Approaches to forming AI-EI Models of mental space for managing project portfolios in construction

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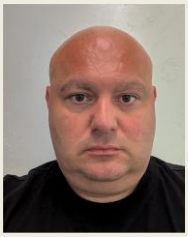
Abstract. In this article analyzes standards, methodologies and scientific works in the field of project management, which can serve as a scientific basis for developing an approach to creating, implementing and maintaining the mental space of a construction project portfolio. The existing definitions of mental space are analyzed. Based on the analysis, taking into account the specifics of the construction industry, our own definitions are proposed (mental space of a construction project portfolio, mental stability of participants and stakeholders of a construction project portfolio, processes for ensuring the effective functioning of the mental space of a construction project portfolio). The specified definitions can form the basis of the thesaurus of the researched direction. A set of principles for creating, implementing and supporting the mental space of a portfolio of construction projects is proposed. The features of creating, implementing and supporting the mental space in the field of implementing the portfolio of construction projects are identified. The "conflict-efficiency" model is proposed for the development of mental space models. Based on the results of the research, the conceptual model of the mental space of EI-AI portfolio management are proposed, the specified model in particular is presented in a plural form. One of the important processes of implementing and supporting the mental space of a portfolio of construction projects is described – the tailoring process. A SWOT analysis of the proposed approach in the first and second forms was conducted. According to the results of such analysis, the proposed approach can be considered viable. Conclusions were drawn regarding the conducted research. Vectors of further research in the chosen direction were formulated.



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INTRODUCTIONS

The modern construction industry, which is project-oriented a priori, since it is focused on the implementation of construction projects, as a result of scaling and consolidation, is forced to focus on a set of projects in its activities. Such a set can be identified as a portfolio (not a program), since the projects of a construction company are not related to the same goal,

because they differ in customers. Each of the customers implements its own project with the construction company, and therefore the set of projects (portfolio) is difficult to compare with the mission of the organization and combine such projects into a program. The portfolio of projects of a construction company may, of course, also include development projects that are not related to construction, but are aimed at increasing the technological or managerial capabilities of the company [1].

The second important factor of modern construction projects and project portfolios is the high turbulence of the external environment. The components of turbulence include the war caused by the aggression of the Russian Federation against Ukraine, accelerated digitalization (as well as the acceleration of the pace of life and entrepreneurship in general), the extremely rapid development of artificial intelligence and management tools (or at least decision support systems) based on it, as well as unpredictable changes in the regulatory environment and stakeholder behavior.

In such conditions, scientists and practitioners are in search of the most effective approaches, methodologies, models and methods for building an effective corporate construction project portfolio management system today.

Methodological developments in the field of portfolio management provide a typical toolkit for a generalized type of projects. Such works include the PMI standard for portfolio management, which defines specific domains of such management (for example, strategic portfolio management and portfolio governance) [2], the ISO standard for project, program and portfolio management [3], which universalizes the relevant approaches, and the IPMA competency standard, which separately defines the competencies of project, program and portfolio managers [4]. Research by scholars in the field of portfolio management is aimed at the application of the Agile methodology [5], the analysis of modern factors of portfolio management effectiveness [6], the integrated application of modern methodologies in management [7], their convergence, hybridization, mixing using traditional and flexible approaches [8], the application of artificial intelligence elements in project and portfolio management support tools [9], the implementation of advanced competency models [10].

Among the leading trends in project management that should be considered within the framework of this study is the development of the emotional intelligence (EI) of the project team. It is considered as a factor of project success [11], formulated as a set of self-awareness, self-control, social sensitivity and management of team relationships based on empathy [12], in other studies emotional intelligence is considered comprehensively, its characteristics and models of work with it are formulated [13], other authors provide a model of EI components: self-control (regulation of emotions, balance, management of stressful situations), emotionality (compassion, emotional perception, manifestation of emotions, relationships), communicativeness (control over emotions, perseverance, social awareness), well-being (optimism, happiness, self-esteem), supporting aspects (adaptability, self-motivation) [14].

Models of emotional intelligence laid the foundation for the development of the concept of mental space of the project and produced relevant scientific research [15], in particular in the context of activities in a digitalized community [16], other authors develop models for applying the concept of mental space of the project in various industries - transport enterprises [17], for innovative projects [18], IT projects [19], finally, some researchers propose the concept of blended mental space for mobility and flexibility as basic of project success [20]. However, it is worth noting that the issue of using emotional intelligence for portfolio management systems of construction projects has not been considered sufficiently. And the issue of models of combining EI and AI elements for the development of mental space of portfolio management systems of construction projects is almost unexplored, which determines the relevance of the topic of this study.

