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Applying the Project Portfolio Management Maturity Level Selection Method to an Organization

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ABSTRACT The purpose of the paper is to create and apply a method for selecting the maturity level of an organization in the field of project portfolio management. A method for assessing the maturity level of an organization in the field of project portfolio management is proposed. The method is based on assessing the application of principles, functions, life cycle, specialized organizational structure, prescribed roles, and responsibilities for their implementation in managing a portfolio of projects. A distinctive feature of the method is that the evaluation uses a generalized table of project portfolio management processes. The functions performed should be reflected in this table. A method is proposed for choosing the maturity level of an organization's project portfolio management based on the optimization of the maturity level and costs of project portfolio management. The method is applied to select a rational level of maturity of project portfolio management for a technical university.

KEYWORDS project portfolio; management; maturity level; cost; assessment; optimization; selection; application.

I. INTRODUCTION

PROJECT portfolio management is used by many large and medium-sized organizations in almost all sectors of the economy. Significant progress has been made in this area. Standards and guidelines for managing project portfolios have been established and widely applied. Among the most common standards and guidelines is [1]. In recent years, many well-known standards and guidelines have been refined to fit not only predictive but also agile project life cycles. Approaches to project portfolio management, specifically focused on agile project life cycles, have been developed [2, 3]. Many computer programs have been developed to manage project portfolios. Their number is measured in dozens.

Despite significant advances in this area, the implementation and development of project portfolio management in a particular organization remains a complex problem. To solve it, it is necessary to answer the question: "should I apply some standard or guidelines for managing a portfolio of projects, create my own standard, or be guided by the intuition, knowledge and experience of managers and do without formalizing these tasks?" A lot depends on the answer to this question. In [4], we defined the level of maturity of an organization in the field of project portfolio management as the level of using the capabilities of project portfolio management.

In paper [5] a systematic literature review was carried out on maturity models of various orientations. For the period from 1976 to 2017, 409 articles on this topic were identified. Of these, 202 articles are devoted to the development of maturity models (49%), 100 articles describe the application of these models (25%), 12 articles are devoted to validation of maturity models (3%). Among the articles reviewed, 32 papers were devoted to maturity models in project management and project portfolio management. Among them, 10 articles were devoted to the development of maturity models, 15 – applications, 7 – Meta-analysis and others.

The paper [6] performed bibliometric analysis of literature on maturity models from 2004 to 2014. It is shown that most publications on maturity models were done in computer science. The conclusion is based on publications that are contained in the Scopus database.

II. RELATED WORKS

Maturity models in the field of project, program and portfolio management have become widespread in recent years. The maturity model should help the organization assess the level of skills of the personnel, the application of best practices, identify strengths, weaknesses, opportunities, and threats.

It should be noted that the goals of applying maturity models can be descriptive, prescriptive, and comparative [7, 8].

There are currently two approaches to creating maturity models: top-down and bottom-up [9]. Assessment of maturity levels can be carried out using both qualitative [10, 11] and quantitative indicators [12]. The problem of creating and applying maturity models is considered in the works [7, 9]. The cycle of development and application of maturity models is proposed in the work [9].

Among the maturity models, the best known is the CMMI® V2.0 model and its predecessors [13]. The CMMI defines Practice Areas. These include: Estimating, Planning, Monitor and Control, Causal Analysis and Resolution, Decision Analysis and Resolution, Configuration Management, Managing Performance and Measurement, Process Management, Process Asset Development, Requirements Development and Maintenance, Process Quality Assurance, Verification and Validation, Peer Reviews, Risk Management, Organizational Training, Governance, Implementation Infrastructure.

Practical areas are divided into Practice groups, and those, in turn, into Practices. To assess the level of maturity in each practice area, a scale of maturity levels of the organization is proposed.

At the Initial (1st) level, the processes in the organization are unpredictable, poorly controlled, appear in response to certain events. At the 2nd level (Managed), processes are defined at the project level, often processes appear in response to certain events. At Level 3 (Defined), processes are defined at the level of the entire organization and are proactive. At the 4th level (Quantitatively Managed), processes are measured and controlled. The highest 5th level is called Optimizing. At this level, the organization is focused on improving processes. The disadvantages of the CMMI® V2.0 model include its rather high complexity and cost.

