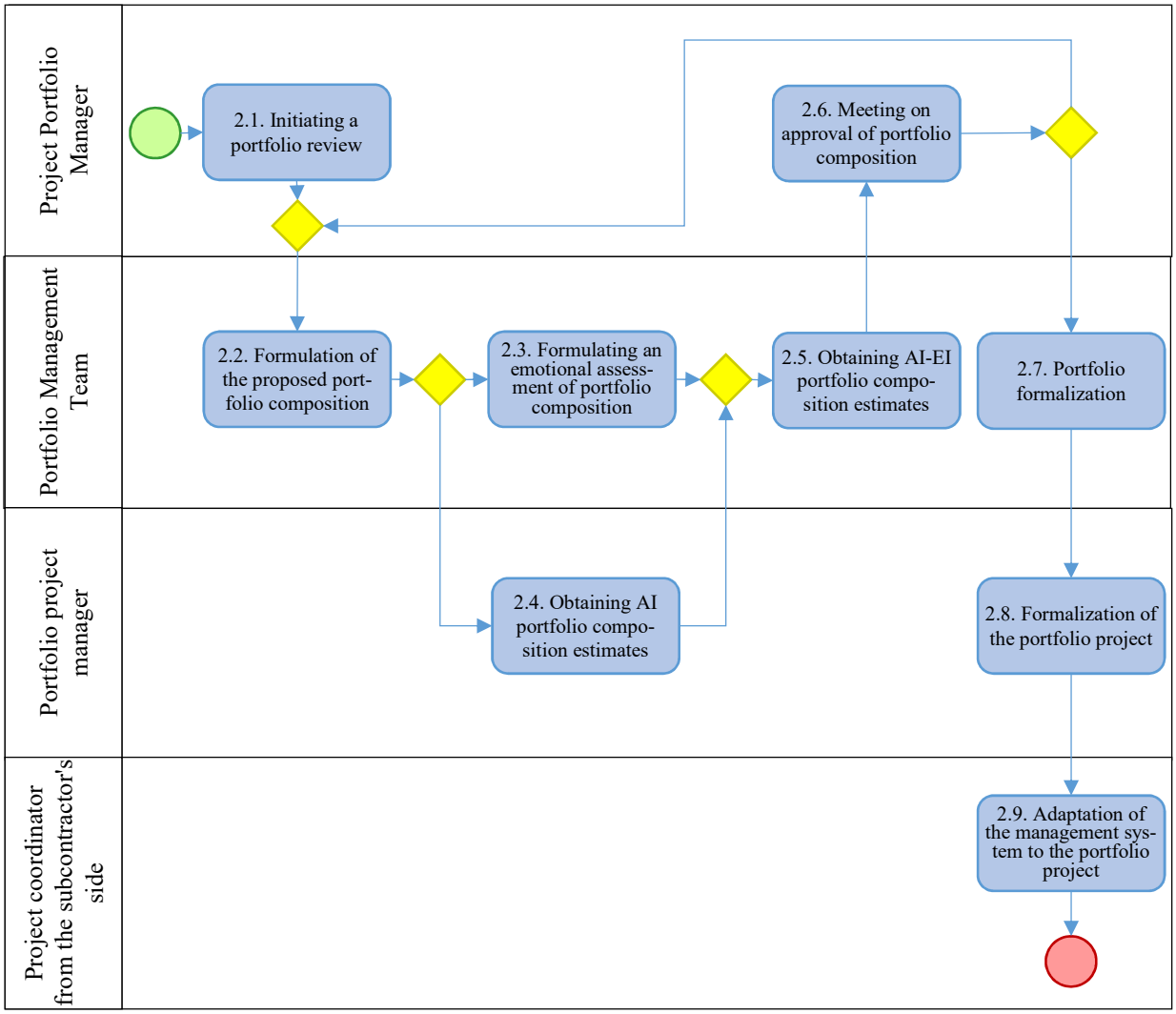

Figure 1 *– Process model 2 "Formation of a portfolio of construction projects" for a general contracting company in BPMN 2.0 notation*