PURPOSE AND METHODS

The purpose of this article is to develop an approach to combining EI and AI elements for developing the mental space of construction project portfolio management systems, and to develop models of such a space.

RESULTS AND EXPLANATIONS

The mental space of portfolio management of construction projects requires a scientific basis that would be built from principles, models, methods, as well as algorithms and management tools created on their basis.

Among the many definitions of mental space, we will list the following three.

Mental space is defined as the environment in which systems of ideas, values, stereotypes of people and, accordingly, nations and states are formed and function [21].

The mental space of a transport enterprise safety project is a system of necessary information, knowledge, practices, processes, procedures, models and methods, which includes both the professional component of ensuring safety in the transport industry and the project management component, which allows making the necessary decisions during the development/implementation of the project [17].

Mental space (ba) is a virtual motivational space where stakeholders have common values of the project mission. Mental space helps stakeholders from different geographical, cultural, industrial, academic and organizational spheres to build interaction and cooperation through the communication base of the project. The success of the project depends on whether the project team managed to form an active mental space [22].

Based on the analysis of relevant definitions and the analysis of the subject area of construction project portfolio management, we will propose our own definition.

Definition 1. The mental space of the construction project portfolio is the environment for implementing the construction project portfolio, which combines the mental spaces of the portfolio implementation participants and stakeholders, balances their values, creates a mental basis for the synergy of competencies and mental stability in a turbulent environment. Such a mental space is aimed at balancing the value-risk ratio of the project portfolio, manages the portfolio structure in such a way that each construction project corresponds to the values of the mental space.

Definition 2. Mental toughness of participants and stakeholders of a construction project portfolio is a state of mind of each participant and stakeholder of a construction project portfolio, as well as project management teams and portfolio management teams, which ensures the use of models and methods to ensure the team's resilience to the challenges of a turbulent environment, creates the basis for the possibility of implementing the portfolio's goals and project objectives in accordance with a defined proactive strategy and dampens external turbulence.

Definition 3. Processes for ensuring the effective functioning of the mental space of a construction project portfolio are a set of interconnected processes that together form a holistic system. Such a system is aimed at constantly increasing the efficiency of the construction project portfolio management system, is implemented through the principles, models, methods and tools for creating, implementing and maintaining the mental space of a construction project portfolio and has IT implementation using artificial intelligence, which, in particular, takes into account the emotional intelligence of portfolio participants and stakeholders. Such processes should be formalized, subject to constant audit and updating, and responsibility for them should be assigned to a member of the construction project portfolio management team.

The description and formalization of the processes for ensuring the effective functioning of the mental space of a construction project portfolio is one of the vectors of future research in the specified direction.

Let's propose a set of principles for creating, implementing and maintaining the mental space of a portfolio of construction projects (Table 1).

Let's identify the features of creating, implementing and maintaining the mental space in the field of implementing the portfolio of construction projects:

- the long-term life cycle of construction projects, as a result of which the processes of maintaining the mental space must be developed in more detail than others;
- the high importance of the technological component in construction projects, as a result of which the construction specifics form a special mental space, which must be taken into account in the models of the processes of its creation, implementation and support;
- construction restoration projects include cross-cultural teams represented by participants from different countries (and accordingly represent different models of mental space), which requires additional models, methods and processes of harmonizing the values of different cultures (in particular in the context of construction project management cultures);
- the requirement to increase the speed of implementation of restoration projects, which requires the use in the mental space of construction projects of models of minimization or sublimation of conflicts that will inevitably arise as a result of the need to comply with the specified requirement;
- the mental space of direct participants in the project implementation differs sharply from the mental space of members of management teams, which requires additional harmonization of values between them, the creation and expansion of the plane of a common mental space.