In [14], a list of best (advanced) practices for managing portfolios, programs and projects is proposed. Best practices include implementing PMI standards for portfolio, program, and project management. For example, the following best practices are suggested for the Develop Project Charter process from the PMBOK Guide®: Standardize Develop Project Charter process, Measure Develop Project Charter process, Control Develop Project Charter process, Improve Develop Project Charter process. When it comes to portfolio management, the list of best practices includes 130 such practices. Each Best Practice contains a Capability and each Capability gives an Outcome. The evaluator should evaluate the implementation of each of the best practices in the organization based on the study of the organization. This can be done by answering the question of whether there is an Outcome for the Capability of best practice or not, or how often the result appears for the Capability of best practice. To apply [14] in an organization, training is required.

The standard [15] identifies five groups of organizational competencies:

- Project, Program and Portfolio governance;
- Project, Program and Portfolio management;
- Project, Program and Portfolio alignment;
- Project, Program and Portfolio resources;
- Project, Program and Portfolio people's competences.

In total, 18 competencies are considered, including Portfolio management. In relation to Portfolio management, it describes what an organization must do to successfully manage a portfolio. There are 7 questions that need to be answered during the assessment. When assessing the competence of an organization, the IPMA Delta approach can be used. In turn, this approach uses competency classes similar to the five levels of maturity adopted in CMMI.

The model [16] also uses five levels of maturity, similar to CMMI. For each maturity level, a question regarding project, program, or portfolio management is proposed to be answered. Each maturity level has its own process areas. For level 1 – 2 areas, for level 2 – 11 areas, for level 3 – 12 areas, for level 4 – 4 areas, for level 5 – 3 areas. The only process area directly related to portfolio management, the Organization portfolio establishment, is maturity level 3. For each process area, the model provides functional achievement / process goals, approach, deployment, consideration, perception, performance indicators.

In [17], a PMMM maturity model is proposed. The model assumes the presence of five levels of maturity: Level 1 – Common language, Level 2 – Common processes, Level 3 – Singular methodology, Level 4 – Benchmarking, Level 5 – Continuous improvement. The author gave descriptions of the features of each level and suggested questions to ask specialists in the company. The correct answers to these questions are given. If the total score for all questions is greater than a certain threshold, this means that the company can start working on the next level of maturity. To assess the level of maturity of the company, it is necessary to select a set of specialists who must pass the specified survey. The questions listed for all five levels do not address portfolio management issues. Although, when describing the features of level 5, considerable attention was paid to project portfolio management.

PPM Express Corporation has defined five levels of portfolio management maturity: Initial, Emerging Discipline, Initial Integration, Effective Integration, and Effective Innovation [18]. PPM Express Corporation is the creator of a modern platform for managing an organization's portfolio using artificial intelligence and machine learning.

In [19], the analysis of existing maturity models was carried out. The complexity of these models was noted among their weaknesses. The paper proposes a model for assessing the maturity of project portfolio management. A feature of the model is the evaluation of portfolio management concepts, processes, and documents. In doing so, the authors use both quantitative and qualitative assessments.

On the site [20], you can perform a self-assessment of the organization and the project management office. Self-assessment is carried out by answering a series of questions. Self-assessment results are given in the form of three assessments: the percentage of the organization's readiness, the adequateness of your abilities, and the state of the internal conditions. After self-assessment of the organization, a set of recommendations is issued. Self-assessment can be performed independently by several employees so that the results can be compared, and the conclusions clarified.

Among the existing maturity models, one should pay attention to the PPM Maturity Assessment Calculator [21]. Its advantage is that it is designed specifically for assessing the maturity of an organization's portfolio management. This tool allows you to get an integral numerical assessment of the maturity of the organization, which is another important advantage. In the PPM Maturity Assessment Calculator, an organization's maturity is assessed by assessing how the assigned project portfolio management functions are being performed.

Among the maturity models that are focused not on the management of project portfolios, but on other areas, the models [22, 23] should be noted.

In [22], a model of the maturity of outsourcing in the IT industry is proposed. This model defines three stages of IT outsourcing maturity: cost, resource, partnership. The paper lists 11 benchmark variables that are used to determine the level of maturity of a company. The results of a survey of 116 largest companies from Norway are presented, which showed that 52% of them are at the stage of costs, 39.7% are at the stage of resources and only 7.8% have risen to the stage of the partnership.

It is proposed [23] to assess the maturity of the development of new services in terms of the implementation of four groups of processes: strategy management, formalization of processes, knowledge management, and customer engagement. Parameters and maturity levels are described for each process group.

