Статтю присвячено вирішенню наукової проблеми формування мета-рівня управління проектами – рівня створення та впровадження орієнтованих на умови конкретних проектно-орієнтованих підприємств методологій управління проектами (МУП). Показано, що впровадження методологій управління проектами в практику діяльності проектно-орієнтованих підприємств потрібно розглядати як проект, який вимагає управління у відповідності з деякою специфічною методологією – мета-методологією управління проектами. Запропоновано концепцію побудови мета-методології управління проектами, в основу якої покладено модель «ПОТОК» (проектно-орієнтована технологічна організація компаній). Розроблено метод формування конфігурації мета-методології управління проектами під умови конкретного проектно-орієнтованого підприємства, в основі якого оцінка відхилення в умовних ймовірностях формування цільових значень параметрів проекту без використання, та з використанням інструментів конкретизованої методології управління проектами.

Застосовуючи представлені наукові результати в процесі створення конкретизованих методологій управління проектами для вітчизняних компаній було визначено, про доцільність використання інструментів МУП: в ТОВ Карбон (Україна) – інструментів управління ресурсами проектів будівництва базових станцій мобільного зв'язку; в ПАТ Тутковський (Україна) – інструментів управління інформацією геологічних проектів; в ICD Investments (Україна) – з інструментів адміністрування девелоперських проектів. Представлено практичні результати формування конкретизованої методології управління проектами для ТОВ Карбон. Успішність створення системи управління проектами в компанії Карбон свідчить про обґрунтованість та достовірність отриманих наукових результатів та їх важливість для практики управління проектами

Ключові слова: мета-методологія управління проектами, конкретизована методологія управління проектами, інструменти управління проектами

DEVELOPMENT OF THE CONCEPT AND METHOD OF BUILDING OF SPECIFIED PROJECT MANAGEMENT METHODOLOGIES

I. Teslia
Doctor of Technical Science, Professor*
E-mail: teslyas@ukr.net
O. Yehorchenkov
PhD*
Department of Geoinformatics
E-mail: alexee@ukr.net
I. Khlevna
PhD*
Department of technology management
E-mail: yuliya.khlevna@gmail.com
A. Khlevnyi
PhD*
E-mail: andlev@ukr.net
*Department of technology management
Taras Shevchenko National University of Kyiv
Volodymyrska str., 60, Kyiv, Ukraine, 01033

1. Introduction

The use of project management methodologies in practice allows project teams to successfully and effectively manage all processes that provide the desired results. In the world, there is a large number of project management methodologies that were created by scientists and practitioners [1–4]. But none of the methodologies is adapted to a particular enterprise, since each enterprise has different experience of professional project management, different levels of technological maturity, has its own specifics. In addition, projects of the same company can vary significantly.

Another drawback to the use of methodologies is that they lack the component of implementation in project-oriented enterprises. And such an implementation entails or-ganizational changes, reengineering of business processes, technological and technical reequipment, etc.

At one time, the space program of the United States began the project management methodology, which is now known as the PMBOK body of knowledge. The P2M methodology was developed for innovative projects and programs, and for projects in the field of IT – agile methodologies.

But there is no methodology for projects of implementation of project management methodologies (standards). And quite often responsible for the project persons do not know or do not understand how to use the tools of the project management methodology. They may start implementing MS Project without developing planning rules or project plan templates, without assigning responsibility persons for entering information in the MS Project, controlling the im-

plementation, etc. And in this case, managers do not consider the fact that the implementation of the project management methodology requires rebuilding the project-oriented enterprise and adapting the methodology to its conditions. There is no understanding that the implementation of project management methodologies needs to raise the level of technological maturity of the enterprise. It is necessary to choose from different methodologies precisely the tools that are most appropriate for the conditions of the enterprise and the specifics of the projects (terms, resources, risks, teams, influences, etc.). Essentially, the concept, principles, rules, regulations, methods, project management means of managing the project of creation and implementation of tools for various project management methodologies at a particular enterprise are required. It is necessary to develop some project management meta-methodology (PMMM), which will describe the processes of implementation of project management methodologies (PMM) at a specific enterprise and will contain relevant tools.