The process begins with the initiation of a portfolio review (first generation or regular review) by the project portfolio manager (function 2.1). After that, the portfolio management team, based on the task from the portfolio manager and the constraints of such a task (formulated by the portfolio manager), formulates the proposed composition of the project portfolio for further consideration (function 2.2). Then, in parallel, the processes of formulating an emotional assessment of the portfolio composition by the portfolio management team (function 2.3) and obtaining an AI assessment of the portfolio composition (function 2.4), for which the project managers included in the portfolio are responsible, take place. After that, the portfolio management team receives a weighted AI-EI assessment of the portfolio composition (function 2.5) according to the following formula:

$$E^{AI+EI} = w_0 \cdot E^{AI} + \sum_i w_i \cdot E^{EI}, \qquad (1)$$

where E^{AI+EI} – overall AI+EI assessment of the portfolio of projects of a construction general contracting organization; w_0 – the weight of the AI score in the overall score; E^{AI} – assessment of a construction general contracting organization's project portfolio using artificial intelligence; E^{EI} – emotional assessment of the project portfolio of a construction general contracting organization by the manager of a project included in the portfolio; w_i – the weight of the EI score of each project manager in the overall score, with $w_0 + \Sigma_i w_i = 1$, and the E scores are scaled on a scale of [0..10].

After that, the portfolio manager organizes a meeting at which a decision is made on the composition of the portfolio, i.e. the inclusion of certain projects in the portfolio or their exclusion from it (function 2.6). Next, the portfolio team formalizes the portfolio, for example, develops and approves its charter (function 2.7), and the portfolio project managers carry out such formalization at the project level (function 2.8), based on such formalization, subcontractors adapt their management systems to the portfolio project in which they participate (function 2.9).

Process model 8 "Implementation of counter-turbulent management of a portfolio of construction projects" is shown in Fig. 2.

The start of this process, which begins with the development of a counter-turbulent impact by the portfolio management team (function 8.1), can occur if four events occur:

1) the triggering of an unforeseeable turbulence trigger, for the observation of which the general contractor's project portfolio manager (at his level) and the portfolio management team (at his level) are responsible;

2) the occurrence of predicted turbulence at the project level, for the observation of which the project managers included in the portfolio are responsible;

3) the occurrence of predicted turbulence at the subcontractor level, for the observation of which the subcontractor's project coordinator is responsible.

After the counter-turbulent impact is developed by the team, an assessment of this impact is carried out in parallel, with the project portfolio manager (function 8.2) and the portfolio project managers (function 8.5) formulating their emotional assessment. At the same time, the portfolio management team is responsible for formulating their emotional assessment of the impact under consideration (function 8.3) and obtaining an assessment of this impact using artificial intelligence tools (function 8.4).

The portfolio management team then receives a weighted assessment of the counter-turbulent impact based on a relationship similar to that in Equation 2.6 (Function 8.6). This assessment is then discussed at a meeting organized by the project portfolio manager (Function 8.7), where the counter-turbulent impact is either rejected (and the process then returns to the implementation of Function 8.1 for developing the counter-turbulent impact), or approved, and the process then proceeds to implementing the approved impact – at the portfolio level (Function 8.8), which is the responsibility of the portfolio management team, and at the project level (Function 8.9), which is the responsibility of the portfolio project managers.

At the subcontracting organization level, this impact is adapted to its own management system, which is the responsibility of the subcontractor project coordinator (Function 8.10).

This completes the process.

The model of process 9 "Evaluation of the effectiveness of the counter-turbulent management system for a portfolio of construction projects" is shown in Fig. 3.

Process 9 begins at the scheduled time specified by the relevant regulatory document of the general contracting organization (Regulations, Regulations, Corporate Culture, etc.) with the process of collecting data to assess the effectiveness of the implemented counter-turbulent impact (function 9.1), for which the portfolio management team is responsible. Typically, the implementation of such a function should begin sometime after the completion of the counter-turbulent impact, so that its effect has already occurred. After the completion of data collection, its effectiveness is assessed in parallel, the project portfolio manager (function 9.2), portfolio project managers (function 9.5) and the project coordinator from the subcontractor (function 9.6) formulate their emotional assessment. At the same time, the portfolio management team is responsible for formulating its emotional assessment of the impact under consideration (function 9.3) and obtaining an assessment of such impact using artificial intelligence tools (function 9.4).