Analysis of the existing maturity models in the field of project portfolio management showed that most of them are quite difficult to apply. To assess the maturity of an organization using these approaches, it is necessary to attract certified specialists. This is costly and time consuming. At the same time, there are publicly available tools that employees can use to self-assess the maturity of an organization. However, it is important for an organization not only to assess the current level of maturity, but also to assess how much it will cost to reach a certain level of maturity in the future. Further, it is relevant for many organizations to choose the optimal level of maturity, which will allow finding a compromise between the capabilities of project portfolio management and cost.

The purpose is to create and apply a method for selecting the level of maturity of an organization in the field of project portfolio management.

III. PROPOSED METHOD

The approach to managing a portfolio of projects in an organization is carried out with varying degrees of obligation and formalization. It can be implemented as an organizational standard, or it can be self-initiated by the portfolio management team. The individual components of the approach can be applied separately, without proper consistency. The organizational structure may not correspond to the accepted approach and be a brake on the way of its development. Roles and responsibilities may not be formally approved. These and other circumstances indicate different levels of maturity of portfolio management in the organization. It should be borne in mind that different levels of management maturity require different efforts to achieve them and, accordingly, costs. It turns out that the choice of approach to project portfolio management does not fully determine the effort and costs that will be required. It is necessary to determine not only the approach but also the level of its application, i.e., the maturity of the organization's portfolio management.

In the process of solving the problem under consideration, we proceeded from the following three hypotheses.

Hypothesis 1. There is a set of portfolio management processes that will ensure the quality of portfolio delivery in accordance with best practices.

Hypothesis 2. Implementation of this set of processes is rather laborious and expensive.

Hypothesis 3. Failure to perform or poor-quality performance of the processes of a given set increases risks or generates them.

A method is proposed for assessing the maturity of an organization in the field of project portfolio management [4], which is based on these hypotheses. A feature of the method is that the methodology of project portfolio management applied in the organization or considered should be presented in a generalized table of processes [24]. Assessment of the level of maturity is carried out, inter alia, by assessing the level of performance of functions on the generalized table of processes. In determining the level of maturity, the components of the methodology may have different weights. The evaluator, examining the state of portfolio management in the organization, answers the questions of the questionnaire. The evaluator can be a specialist in the field of project portfolio management, who owns the methodologies, standards, guidelines included in the generalized body of knowledge on project portfolio management [24].

The survey questions are divided into four parts. The first part deals with the application of the principles of portfolio management in the organization. Five answer options are given, from which the evaluator must choose one.

1. The principles of project portfolio management are not used.

2. The principles of portfolio management are applied sporadically. There are no formalized processes for their application.

3. The principles of project portfolio management are applied regularly. The processes of their application are not formalized.

4. The principles of portfolio management are applied regularly. The processes of their application are formalized. The organization is not committed to improving the application of these principles.

5. The principles of project portfolio management are applied regularly. The processes of their application are formalized. The organization is working to improve the application of these principles.

The second part of the questionnaire evaluates the performance of portfolio management functions in the organization. The assessment is carried out according to the generalized table of project portfolio management processes (table 1 and table 2 [24]). In this case, a function is understood as the execution of a process at the intersection of a group of processes and a knowledge area of the generalized table of processes. The questionnaire is filled in for each cell of the generalized table. The evaluator must choose the most correct answer.

1. The portfolio management function is not performed.

2. The portfolio management function is performed sporadically. There is no formalized process for its implementation.

3. The portfolio management function is performed regularly. The execution process is not formalized.

4. The project portfolio management function is performed regularly. The execution process is formalized. The organization is not committed to improving the performance of this function.

5. The project portfolio management function is performed regularly. The execution process is formalized. The organization is working to improve the performance of this function.

There are two processes at the intersection of "the Determination of Goals and Criteria, Management Principles, Methods for Achieving Goals, Resources, and Appointment of a Portfolio Manager" process group and "the Portfolio Strategic Management" Knowledge Area. Therefore, questions should be addressed to each of them separately.

The question of the questionnaire, included in its third part, relates to the application of the concept of "life cycle of a project portfolio". The evaluator must choose one of the answers.

1. The project portfolio life cycle is not applied.

2. The life cycle of a portfolio of projects is applied sporadically. There are no formalized processes for its implementation.