2. Literature review and problem statement

The role of the PMM in the management of project-oriented enterprises is increasingly important. This is due to the fact that today's requirement is effective management in order to achieve the goals and receive the planned results. In [5], it was found that the application of management methodologies makes it possible to achieve an economic effect from 15 % to 20 %. The study of methodologies is dealt with in the works of many researchers, and the concept of project management methodology is quite broad and ambiguous on the one hand, and on the other – brought to the level of a set of practices. The author [6] presents the necessity of using the methodology of project management in the context of scientific activities of the project management discipline. In [7], the project management methodology is presented as a combination of logically related practices and methods; the PMBOK [1] standard is also considered from a practical point of view. The study [8] reflects the author's opinion that in the modern era of human development, the methodology of project management should be interpreted in the organizational-activity paradigm. This confirms the idea that there is a need to create some add-on over project management methodologies that will allow selecting best practices, tools and creating project management standards for a particular enterprise.

Let us consider in more detail the studies about project management methodologies in terms of processes of PMM implementation in a particular enterprise.

The paper [9] presents the basics of professional knowledge and competencies in three areas: conceptual, technical and behavioral. The paper proposes methods of project management processes considering the specifics of domestic enterprises. But the paper does not cover the question of how managers should behave when implementing the methodology, how they can influence the implementation process. The study [10] reflects the systematization of existing tools for managing enterprise development in Ukraine, the use of projects and programs as tools for enterprise development in today's conditions. The study does not cover the issue of creating tools that facilitate the implementation of project management methodologies.

The purpose of [11] was to develop a convergent approach in the development of PMM. At the same time, the paper does not sufficiently cover the mechanisms of convergence of existing methodologies with the knowledge of a particular enterprise. This makes it impossible to bring the tools of existing methodologies to the specifics of a particular enterprise.

Methods of creating and selecting a methodology are reflected in [12, 13]. But they do not cover the issue of the practical use of methodologies in the enterprise. This approach is presented in [14]. But the paper does not formalize the tasks that need to be solved in each phase of the life cycle of the project of implementation of the project management methodology.

Implementation of project management methodologies in the practice of project-oriented enterprises is presented in [15], which introduces the PRINCE 2 methodology implementation to the practice of service enterprises. However, the paper does not reveal the essence of the information influence on the project participants to achieve the result from the implementation. The approach to using information influence is presented in [16], which proposes the creation of the meta-methodology. The paper does not cover the issues of its assessment. There is no description of how the proposed methodology will work in a particular enterprise. The use of meta-methodology in the practice of geological projects is presented in [17], however, the concept of a project-oriented technological organization of the enterprise, which would form the basis of project management meta-methodology, was not covered in the paper. Algorithms for the formation of meta-methodology under the conditions of a specific enterprise – a specified project management methodology (SPMM) is presented in [18]. But the question of the choice of SPMM instruments remains open.

Considering the foregoing, we can conclude that the scientific problem of selecting and implementing existing practices, tools and standards of project management in the practice of project-oriented enterprises is very important. Since today there are no methodological developments in this area, there is a need to create standards for projects of implementation of project management methodologies. It is proposed to develop a concept for building a meta-methodology for project management, and on this basis create a method that will allow building the optimal configuration of projects for the creation and implementation of project management methodologies under the conditions of a specific project-oriented enterprise.

3. The aim and objectives of the study

The aim of the study is improving project management by creating tools for implementing project management methodologies under the conditions of a specific project-oriented enterprise.

To achieve the stated aim, the following objectives were set:
– to formulate the concept of building a project management meta-methodology aimed at improving the processes of management of projects of implementation of project management standards in project-oriented enterprises;
– to develop a method for forming a project management meta-methodology configuration, which ensures the selection of project management tools aimed at increasing the probability of obtaining the planned results of projects in specific project-oriented enterprise.