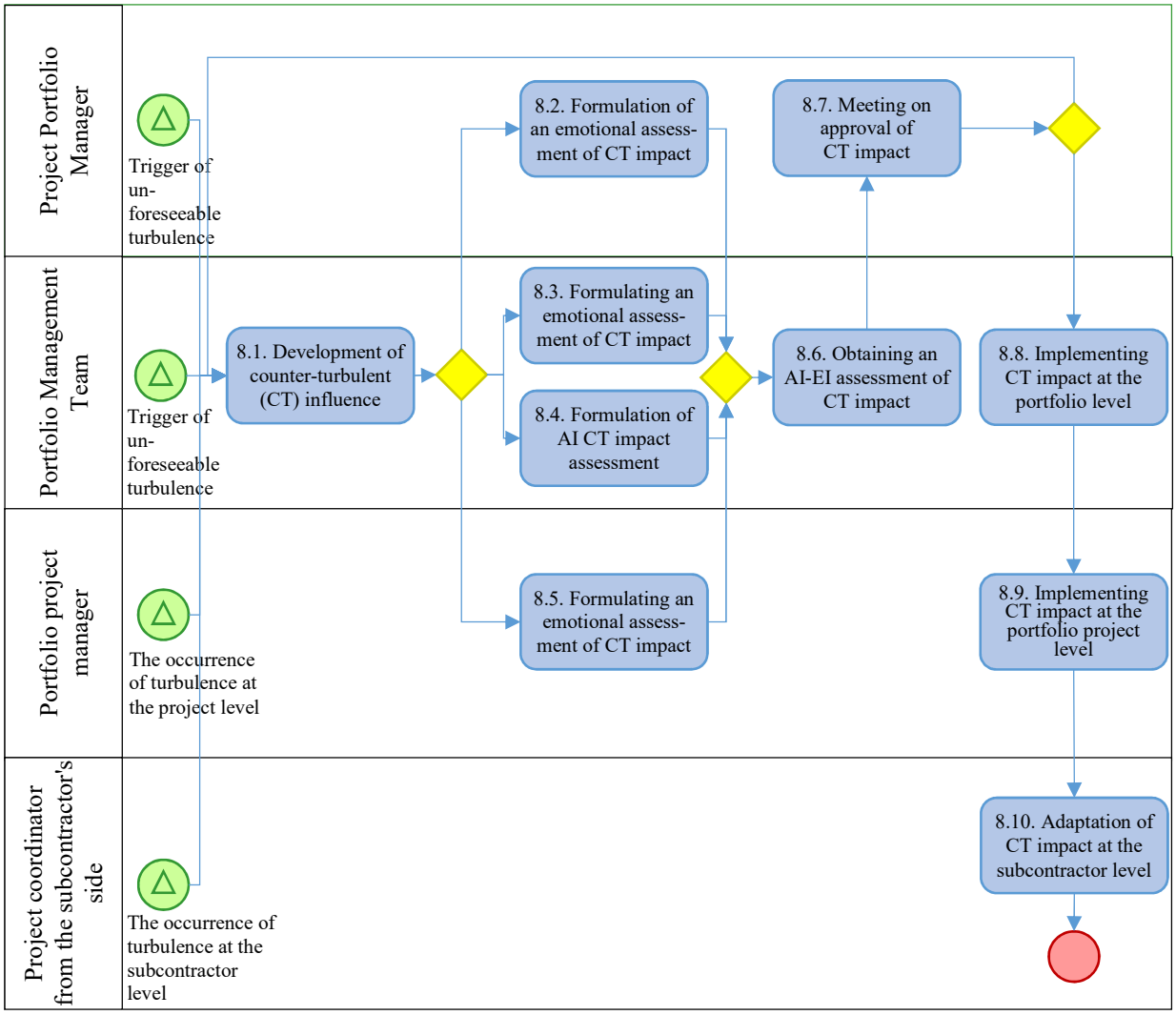

Figure 2 *– Process model 8 "Implementation of counter-turbulent management of a portfolio of construction projects" for a general contracting company in BPMN 2.0 notation*

Next, the portfolio management team receives a weighted assessment of the effectiveness of the counter-turbulent impact according to a relationship similar to that set out in formula 2.6 (function 9.7). After that, such an assessment is reviewed at a meeting and either returned for revision (and then function 9.1 for data collection is re-implemented), or accepted and, based on the results of the implementation of the counter-turbulent impact and its effectiveness assessment, changes are made to the process of its implementation at the portfolio level, for which the portfolio management team is responsible (function 9.9), the portfolio project levels, for which the portfolio project managers are responsible (function 9.10), and the subcontracting organization project management system levels, for which the subcontractor project coordinator is responsible (function 9.11).