3. The project portfolio life cycle is applied regularly. Its implementation processes are not formalized.

Table 1. The proposed processes

Knowledge Areas	Process Groups			
	Determination of Goals and Criteria, Management Principles, Methods for Achieving Goals, Resources, and Appointment of a Portfolio Manager	Preliminary Selection of Components	Balancing (Optimization) of a Portfolio	Authorization of Components
Portfolio Strategic Management	1. Development and approval of the charter of the portfolio 2. Development of a portfolio management plan	3. Preliminary selection, evaluation, and categorization of potential components	4. Portfolio optimization within the categories and the whole portfolio	5. Component authorization
Portfolio Performance Management	11. Development of a portfolio performance management plan	12. Evaluation of the effectiveness of potential components		
Portfolio Communication Management	14. Development of a plan for interaction with stakeholders	15. Communication with stakeholders during the pre-selection process	16. Exchange of information with stakeholders in the process of portfolio optimization	
Portfolio Risk Management	21. Developing a risk management plan	22. Risk assessment of potential components		

Table 2. The proposed processes (continued)

Knowledge Areas	Process Groups				
	Monitoring and Control				Closing of Components
	Accounting and forecasting	Control	Analysis	Decision making	
Portfolio Strategic Management	6. Portfolio performance accounting and forecasting	7. Portfolio monitoring	8. Analysis of portfolio performance	9. Decision making	10. Component closure
Portfolio Performance Management	13. Monitoring and managing portfolio performance				
Portfolio Communication Management	17. Exchange of information with stakeholders on the results of accounting and forecasting portfolio performance	18. Exchange of information with stakeholders on the results of monitoring portfolio performance.	19. Exchange of information with stakeholders on the results of portfolio performance analysis	20. Exchange of information with stakeholders on the decisions taken	
Portfolio Risk Management	23. Portfolio risk monitoring and management				

4. The project portfolio life cycle is applied regularly. The processes of its implementation are formalized. The organization is not committed to improving the performance of the portfolio life cycle.

5. The project portfolio life cycle is applied regularly. The processes of its implementation are formalized. The organization is committed to improving the performance of the project portfolio life cycle.

Using the question of the questionnaire included in its fourth part, they assess the presence of a specialized organizational structure for managing a portfolio of projects, prescribed roles, and responsibilities for their implementation. Answer options may be as follows.

1. The specialized organizational structure, roles and responsibilities of the organization's portfolio management are absent or formally exist but are not used.

2. The specialized organizational structure, roles and responsibilities of the organization's portfolio management are applied sporadically. This organizational structure, roles and responsibilities are not implemented on an ongoing basis.

3. The specialized organizational structure, roles and responsibilities of the organization's portfolio management are applied regularly but are not formally implemented in the organization.

4. The specialized organizational structure, roles and responsibilities of the organization's portfolio management are formally put in place and are regularly used.

5. The specialized organizational structure, roles and responsibilities of the organization's portfolio management are formally put in place and are regularly used. The organization is committed to improving the organizational structure, roles and responsibilities of the organization's portfolio management.

After filling out all the questionnaires, the points are calculated. If an affirmative answer is received for option 1, then 1 point is awarded, for option 2 – 2 points and so on, for option 5 – 5 points.

Each questionnaire and, accordingly, the factor that is assessed has a weight:

q_i, $i=\overline{1,n}$, $1 \geq q_i \geq 0$, $\sum_{i=1}^{n} q_i = 1$, n – the number of questionnaires in the study. In this case $n = 26$.

To set the weights q_i, we used assessments of the consequences of risk events, which are that the principles, processes, life cycle, organizational structure do not use. The consequences of potential risks are proposed to be assessed on a five-point scale. The maximum score "5" corresponds to the maximum negative consequence of the risk. The following grading system can be adopted:

5 points – disastrous consequences for the organization,

4 points – the loss of very significant benefits for the organization, which will make it difficult to achieve its strategic goals,

3 points – loss of noticeable benefits for the organization,

2 points – loss of benefits that will not affect the achievement of the strategic goals of the organization,

1 point – insignificant loss of benefits for the organization.

Table 3 shows the assessments of potential risks in case of non-implementation of the relevant processes, presented by the authors.

The consequences of non-fulfillment (non-application) of the principles, life cycle, organizational structure was given 5 points. We added the scores of all consequences and received 104. Next, the score of each component was divided by 104 and received the weight of each component.

The final assessment of the organization's maturity is obtained by formula:

Table 3. Consequences of risks arising from non-execution of the process

Knowledge Areas	Process Groups									
	Determination of Goals and Criteria, Management Principles, Methods for Achieving Goals, Resources, Appointment of a Portfolio Manager		Preliminary Selection of Components	Balancing (Optimiza-tion) of a Portfolio	Authorizatio n of Components	Monitoring and Control				Closing of Components
						Accounting and Forecasting	Control	Analysis	Decision Making	
Portfolio Strategic Management	5	5	4	5	3	3	3	3	3	3
Portfolio Performance Management	4		3	-	-	4				-
Portfolio Communication Management	5		4	4	-	4	4	4	4	-
Portfolio Risk Management	4		4	-	-	4				

$$M = \sum_{i=1}^{n} q_i m_i , \qquad (1)$$

where m_i – is the score gained when filling out the i-th questionnaire, q_i - is the weight of the i-th questionnaire (factor), n - is the number of questionnaires in the study.