4. Concept of project management meta-methodology building

The success of projects depends largely on management tools created by many generations of scientists and practitioners. Implementation of PMM tools is a complex project. Its success depends on specific tools. These tools provide a great deal of analytical work, influences management control the effects on employees, and require additional knowledge of the compliance of the implemented PMM tools with the managerial functions of the project-oriented enterprise.

Characteristics of the implementation of the PMM, as a project, are presented in Table 1. In order to effectively manage the implementation of the PMM projects, it is proposed to create a focused methodology for them – project management meta-methodology [16–19].

Definition 1. Project management meta-methodology (PMMM) is a systematic set of conceptual representations, principles, theoretical models, methods and practical tools aimed at managing the implementation of project management methodologies in project-oriented enterprises.

The PMMM will determine the best way for implementation standard project management processes to best meet the needs and specifics of a particular organization. It will include concepts, principles, theoretical models and methods and practical means of managing methodologists in the process of project-oriented enterprise analysis, selection of project management tools, business process modeling, organizational reorganization of enterprises, etc. The PMMM will contain tools and mechanisms aimed at implementation of methodologies for project, program, or portfolio management at project-oriented enterprises in order to maximize the results of projects with limited resources.

Table 1

Comparative characteristics of projects

Project components	Project classes			
	Innovation Projects	IT Projects	Organizational Projects	Projects of PMM Implementation
Product	New object	Software	Organization	Methodology
Duration	Long-term, medium-term, short-term	Medium-term, short-term	Long-term, medium-term	Short-term
Cost	High	Low	Average	Low
Risks	Financial, timeliness, competitors	Changes in customer requirements, deviation in terms, out-dates for users, technical	Mistakes of managers, financial	Conflicts, mistakes of managers, using of unnecessary tools, knowledges, PMM processes, implementation terms
Uncertainty	Regarding the process and outcome	Regarding the product	Regarding the stakeholder's reaction	Regarding the process and outcome; regarding the product; regarding the stakeholder's reaction
Stakeholders	Investors, Enterprise	Customers	Customers	Enterprise
Methodologies	P2M	Agile, SCRUM	PMBok	–

The result of applying the PMMM is the formation and implementation of a project management methodology that integrates tools, processes, knowledge of existing project management methodologies and project implementation conditions at a specific enterprise. Such a methodology will be called a specified project management methodology (SPMM) [18].

Definition 2. Specified project management methodology (SPMM) of a project-oriented enterprise is a set of approaches, principles, concepts, structures, models and methods for managing projects that meet the needs of a particular project-oriented enterprise and allow successful completion of its projects.

Meta-methodology is a tool for managing the project of forming and implementing the SPMM.

The concept of creation and use of project management meta-methodology can be presented as a "POTOC" model (model of the project-oriented technological organization of the company) (Fig. 1).
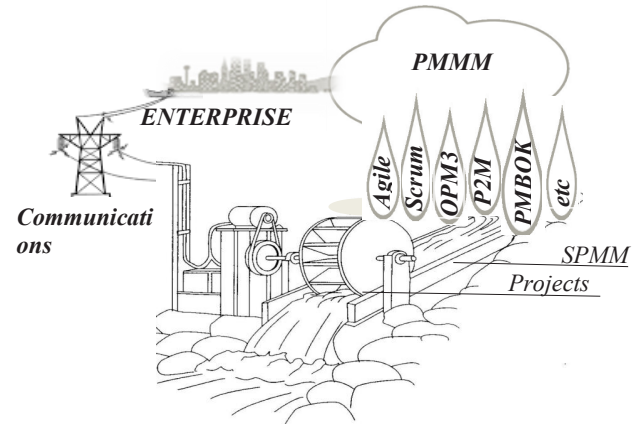

Fig. 1. Model of the project-oriented technological organization of the company — "POTOC"

The main features of the formation and implementation of the project of implementation of a specified project management methodology, which form the content of the project management meta-methodology, include:

1. *The decisive role of information influences.* Mechanisms of implementation of information technology, or innovation, or a new organization are based on information influences on the internal environment of a project-oriented enterprise. The same applies to the specified project management methodology.