Table 1

Principles of creating, implementing and maintaining the mental space of construction projects

No.	Principles	Content of the principle	Responsible
1	The principle of a single mental space	The portfolio mind space connects the mind spaces of the portfolio project teams, the portfolio management team, and stakeholders.	Project Portfolio Manager
2	Principle of balancing stakeholder values	Mental space contains models for measuring the achievement of portfolio participants' values and methods for balancing such values.	Project Portfolio Manager, Project Managers
3	The principle of joint competence	In the mental space, using tools for joint constant online communication on the appropriate platform, a joint discussion is implemented when making decisions from the portfolio based on the combined competence of participants and stakeholders.	All participants and stakeholders of the project portfolio
4	The principle of empathy	Empathy and mutual emotional support among project and portfolio management team members, as well as between such teams and stakeholder representatives in the portfolio mental space.	HR manager, project portfolio manager, project managers
5	The principle of synergism	The combination of elements of the mental space (joint competence, empathy, balancing of values, etc.) is aimed at obtaining synergy from portfolio interactions in the management system.	Project Portfolio Manager, Project Managers
6	The principle of mental resilience	Implementation of proactivity as a movement according to one's own strategy, taking into	Project Portfolio Manager, Project Managers

		account the prediction of the behavior of the external turbulent environment	
7	The principle of combining the EI of the portfolio management team and the AI of management tools	Mental space is aimed at creating a comfortable environment for the coexistence of emotional intelligence of teams and artificial intelligence of management tools, minimizing the conflicts of such coexistence and developing their effective interaction.	EI-AI Management Consultant or portfolio management team member assigned such responsibilities
8	The principle of mental toughness of teams	Using methods of normalizing mental space through models and methods of team building, conflict management, dynamic leadership, psychological relief, unification around the goal of the portfolio, corporate culture and mission of the construction company	HR manager

In the development of mental space models, let's propose the "conflict-effectiveness" model:

$$K^{ke} = \sum_i (w_i \cdot t_i + w_i \cdot c_i + w_i \cdot q_i + w_i \cdot m_i) - \sum_j (w_j \cdot t_j + w_j \cdot c_j + w_j \cdot q_j + m_j \cdot l_j) = K^{ke+} - K^{ke-}; \quad (1)$$

$$K^{ke\%} = \frac{K^{ke+} - K^{ke-}}{K^{ke+}}$$

where K^{ke} – an indicator of the effectiveness of conflict management in the mental space of a portfolio of construction projects, which can be called the "conflict-effectiveness" indicator (in absolute terms);

w_i – weighting coefficients of each indicator in the overall assessment, determined by experts [0..1];

t_i – reduction in portfolio realization time due to constructive conflict resolution (in relative indices [0..1]), t_j – delay in portfolio realization time due to destructive conflict resolution (in relative indices [0..1]);

c_i – portfolio budget savings due to constructive conflict resolution (in relative indices [0..1]), c_j – portfolio budget overrun due to destructive conflict resolution (in relative indices [0..1]);

q_i – increase in the quality of portfolio products and processes due to constructive conflict resolution (in relative indices [0..1]), q_j – decrease in the quality of portfolio products and processes due to destructive conflict resolution (in relative indices [0..1]);

m_i – increase in the maturity level of the mental space of the portfolio due to constructive conflict resolution (in relative indicators [0..1]), m_j – decrease in the maturity level of the mental space of the portfolio due to destructive conflict (in relative indicators [0..1]);

i – counter of the number of conflicts that ended with an increase in the efficiency of the project portfolio;

j – counter of the number of conflicts that ended with a decrease in the efficiency of the project portfolio;

K^{ke+} – indicator of increasing the effectiveness of conflict management in the mental space of construction projects portfolio;

K^{ke-} – indicator of the decrease in the effectiveness of conflict management in the mental space of the construction project portfolio;

$K^{ke\%}$ – an indicator of the effectiveness of conflict management in the mental space of a portfolio of construction projects, which can be called the "conflict-effectiveness" indicator (in relative terms).

The "conflict-effectiveness" model should be part of the mental space. The presence of management conflicts is an obligatory element of every project and portfolio in the search for increasing the effectiveness of the management system.

The long-term result of managing the "conflict-effectiveness" model should be the harmonization of the values of the conflicting stakeholders and the stabilization and normalization of the mental space of the construction project portfolio.

Based on the research results, we propose a conceptual model of the mental space of EI-AI portfolio management (Fig. 1). In this model, the environment for implementing the mental space is the distributed communication environment of the participants in the construction project portfolio. Such an environment should be implemented on an appropriate IT platform. Examples of such platforms include Microsoft 365, Google Ecosystem, ERP-system or own development. The interaction of the participants in the construction project portfolio and stakeholders on the specified platform is based on the principles of EI-AI portfolio management (see Table 1). The implementation of the construction project portfolio is based on the project management methodology, which should contain a code of corporate culture in the knowledge base. Such a code should regulate activities in the mental space of the construction project portfolio and should contain the processes of such mental space. The development of such processes can be one of the vectors of further research in the chosen direction.