The described method can be applied not only to assess the already achieved level of maturity of the organization in the field of project portfolio management, but also to select the potential optimal level of maturity of the organization, considering its capabilities.

The following method is proposed for choosing the level of maturity of an organization's portfolio management.

1. Combinations of principles, rules, processes, practices, life cycle, organizational structure, and prescribed roles of project portfolio management are selected, which are potentially suitable for a given organization. Such combination is a project portfolio management methodology [4]. For each considered methodology, the possible levels of application of its components are set in the sense corresponding to the questions of the questionnaires when assessing the level of maturity of the organization. As a result, we get h potentially suitable combinations of principles, rules, processes, practices, life cycle, organizational structure, prescribed roles of project

portfolio management and the degree of their implementation that are potentially suitable for a given organization.

2. The number of the considered variant of the methodology for managing the portfolio of the organization's projects and the degree of its implementation is set $j = 1$.

3. The j-th version of the methodology for managing a portfolio of projects of the organization and the degree of its implementation is considered. Assuming that this combination will be applied, the organization's potential maturity in portfolio management is assessed. The resulting estimate will be called M_j.

4. Costs C_{impl} for the implementation of the considered methodology for managing a portfolio of projects of the organization are estimated at a given degree of its implementation, as well as the current costs C_{pl} for its implementation during the planning period T. Average annual costs are calculated:

$$C_j = \frac{C_{impl} + C_{pl}}{T}.$$

5. If $j < h$, assignment $j := j + 1$ is made. Let us move on to point 3 of the method.

6.Using one of the methods for solving multicriteria problems, the problem is solved:

$$j = \arg\max_j \{M_j, -C_j\}_{j=1}^{h}. \quad (2)$$

As a result, the optimal methodology for managing the portfolio of projects and the degree of its implementation will be found, i.e., optimal maturity level.

To solve the two criteria problem under consideration, one can propose to make a choice based on the criterion:

$$K_j = \frac{M_j}{C_j},\ j = \overline{1,h}. \quad (3)$$

In this case, the combination of performing the functions of managing the organization's portfolio of projects is better, in which the ratio of the assessment of the organization's maturity to the costs of managing the portfolio is greater. K_j is an assessment of the effectiveness of portfolio management in an organization.

IV. CASE STUDY

Let us consider the application of the proposed method to select a rational level of maturity of project portfolio management at a technical university. For several reasons, the name of the university is not given in the article.

Regarding the university in question, the following answers to the questionnaire were received. The questionnaires were completed by the authors of this article.

Answer to the question included in the first part was rated 2 points, i.e., portfolio management principles are applied sporadically. There are no formalized processes for their application.

The ratings of the answers to the questions included in the second part are presented in Table 4.

The assessment of answer to the question included in the third part was 4 points, i.e., the project portfolio life cycle is applied regularly. The processes of its implementation are formalized. The organization is not committed to improving the performance of the portfolio life cycle.

Table 4. Performance of project portfolio management functions in points

Knowledge Areas	Process Groups									
	Determination of Goals and Criteria, Management Principles, Methods for Achieving Goals, Resources, Appointment of a Portfolio Manager		Preliminary Selection of Components	Balancing (Optimization) of a Portfolio	Authorization of Components	Monitoring and Control				Closing of Components
						Accounting and Forecasting	Control	Analysis	Decision Making	
Portfolio Strategic Management	3	3	2	3	4	4	4	3	3	4
Portfolio Performance Management	1		2	-	-	3				-
Portfolio Communication Management	2		2	1	-	3	3	3	2	-
Portfolio Risk Management	1		1	-	-	1				-

The answer to the question included in the fourth part was estimated at 4 points or a specialized organizational structure, the roles and responsibilities of the organization's portfolio management are formally put in place and are regularly used.

The final assessment of the organization's maturity is obtained by formula (1). In our case, we got 2.59 points.

The costs of performing processes for managing a portfolio of projects during the year are calculated in 2021 prices. When estimating the costs, we considered the salary of the head of the research department of the university and five employees of this department. It is this team that manages the portfolio of projects at the university. For each process, it was assessed how many employees and how many days it took to complete it. Costs in thousands of UAH for the existing project portfolio management methodology are presented in Table 5.