Definition 3. Influence on the process of implementation of the specified project management methodology is a set of external, internal, combined, positive and negative, direct and reverse, managed and unmanaged information actions on the implementation process of the SPMM. Such actions determine the reaction of the project participants to the formation of the SPMM.

Implementation of the SPMM requires employees of enterprises to change the usual pace of their work. A holistic and integrated approach is needed that includes the development of a proper strategy and the scientific basis for implementation and a plan for the implementation of a specified project management methodology that considers all the features of the enterprise and its information infrastructure. And all this is formed by the information influences on project participants.

2. Scientists and practitioners. Usually a methodologist is a scientist who, based on the achievements in the project management science, forms and implements the SPMM. Therefore, the implementation of the project management methodology should be considered at the intersection of functions of managers and practitioners with the functions of scientists who develop project management methodologies.

3. Analytical work. Implementation of the SPMM can be based only on perfect analytical work. This will allow obtaining information on the readiness of the enterprise as a whole and its structural subdivisions to form the SPMM, identifying management functions that require reengineering and SPMM tools, which are most suitable for the implementation of these functions.

4. Some project tasks and works are transferred to the methodological environment. This requires:

– distributing the implementation functions between traditional management methods and the PMMM functions;

– teaching project teams not only to manage projects, but also to interact with the SPMM implementation team.

Proceeding from the above features of the SPMM implementation projects, the project management meta-methodology should include areas of knowledge that make it possible to build purposeful systems of influence on the project participants in order to form the SPMM. In particular:

Management of the psychology of changes is the application of knowledge of:

– PMM and psychology, in particular personality psychology, the theory of information interaction;

– management of psychological maturity, regarding the necessity of SPMM implementation by project participants;

– identifying and encouraging stakeholders in SPMM implementation and punishing non-interested parties.

This area of knowledge also embodies knowledge that contributes to raising the level of corporate culture and its support for new ways of working.

Implementation management is based on the knowledge of theoretical models, methods and practical tools aimed at managing the implementation of a specified project management methodology in project-oriented enterprises. In this area, knowledge of basic regulatory documents for the SPMM formation, compliance with the SPMM implementation plan and deviations regulation by the tools of information influence is also used. Knowledge of SPMM implementation control, compliance with the budget and project terms, knowledge that provides the necessary responses in the management system to optimize the SPMM implementation process.

Management of methodological maturity consists in:

– the management's understanding of the fundamentals of project management methodologies, in particular the methodology of SPMM implementation;

– systematization a set of conceptual representations, principles, theoretical models, methods and practical tools of the project management methodology, which should be implemented on a project-oriented enterprise;

– mastering the principles of adaptation of existing methodologies to the features of a project-oriented enterprise. In the meta-methodology, own training tools, including the learning of SPMM implementation, should be developed;

– providing an understanding of the project participants and priority of benefits over implementation costs, the ability to apply modern project management methodologies in practice.

Management of the SPMM information environment is based on the identification of key indicators of the PMM information environment and the enterprise information environment to create an SPMM informational environment. It is carried out on the basis of an expert assessment of the criteria selection for the information environment of the PMM and the enterprise. It is based on the information processes and information management processes, receiving information about the SPMM implementation and carrying out the information influence on the SPMM implementation process.

Influences management embodies the choice of the necessary classes of influences, which will ensure a strengthening of the positive and a reduction of the negative influence on the implementation project. Such influences create the preconditions for developing the necessary reactions in the SPMM implementation system. It involves changing the probability of one or another action of the control system in the realization of a separate influence, or classes of influences. It depends on the deviation between the target and actual SPMM. If selected influences do not ensure the implementation of the target SPMM, then the selection of additional influences is carried out through feedback.

These areas of knowledge will allow effective management of the project of implementation of a specified project management methodology and proper construction of its environment, structures. And most importantly, the formation of the configuration of SPMM in such a way that its tools would be most effective in the conditions of a particular enterprise. Consider this question.