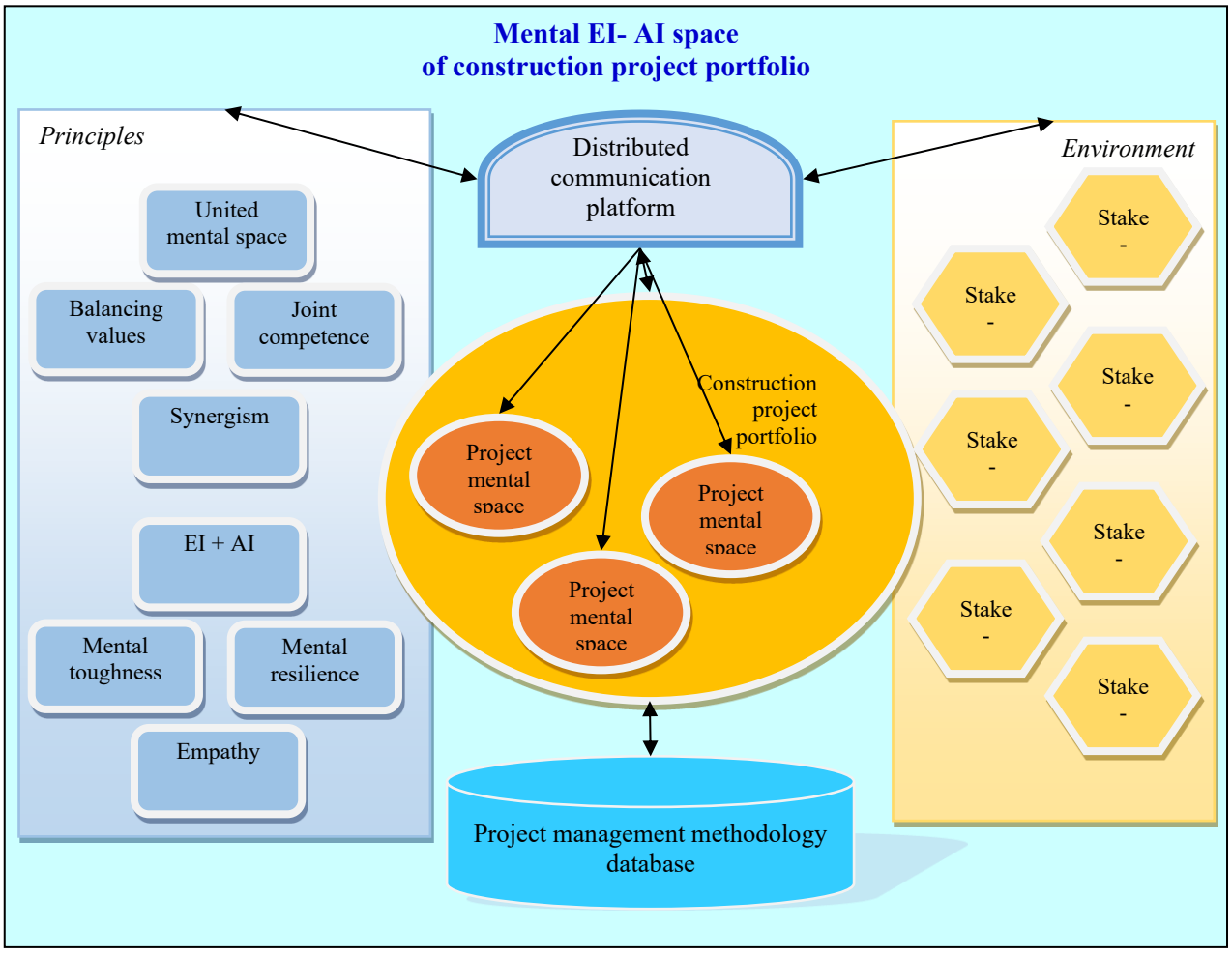

Figure 1. Conceptual model of the mental space of the EI-AI portfolio management

The conceptual model in set form can be represented by the formal seven:

$$S = <M, P, P^m, R^m, H, G, L> \quad (2)$$

where M – a set of models and methods included in the construction project management methodology;

G – a set of principles of the EI-AI mental space of construction project portfolio management;

P – a set of construction projects included in the portfolio and artifacts of such projects;

P^m – set of participants in the implementation of construction projects, including the project management team, the project team, teams from counterparties participating in the implementation of projects (including competency models and mental models of such participants);

R^m – set of participants in the construction project portfolio management team, including competency models and mental models of such participants;

H – set of stakeholders in the construction project portfolio, including competency models and mental models of stakeholder representatives;

L – set of processes for implementing mental space on a distributed communication platform.