This completes the process.

The business process model of counter-turbulent portfolio management in a general contracting organization is proposed to be presented using set theory in the following form:

$$P^{KTV} = <S^{KTV}, F^{KTV}, C^{KTV}, R^{KTV}>, \quad (2)$$

where P^{KTV} is a process model, S^{KTV} is a set of process participants, F^{KTV} is a set of process functions, C^{KTV} is a set of connections between functions, R^{KTV} is a set of transition conditions between functions.

The specified formalization is aimed at organizing and systematizing processes, their archiving in a knowledge base for further use during the implementation of the project portfolio of the general contracting organization.

Conclusion

The field of project portfolio management in the construction industry requires new models and methods in the face of modern challenges facing construction and high turbulence in the environment. The creation and study of such models may involve not only their formalization in the form of mathematical models, but also their representation in the form of business process models using appropriate standards for their description and regulation.

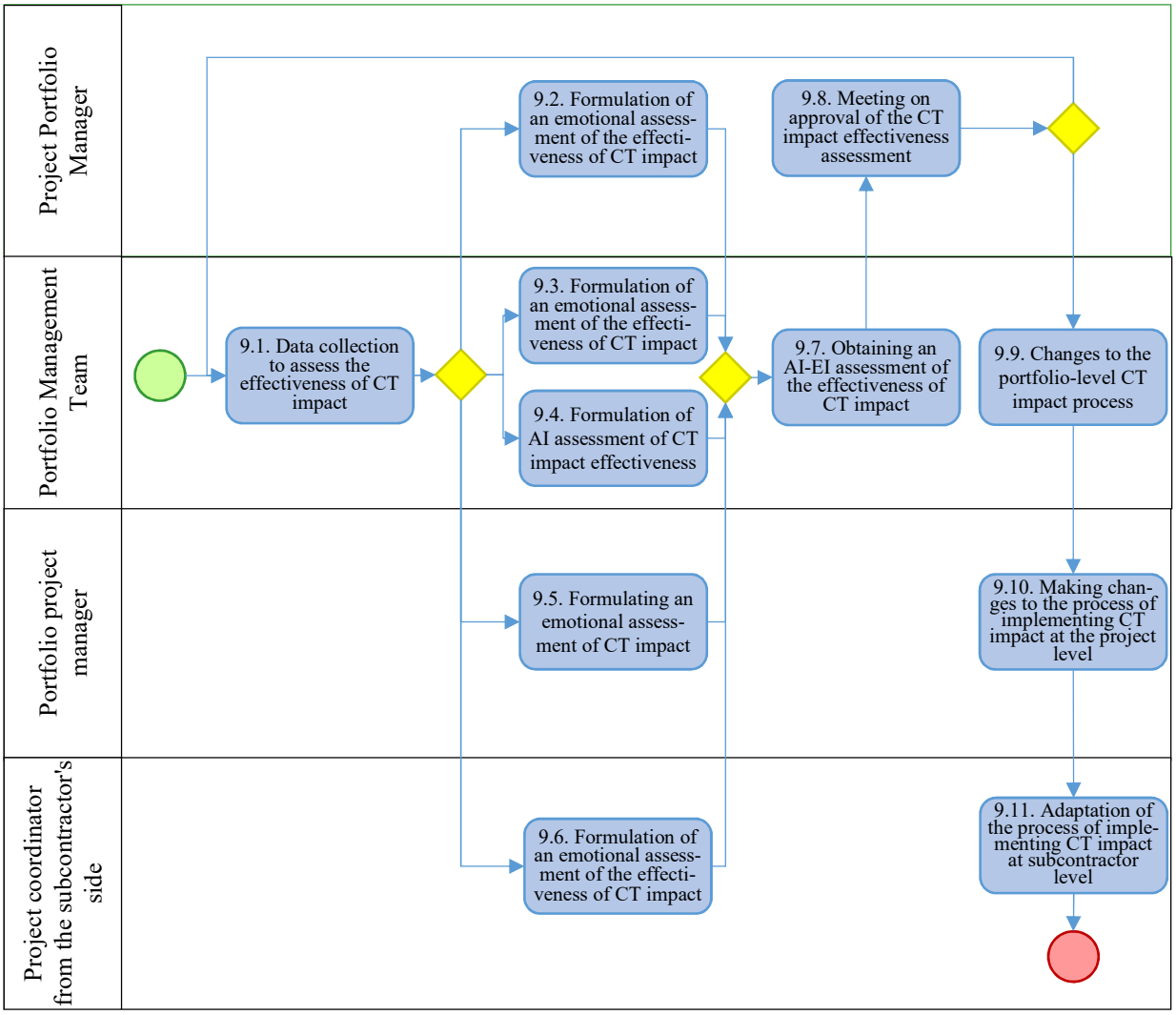

Figure 3 *– Process model 9 "Evaluation of the effectiveness of the counter-turbulent management system for a portfolio of construction projects" for a general contracting company in BPMN 2.0 notation*

This article analyzes research on project management, project portfolio management, and risk management. The previously unsolved part of the scientific problem is identified. Within the type of "management processes," a set of processes for counter-turbulent management of construction project portfolios by a general contracting organization is proposed (11 such processes are identified). An analysis of the applicability of models and methods of artificial intelligence and emotional intelligence (separately and together) for the proposed set of processes is conducted. Process 2 "Formation of a construction project portfolio," process 8 "Implementation of counter-turbulent management of a construction project portfolio," and process 9 "Evaluation of the effectiveness of the counter-turbulent management of a construction project portfolio system" are considered. Models of such processes are proposed and described in the BPMN 2.0 business process description notation. Within the framework of the process description, a model of weighted AI-EI portfolio composition assessment and a business process model of counter-turbulent portfolio management in a general contracting organization are proposed.

The use of these models will allow formalizing and systematizing the activities of construction general contracting organizations in the field of risk management of construction project portfolios, using the proposed counter-turbulent management approach.