5. Formation of the configuration of the specified project management methodology by the PMMM tools

The main task associated with the formation of the SPMM is to implement those tools of a variety of project management methodologies that will be most effective in a specific operating company. And here comes the scientific task of estimating the effectiveness of the selected project management tools. Selection of tools appropriate for a particular enterprise will show how useful for project management is the project management meta-methodology.

Definition 4. SPMM configuration is a set of organizational, methodological and technical tools for project management that are appropriate to apply in a particular project-oriented enterprise and which contribute to the successful completion of projects of this enterprise.

Definition 5. Configuration of the project of SPMM implementation is a set of processes for the formation and management of the formation of organizational, methodological and technical tools for project management that is appropriate to apply in a particular project-oriented enterprise.

The complexity of this problem is that it is impossible to directly assess the "correctness" of the selection of project management tools. This can only be done on the basis of the results of the projects (Fig. 2).

It is necessary to develop tools for the PMMM assessment using the configuration of SPMM in terms of its influence on the results of enterprise projects. Indeed, if without the SPMM introduction, the success of the projects can be assessed by some integrated x^- value and, after implementation, by the value x^+, while the assessment of the success of projects after implementation is much higher than before implementation ($x^+>>x^-$), then it is possible to say that the SPMM is useful. So, using of the PMMM is justified. Typically, SPMM configurations may be different,

and accordingly, you can assess it by different values. Let the alternative SPMM configurations are: $\Psi_1,..., \Psi_i,..., \Psi_n$. If appropriate assessments of the effectiveness of project management with the use of these configurations $x_1,..., x_i,..., x_n$ are given, then the PMMM will be really effective if its use will allow the implementation of such a configuration of the SPMM Ψ_j, for which

$$x_i x_j : x_j \geq x_i,$$

where x_i is the assessment of the effectiveness of project management when using the SPMM with the configuration Ψ_i; x_j is the assessment of the optimal configuration of the SPMM Ψ_j.

Therefore, the assessment of management effectiveness can be obtained through an assessment of the results of the projects themselves. But the results of projects depend not only on the efficiency of management, but also on external influences, unpredictable and hardly predictable factors, most of which are random, depend on resource support, etc. So, increasing the effectiveness of management only with some probability will improve the results of projects. Proceeding from this, we use the probabilistic approach to assess the configuration of the SPMM. We will assume that the implementation of the SPMM increases the probability of obtaining planned benefits from projects. This requires additional costs for the creation and implementation of the SPMM.

To determine the benefits of improving all project parameters as a result of the operation of a subset of SPMM instruments, it is advisable to use the formula:

$$x_m^+ = \sum_{\Pi_k \in \Pi} \left[S_k \cdot \left(p\left(R_k / \Psi_m\right) - p\left(R_k / \overline{\Psi_m}\right)\right)\right], \qquad (1)$$

where x_m^+ is the assessment of the total benefits from the project activity using the SPMM with the configuration Ψ_m; Π is the enterprise project portfolio; Π_k is the project; S_k is the planned benefits from the project Π_k; $p\left(R_k / \Psi_m\right)$ is the conditional probability of obtaining the planned results in the project Π_k provided that the SPMM with the configuration Ψ_m will be implemented; $p\left(R_k / \overline{\Psi_m}\right)$ is the conditional probability of obtaining the planned results in the project Π_k provided that the SPMM with the configuration Ψ_m will NOT be implemented.
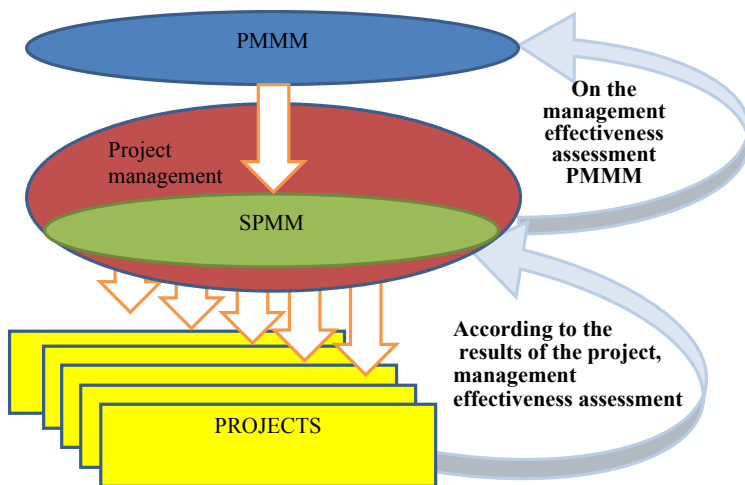