A separate aspect of the functioning of the mental space in the modern turbulent environment of the construction project portfolio is the ability of the mental space to adapt and adjust to the environmental conditions. For this reason, one of the important processes of implementing and maintaining the mental space of the construction project portfolio is the tailoring process (according to the terminology of the PMBOK standard [1]). Let's identify the main artifacts of such a process, including:

- a set of participants in the mental space of the construction project portfolio (project implementation participants, project management teams, portfolio management team, stakeholders);
- a set of values of participants in the mental space of the construction project portfolio;
- a set of expectations of participants in the mental space of the construction project portfolio;
- models of response to risks, the source of which are participants in the mental space of the construction project portfolio;
- models of response to critical risks and catastrophic changes, the source of which is the turbulent environment of the portfolio;
- methods of adjusting the mental space of the construction project portfolio after the impact on the mental space of risks, changes and conflicts arising in the construction project portfolio.

It is important that the process of tailoring the mental space of the construction project portfolio to changes be:

- *described* – through questionnaires of the process participants, recording its main artifacts and features;
- *formalized* – presented in the form of business process models: UML, BPMN 2.0 or etc.;
- *automated* – implemented in the system of executed business processes in the corresponding specialized software product intended for this purpose.
- *integrated* into the system of processes for creating, implementing and maintaining the mental space of a portfolio of construction projects.

Let's conduct a SWOT analysis of the proposed approach to creating, implementing and maintaining the mental space of a portfolio of construction projects (Table 2).

We will conduct further analysis using the second (extended) form of SWOT analysis, we will highlight four cross-fields of the elements of the first form.

SO field (how to use Strengths to realize the Opportunities of the enterprise). Implementation of a strategy for institutionalizing communications with stakeholders of the construction project portfolio, creation of a permanent IT platform for such communications,

systematic work on preparing for each communication session. The adaptability of the approach allows us to adapt to the conditions of the construction company's reputation formation and take measures for its constant growth. The systematic approach allows us to take into account errors in the feedback loop and avoid them in future periods of project portfolio implementation. Improving the team's microclimate is able to reveal more of the creative potential of its participants, in particular regarding the expansion of the project portfolio as a result of successful communication with potential customers of construction projects.

ST field (how to avoid Threats using Strengths). The adaptability of the proposed approach can be formalized in the form of processes, in particular, in terms of responding to critical risks, thanks to which the construction project portfolio management system can be able to overcome (or effectively respond to) most of such risks. The improved team microclimate creates a mental space of goodwill, thanks to which it is possible to overcome or significantly mitigate the rejection of the approach by the middle management of the construction organization. Not only the declared, but also the implemented systematic approach to the development of the mental space can improve the perception by stakeholders of the opportunities associated with cooperation with the construction company, which can overcome or significantly mitigate their rejection of the proposed approach.

WO field (how to avoid external Weakness through Opportunities). Established effective cooperation with stakeholders can help a construction company overcome critical risks by involving stakeholders in such overcoming. The reputation of a construction company, which is enhanced by the development of the mental space approach, can dampen or even sublimate the rejection of the approach by the middle management of the construction organization, as a result of the communication of the portfolio management team with the middle management and proving the dependence of the company's success on the implementation of the mental space concept. A portfolio of construction projects, which is constantly expanding and replenished with new projects from new (or existing) customers, is able to overcome the rejection of the new approach by stakeholders and change their negative expectations to positive ones.

Table 2

SWOT analysis of the mental space approach to a construction project portfolio

Strengths	Weakness
1. Improving the microclimate of the portfolio management team and project management teams, resulting in increased management efficiency. 2. Systematic approach that combines the emotional intelligence of the team and the artificial intelligence of the decision support system for the construction project portfolio management team. 3. Adaptability of the approach, the possibility of its adjustment (tailoring) to the conditions of construction organizations, ensuring the possibility of its effective functioning in the conditions of the modern turbulent project environment.	1. The complexity of the approach, which requires highly qualified project management specialists to implement it, who would simultaneously possess competencies in at least three areas – the construction industry, project management, emotional intelligence. 2. Insufficient testing of the proposed approach in the practice of construction organizations. 3. High dependence of the success of the approach implementation on the construction project portfolio manager and the project manager for the implementation of the approach to create, implement and maintain the mental space of the construction project portfolio.
Opportunity	Threats