Under the existing portfolio management methodology, UAH 423.5 thousand is spent on project portfolio management in year.

To increase the level of maturity of project portfolio management at the university, it is necessary to introduce the regular application of the principles of project portfolio management, formalize the processes of their application, improve the implementation of existing portfolio management processes, and introduce new processes that are not yet implemented.

Improving the execution of processes, mastering new ones, formalizing processes can be implemented by introducing a computerized management system for a portfolio of projects and university projects. Jira Portfolio Commercial can be used as such a system [25].

When implementing Jira Portfolio Commercial, the maturity score must be recalculated. For answer to the question included in the first part, you can put a point 4, since increasing the level of maturity of the organization requires the regular application of the principles of project portfolio management and formalization of the processes of their application. With further improvement in the application of portfolio management principles, the score can be changed to 5.

In this case, the estimates of the answers to the questions included in the second part will take the form shown in Table 6.

The scores for the answers to the questions included in the third and fourth parts will be kept at the level of 4 points, i.e., the project portfolio life cycle is applied regularly. The processes of its implementation are formalized.

Table 5. Costs in thousand UAH for the existing project portfolio management methodology

Knowledge Areas	Process Groups								
	Determination of Goals and Criteria, Management Principles, Methods for Achieving Goals, Resources, Appointment of a Portfolio Manager	Preliminary Selection of Components	Balancing (Optimiza-tion) of a Portfolio	Authorizatio n of Components	Monitoring and Control				Closing of Components
					Accounting and Forecasting	Control	Analysis	Decision Making	
Portfolio Strategic Management	16,5	38, 5	27,5	16,5	27,5	27,5	16,5	16,5	16,5
Portfolio Performance Management	-	82,5	-	-	60,5				-
Portfolio Communication Management	5,5	5,5	-	-	16,5	16,5	16,5	16,5	-
Portfolio Risk Management	-	-	-	-	-				-

The organization is not committed to improving the performance of the portfolio life cycle. The specialized organizational structure, roles and responsibilities in the organization's portfolio management are formally put in place and are regularly used.

As a result of work to improve the management of the organization's portfolio of projects, the assessment of its level of maturity in this area will be 3.34 points, i.e., will grow significantly.

The salary costs of portfolio management staff (including taxes) following the implementation of Jira Portfolio Commercial are shown in Table 7.

After the introduction of a computerized project portfolio management system, the cost of carrying out portfolio amounts to UAH 346.5 thousand (in 2021 prices). The cost of purchasing a license for the software product Jira Portfolio Commercial 500 Users (Atlas15448040) is 346.64 thousand UAH [22]. We assume that we will use the product for 5 years. As a result, the cost of software for one year will be equal to UAH 69.328 thousand. The total costs of purchasing a software product and performing processes for managing a portfolio of projects will amount to UAH 415.8 thousand in a year.

To solve the problem of choosing the optimal level of maturity, we will use the criterion (3), whose combination of performing the functions of managing the organization's portfolio of projects is better, in which the ratio of the assessment of the organization's maturity to the cost of managing the portfolio is greater.

Table 6. Performance of project portfolio management functions in points

Knowledge Areas	Process Groups									
	Determination of Goals and Criteria, Management Principles, Methods for Achieving Goals, Resources, Appointment of a Portfolio Manager		Preliminary Selection of Components	Balancing (Optimiza-tion) of a Portfolio	Authorizatio n of Components	Monitoring and Control				Closing of Components
						Accounting and Forecasting	Control	Analysis	Decision Making	
Portfolio Strategic Management	3	3	3	3	4	4	4	3	3	4
Portfolio Performance Management	3		3	-	-	4				-
Portfolio Communication Management	3		3	4	-	3	3	3	3	-
Portfolio Risk Management	3		3	-	-	3				-

Table 7. Costs in thousands of UAH after the introduction of a computerized portfolio management system

Knowledge Areas	Process Groups								
	Determination of Goals and Criteria, Management Principles, Methods for Achieving Goals, Resources, Appointment of a Portfolio Manager	Preliminary Selection of Components	Balancing (Optimiza-tion) of a Portfolio	Authorizatio n of Components	Monitoring and Control				Closing of Components
					Accounting and Forecasting	Control	Analysis	Decision Making	
Portfolio Strategic Management	16,5	38,5	27,5	16,5	5,5	5,5	16,5	16,5	16,5
Portfolio Performance Management	5,5	82,5	-	-	27,5				-
Portfolio Communication Management	5,5	5,5	5,5	-	5,5	5,5	5,5	5,5	-
Portfolio Risk Management	5,5	5,5	-	-	22				-

With the existing approach to project portfolio management, we will get $K_1 = 6{,}11$ points / million UAH. When improving project portfolio management, including the introduction of a computerized project portfolio management system, $K_2 = 8{,}03$ points / million UAH. Thus, improving project portfolio management in an organization is advisable.