Fig. 2. Assessment of the project management meta-methodology based on project results

Costs for the SPMM configuration can be estimated through the costs of research of the enterprise aimed at creating and implementing the SPMM, development of the SPMM itself and its implementation.

$$x_m^- = S_m^d + S_m^r + S_m^w, \qquad (2)$$

where x_m^- is the estimation of total costs of creation and implementation of the SPMM with the configuration Ψ_m; S_m^d is the costs of enterprise research in order to create and implement the SPMM with the configuration Ψ_m; S_m^r is the costs of creation of the SPMM with the configuration Ψ_m; S_m^w is the costs of implementation of the SPMM with the configuration Ψ_m.

Considering the benefits of improving the efficiency of management through the use of SPMM tools and the costs of their creation and implementation, we will obtain the optimal configuration of the SPMM, which should be created within the framework of the PMMM

$$\sum_{\Pi_k \in \Pi} [S_k \cdot (p(R_k / \Psi_m) - (p(R_k / \overline{\Psi}_m))] - \\ - S_m^d - S_m^r - S_m^w \rightarrow \max, \qquad (3)$$

all with restrictions

$$\Pi_k \in \Pi;$$

$$S_m^d - S_m^r - S_m^w \leq S_0,$$

where S_0 is the budget of the SPMM creation and implementation project; $\Pi_k \in \Pi$; is the set of projects that are implemented at a project-oriented enterprise at a given time.

Formula (3) reflects the assessment of the effectiveness of SPMM instruments not on a single project, but on all projects of the enterprise, since projects may have their own specifics and require various SPMM tools for management.

Accordingly, the optimization problem is a selection of a subset of SPMM tools that will maximize the probability of obtaining the desired project results with minimal implementation costs. The tools should maximize the effectiveness of project management, reduce the losses from inappropriate project decisions, give managers the most needed information.

The trend of dependence of benefits from the SPMM tools and implementation costs is shown in Fig. 3.

In this case, the benefits of SPMM implementation can be represented by the trend shown in Fig. 4.

Point X in Fig. 4 corresponds to the optimal configuration of the SPMM:

$$S^+ - S^- \rightarrow \max.$$

Of course, for different SPMM tools, graphs (Fig. 4) will be different. And there will be different optimal values. Therefore, the problem to be solved in the PMMM is to choose such a configuration of the SPMM Ψ_m, for which the target value (3) will be maximal. In fact, from project management tools that are available in a variety of methodologies, it is advisable to select those that will provide the target value (3). To solve this problem, it is needed:

1. Based on the research of project management methodologies and peculiarities of project-oriented enterprise activities, to identify and formalize the SPMM tools that can be used at the enterprise.

2. To estimate how much the probability of project success will increase due to changes in the management system of these projects.

3. To evaluate the impact of SPMM tools on positive changes in the project management system.

4. To develop a model of project management on the basis of the PMMM, which will allow developing a rational strategy for the selection and implementation of enterprise project management tools.
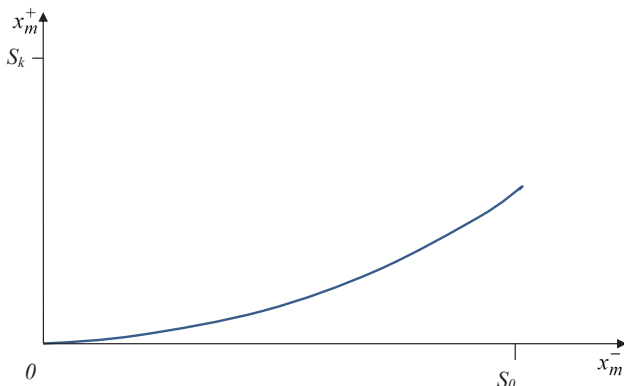