1. Establishing effective cooperation among stakeholders of both the construction project portfolio as a whole and individual projects included in the portfolio. 2. The possibility of increasing the reputation of the construction organization (company) as a result of the successful implementation of the approach to creating, implementing and maintaining the mental space of the construction project portfolio. 3. The possibility of expanding the construction project portfolio, adding new projects to the portfolio from new customers as a result of such an effectively functioning mental space of the portfolio.	1. The threat of deterioration of the functioning of the mental space of the construction project portfolio due to the excessive criticality of risks, the source of which is the turbulent project environment, and the inability of the mental space to effectively dampen such risks. 2. The threat of non-acceptance of the approach by the middle management of the construction organization (company), as a result of which the implementation of the approach will be sabotaged, which will cast doubt on both its effectiveness and the possibility of completing the implementation. 3. Non-acceptance of the new approach by stakeholders of the construction project portfolio, with whom it will not be possible to establish effective relationships, as a result of which the reputation of the construction organization may weaken.

WT field (what could be the worst development option for the enterprise when imposing Threats on Weaknesses, and how to counteract it). As part of the implementation of the strategy of getting rid of weaknesses to overcome the looming threats, a construction company implementing the concept of mental space development can apply the following. The work of the project portfolio management team to simplify the perception of the approach by the participants and stakeholders of the portfolio, or simplify the approach to the extent that its essence will remain unchanged, but redundant elements for the construction organization will be removed. That is, the implementation of minimally sufficient functionality to implement the concept of mental space. Insufficient testing of the approach can be compensated for by its implementation according to the agile principle (for example, according to the Scrum framework). Then, after each sprint, in the retrospective of such a sprint, knowledge can be accumulated about the features of the implementation. Thus, with each subsequent sprint, competence in testing the approach will be created and increased, and implementation participants will develop the appropriate competencies. Overcoming the high dependence of the success of the approach implementation on the portfolio manager and the project manager of the approach implementation can be overcome by formalization - a description of the approach processes and their automation. This (among other things) will also help prevent the approach from being rejected both inside and outside the construction company.

CONCLUSIONS

Modern conditions for the implementation of construction project portfolios require the use of new scientific approaches. One of the directions for the development of such approaches should be considered the integration (hybridization) of models and methods of portfolio management, another important one is the consideration of the emotional component and emotional intelligence of participants in the implementation of the portfolio. This is especially important for the construction industry, where there is a significant gap in the mental space of project executors and project and portfolio management teams. Therefore, the combination of the emotional intelligence of participants in the construction

project portfolio, additionally with the use of artificial intelligence in management tools, is appropriate for the creation, functioning and development of the mental space of construction projects. And the creation of models of such a space is an urgent scientific task that potentially has significant practical value in the harsh conditions of the implementation of modern construction projects, in particular projects for the restoration of the infrastructure of Ukraine.

This article analyzes standards, methodologies and scientific works in the field of project management that can serve as a scientific basis for developing an approach to creating, implementing and maintaining the mental space of a construction project portfolio. The existing definitions of mental space are analyzed. Based on the analysis conducted, taking into account the characteristics of the construction industry, our own definitions are proposed (mental space of a construction project portfolio, mental stability of participants and stakeholders of a construction project portfolio, processes of ensuring the effective functioning of the mental space of a construction project portfolio). These definitions can form the basis of a thesaurus of the researched direction. A set of principles for creating, implementing and maintaining the mental space of a construction project portfolio is proposed. The features of creating, implementing and maintaining mental space in the field of implementing a construction project portfolio are identified. The "conflict-effectiveness" model is proposed for the development of mental space models. Based on the research results, we propose a conceptual model of the mental space of EI-AI portfolio management, the specified model is presented in the plural form. One of the important processes of implementation and support of the mental space of the portfolio of construction projects is described - the process of tailoring. A SWOT analysis of the proposed approach in the first and second forms is conducted. According to the results of such analysis, the proposed approach can be considered viable.

Let us formulate vectors of further research in the chosen direction:

- expansion of the thesaurus of the mental space of construction projects;
- development of models of the types of the construction projects portfolio mental space, a separate possible direction is the development of the mental space models for different types of portfolios;
- description and formalization of the processes of ensuring the effective functioning of the mental space of the construction projects portfolio;
- testing of the proposed approach to the creation, implementation and maintenance of the mental space of the construction projects portfolio at construction enterprises;
- preparation of methodological materials on projects for the implementation of the specified approach, with the possibility of using such materials in the educational process in higher education institutions.

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