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Use of Artificial Intelligence. The author confirms that in the creation of this work he/she did not use artificial intelligence tools.

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МОДЕЛІ БІЗНЕС-ПРОЦЕСІВ КОНТРТУРБУЛЕНТНОГО ПОРТФЕЛЬНОГО УПРАВЛІННЯ В ГЕНПІДРЯДНІЙ ОРГАНІЗАЦІЇ

Анотація. *У статті проаналізовано дослідження з управління проєктами, управління портфелями проєктів та управління ризиками. Виокремлено невирішену раніше частину наукової задачі. У межах типу «управлінські процеси» запропоновано множину процесів контртурбулентного управління портфелями будівельних проєктів генпідрядною організацією (ідентифіковано 11 таких процесів: 1. Проведення перемовин із замовником про виконання функції*

генпідряду. 2. Формування портфеля будівельних проєктів. 3. Визначення структури відповідальності за управління портфелем будівельних проєктів. 4. Визначення субпідрядників генпідрядною будівельною організацією. 5. Моніторинг реалізації портфеля будівельних проєктів. 6. Вдосконалення моделей, методів та ІТ-інструментів моніторингу портфеля будівельних проєктів. 7. Вдосконалення системи управління якістю управління портфелем будівельних проєктів. 8. Реалізація контртурбулентного управління портфелем будівельних проєктів. 9. Оцінювання ефективності системи контртурбулентного управління портфелем будівельних проєктів. 10. Перегляд складу портфеля будівельних проєктів. 11. Визначення мотивації за успішну реалізацію портфеля будівельних проєктів). Проведено аналіз щодо застосовності моделей та методів штучного інтелекту (AI) та емоційного інтелекту (EI) окремо та в комбінації для запропонованої множини процесів. Визначено процеси, для яких показники застосовності AI, EI та комбінації AI+EI є найвищими. Також ідентифіковано процеси, для яких спостерігається найнижче і найвище сукупне значення запропонованих показників. Розглянуто процес 2 «Формування портфеля будівельних проєктів», процес 8 «Реалізація контртурбулентного управління портфелем будівельних проєктів» та процес 9 «Оцінювання ефективності системи контртурбулентного управління портфелем будівельних проєктів». Запропоновано та описано моделі таких процесів у нотації опису бізнес-процесів BPMN 2.0. У межах опису процесів запропоновано модель зваженої AI-EI оцінки складу портфеля та модель бізнес-процесу контртурбулентного портфельного управління в генпідрядній організації. Сформульовано висновки з проведених досліджень.

Ключові слова: управління проєктами та програмами; управління портфелями проєктів; генпідрядна організація; контртурбулентне управління; модель бізнес-процесу

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