Fig. 3. Dependence of benefits from the tools of the specified project management methodology and the costs of their implementation
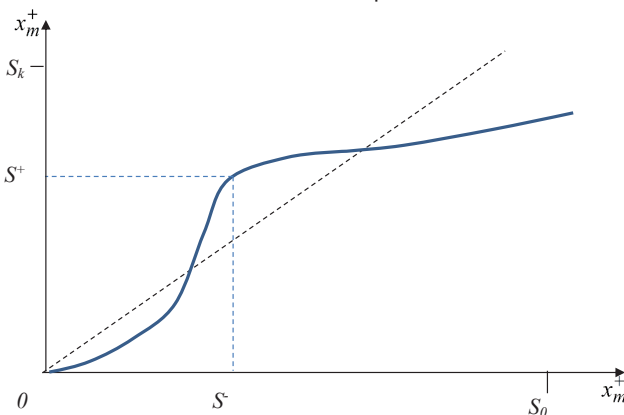

Fig. 4. Dependence of benefits from the project management on the cost of the SPMM project implementation

The implementation of any project management methodology should improve the performance of the entire project management system through the use of new tools of organizational development, planning, information provision, etc. In fact, the SPMM tools should "positively influence" the parameters of the project management system. Namely, the work of the project team, managerial decisions, stakeholder satisfaction, reliability, timeliness and completeness of information, reduction of project risks, etc. In turn, changes in the management system will positively affect project parameters, in particular, the work of project performers, duration of the project, project cost, project quality level, completion of most projects, etc., and as a result all this is aimed at achieving the target value (3). The only problem is that different tools of different methodologies influence the target value differently (3). Accordingly, the PMMM should contain tools for the estimation of the influence of different

tools of different methodologies on improving the project management system. Consider this issue in the context of choosing the configuration of SPMM (including some or other project management tools), which, due to improved project management system, will increase the probability of obtaining planned project results.

In Table 2 it is shown how the areas of knowledge of project management meta-methodology with SPMM tools are interrelated. In Table 3, it is shown how these tools affect the success of the projects. Finding the best trajectory of motion from the project management meta-methodology to the success of the projects and determines the optimal configuration of the SPMM.

To form the configuration of the SPMM implementation project, it is enough to determine the influences of the project management tools on the results. Those tools that greatly influence the projects of a particular enterprise will form the basis of the SPMM implementation project.

Table 2

Influences of project management meta-methodology on the formation of a specified project management methodology configuration

Implemented SPMM tools	SPMM knowledge area				
	Psychology of change management	Implementation management	Methodological maturity management	Management of information environment of SPMM	Influences management
I_1	V_{11}^{y}	V_{12}^{C}	V_{13}^{y}	V_{14}^{y}	V_{15}^{y}
I_2	V_{21}^{y}	V_{22}^{y}	V_{23}^{y}	V_{24}^{y}	V_{25}^{y}
...	...	...	...	...	...
I_j	V_{j1}^{y}	V_{j2}^{y}	V_{j3}^{y}	V_{j4}^{y}	V_{j5}^{y}
...	...	...	...	...	...
I_n	V_{n1}^{y}	V_{n2}^{y}	V_{n3}^{y}	V_{n4}^{y}	V_{n5}^{y}

Note: the cells of Table 2 show the influences of knowledge of project management meta-methodology on the formation of the SPMM configuration

Table 3

Influence of the tools of the specified project management methodology on project parameters improvement

Projects parameters	SPMM tools				
	I_1	...	I_j	...	I_n
β_1					
β_2	V_{21}^{Π}	...	V_{2j}^{Π}	...	V_{2n}^{Π}
...	...	...	...	...	...
β_r	V_{r1}^{Π}	...	V_{rj}^{Π}	...	V_{rn}^{Π}
...	...	...	...	...	...
β_L	$V_{L\,1}^{\Pi}$	...	$V_{L\,j}^{\Pi}$	...	$V_{L\,n}^{\Pi}$