V. DISCUSSION

Establishing portfolio management in an organization requires choosing an approach to fulfill this complex and responsible function. The concept of the approach includes principles, rules, processes, practices, life cycle, organizational structure, prescribed roles, which are complemented by tools and methods for implementing processes, document templates.

However, choosing a specific approach to portfolio management does not guarantee success. Much depends on the level of use of the portfolio management capabilities in the organization, i.e., on the level of its maturity. Several maturity models are known in the field of project, program, and portfolio management. Analysis of the existing maturity models showed that most of them are quite difficult to apply. It is important for an organization not only to assess the current level of maturity, but also to assess how much it will cost to bring it to a certain level of maturity in the future. For many organizations, it is important to choose the optimal maturity level that will allow you to find a compromise between future portfolio management capabilities and cost.

The purpose of the paper was to create and apply a method for choosing the level of maturity of an organization in the field of project portfolio management.

In contrast to [13-17], the paper proposes a method for assessing the level of maturity of an organization in the area of project portfolio management. The use of the generalized body of knowledge on project portfolio management [24] made it possible to propose a breakdown of all the questions in the

questionnaire into four parts: an application of the principles of project portfolio management in an organization, a performance of functions (processes) of project portfolio management in an organization, application of the concept of "life cycle of a project portfolio", availability of a specialized organizational structure for managing a portfolio of projects, defined roles and responsibilities for their implementation. It is these parts that form the structure of the generalized body of knowledge.

For comparison, the PPM Maturity Assessment Calculator [21] breaks the questionnaire questions into six subcategories: portfolio governance, portfolio definition, portfolio optimization, resource management, performance management, and project portfolio data and analysis.

A distinctive feature of the method is that the evaluation uses a generalized table of project portfolio management processes. The functions performed should be reflected in this table. Each function in the table is assigned a weight. Weights are also assigned to all other components of the portfolio management approach. To set the weights, we used assessments of the consequences of risk events, which the principles, processes, life cycle, organizational structure do not use. The consequences of potential risks are proposed to be assessed on a five-point scale.

A method is proposed for choosing the maturity level of an organization's project portfolio management based on the optimization of the maturity level and costs of project portfolio management.

VI. CONCLUSION

The method for choosing the maturity level of an organization's project portfolio management is applied to select a rational level of maturity of project portfolio management at a technical university.

Using the questionnaires described in the paper, the authors evaluated the application of the principles, project portfolio management functions, the life cycle of the project portfolio, a specialized organizational structure for managing the project portfolio, the prescribed roles, and responsibilities for their implementation. The maturity score of the university in the field of project portfolio management was 2.59 points.

To increase the level of maturity of project portfolio management at the university, it is necessary to introduce the regular application of the principles of project portfolio management, formalize the processes of their application, improve the implementation of existing portfolio management processes, and introduce new processes that are not yet implemented. The solution to these problems can be achieved by computerizing processes. Jira Portfolio Commercial can be used as a tool for computing. At the same time, the level of maturity of the university will rise to 3.34 points.

Comparison of the level of maturity and the cost of management (3) showed that improving the level of maturity is advisable. With the introduction of computerization of project portfolio management, this ratio will increase by 1,31 times. This conclusion can be used when making decisions regarding the further development of project portfolio management at a technical university.

References

[1] *The Standard for Portfolio Management*, 4th ed., PMI, 2017.

[2] *SAFe 5 for Lean Enterprises,* 2021, [Online]. Available at: https://www.scaledagileframework.com/

[3] *The Scrum@Scale Guide,* Version 2.1, January 2021, 2021, 22 p.

[4] I. Kononenko and M. Kpodjedo, "Method of selecting the maturity level of an organization when managing a project portfolio," *Proceedings of the 2020 IEEE 15th International Scientific and Technical Conference on Computer Sciences and Information Technologies, (CSIT),* 2020, 2, pp. 207–210. https://doi.org/10.1109/CSIT49958.2020.9321958.

[5] J. Batista Sarmento dos Santos-Neto, A. P. Cabral Seixas Costa "Enterprise maturity models: a systematic literature review," *Enterprise Information Systems,* vol. 13, issue 5, pp. 719-769, 2019. https://doi.org/10.1080/17517575.2019.1575986.

[6] T. L. Reis, M. A. S. Mathias, O. J. Oliveira, "Maturity models: identifying the state-of-the-art and the scientific gaps from a bibliometric study," *Scientometrics,* vol. 110, issue 2, pp. 643–672, 2017. https://doi.org/10.1007/s11192-016-2182-0.

[7] T. de Bruin, M. Rosemann, R. Freeze and U. Kulkarni, "Understanding the main phases of developing a maturity assessment model," *Proceedings of the 16th Australasian Conference on Information Systems ACIS'2005,* Sydney, NSW, Australia, November 29 – December 2, 2005.

[8] M. Röglinger, J. Pöppelbuß, J. Becker, "Maturity models in business process management," *Business Process Management Journal*, vol. 18, no. 2, pp. 328-346, 2012, https://doi.org/10.1108/14637151211225225.

[9] T. Mettler, "Maturity assessment models: A design science research approach," *International Journal of Society Systems Science,* vol. 3, issue 1–2, pp. 81–98, 2011. https://doi.org/10.1504/IJSSS.2011.038934.

[10] W. Guédria, Y. Naudet, D. Chen, "Maturity model for enterprise interoperability," *Enterprise Information Systems*, vol. 9, issue 1, pp. 1-28, 2015. https://doi.org/10.1080/17517575.2013.805246.

[11] G. Leal, W. Guédria, H. Panetto and M. Lezoche, "Towards a comparative analysis of interoperability assessment approaches for collaborative enterprise systems," *Proceedings of the 23rd IPSE International Conference on Transdisciplinary Engineering*, Curitiba, Brazil. October, 2016, pp.45-54.

[12] T. Ford, J. Colombi, S. Graham and D. Jacques, "The interoperability score," *Proceedings of the 5th Annual Conference on Systems Engineering Research (CSER2007)*, volume 1, Stevens Institute of Technology, Hoboken, New Jersey, March, 2007.

[13] *ISACA. CMMI Performance Solutions,* 2021, [Online]. Available at: https://cmmiinstitute.com/cmmi

[14] *Organizational Project Management Maturity Model (OPM3®),* third ed., PMI, 2013.

[15] *Organisational Competence Baseline for Developing Competence in Managing by Projects*, IPMA, 2016.

[16] *Portfolio, Programme & Project Management Maturity Model (P3M3),* Version 1.0, Office of Government Commerce (OGC), Crown, 2006.

[17] H. Kerzner, *Using the Project Management Maturity Model. Strategic Planning for Project Management,* third ed., Wiley, 2019. https://doi.org/10.1002/9781119559078.

[18] *Integrated Project Portfolio Management,* 2021, [Online]. Available at: https://ppm.express/blog/introduction-to-portfolio-management-a-ppm-maturity-model

[19] S. Nikkhou, K. Taghizadeh, S. Hajiyakhchali, "Designing a portfolio management maturity model (Elena)," *Procedia – Social and Behavioral Sciences*, vol. 226, pp. 318–325, 2016. https://doi.org/10.1016/j.sbspro.2016.06.194.

[20] *ITM Platform. Projects. Programs. Portfolio,* 2021, [Online]. Available at: https://www.itmplatform.com/en/blog/ppm-maturity-level-what-is-it-and-next-steps-towards-growth/

[21] *Acuity PPM,* 2021, [Online]. Available at: https://acuityppm.com/ppm-solutions/ppm-maturity-assessment/

[22] H. Solli Sæther, P. Gottschalk, "Maturity in IT outsourcing relationships: an exploratory study of client companies," *Industrial Management & Data Systems,* vol. 108, no. 5, pp. 635-649, 2008. https://doi.org/10.1108/02635570810876769.

[23] D. Jin, K.-H. Chai, K.-C. Tan, "New service development maturity model," *Managing Service Quality: An International Journal,* vol. 24, no. 1, pp. 86-116, 2014. https://doi.org/10.1108/MSQ-10-2012-0134.

[24] I. Kononenko and M. Kpodjedo, "The basics of the project portfolio management generalized body of knowledge," *Proceedings of the 2nd International Workshop IT Project Management (ITPM 2021),* Slavsko,

Lviv region, Ukraine, February 16-18, 2021. CEUR Workshop Proceedings (CEUR-WS.org) Vol-2851, pp. 271-282.

[25] *Soft Online,* 2021, [Online]. Available at: https://softonline.com.ua/catalog/atlassian/

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