Note: the cells of Table 3 (V_{rj}^{Π}) show the influences of SPMM tools on projects

The impact of SPMM tools on projects will be determined by the coefficient of importance of the SPMM tool I_j for project management – α_j. To obtain the value of the

coefficient of importance of the SPMM tool I_j for project management – α_j, we take into account the deviation of the conditional probability of obtaining the planned value of the project parameter from absolute probability:

$$\alpha_j = \frac{\sum_{r=1}^{L\beta} \mu_r \cdot \sum_{k=1}^{L\Pi} [p(\beta_{kr} \geq \beta_{kr}^0 / I_j \Pi_k) - p(\beta_{kr} \geq \beta_{kr}^0)]}{L_\beta \cdot L_\Pi \cdot s_j}, \quad (4)$$

where α_j is the importance of the SPMM tool I_j for project management; s_j is the cost of the SPMM tool I_j; μ_r is the importance of the project parameter β_r; L_β is the number of project parameters; L_Π is the number of projects; $p(\beta_{kr} \geq \beta_{kr}^0 / I_j \Pi_k)$ is the conditional probability that the project parameter β_{kr} will assume the planned value under the conditions of using the SPMM tool I_j in the project Π_k; $p(\beta_{kr} \geq \beta_{kr}^0)$ is the statistical probability that the project parameter β_{kr} took the planned value in previous projects.

The given probabilities can be obtained from both the information standard of the enterprise and in the expert way.

The approach to determining the coefficient of importance of the I_j tool for project management will be in:

1. Determining the importance of project parameters relative to the benefits of improving them (e.g., what is more important, timely completion of a project with over-spending of the budget, or investing in the budget, but delaying the project).

2. Estimation of the probability of improvement of project parameters under the influence of the SPMM tool.

3. Determining the benefits of the influence of a set of SPMM tools, which will be included in some configuration of the SPMM, on a separate project parameter.

4. Calculating the benefits of the influence of a set of SPMM tools on all project parameters.

5. Determining the costs of implementing each tool.

6. Formation of the optimal configuration of SPMM from a subset of tools that will provide maximum profit at minimal cost.

For obtaining estimates of the importance of each project parameter, it is planned to use the expert estimation method. Expert estimations are presented in the form of tables (Table 4) for each pair of project parameters.

The importance of the project parameter is proposed to be calculated according to the formula:

$$\mu = \frac{\sum_{j=1}^{r-1} (h_{rj} + 1) - \sum_{j=r+1}^{L\beta} (h_{rj} - 1)}{2 \cdot (L_\beta - 1)}, \quad (5)$$

where h_{rj} is the expert estimation of the priority of the project parameters (β_r is more important than β_j, then +1 is given, if vice versa, then (–1)); μ_r is the importance of the project parameter β_r; L_β is the number of project parameters.

The probabilities included in the formula (4) can be obtained either on the basis of statistical data or on the basis of expert estimates. The probabilities of the target (planned) value of the project parameters can be presented as a table (Table 5).

The action of SPMM tools will change the probability of forming the target (planned) value of the project parameters. These changes will result in the correction of the values presented in Table 5. The results of the use of tools will form a new table of the target (planned) value of the project parameters (Table 6).

Table 4

Matrix of expert assessments of the importance of project parameters

Project parameters	Parameter 1	...	Parameter i	...	Parameter L
Parameter 1	0	...	–	...	–
...	...	...	...	...	...
Parameter i	h_{14}	...	0	...	–
...	...	...	...	...	...
Parameter L	h_{16}	...	h_{i4}	...	0

Note: the cells of the table indicate +1, if the more important parameter is written in a line, and −1, if the more important parameter is written in a column, 0 if the parameters are equal

Table 5

Initial (before the introduction of SPMM) probability of the values of the project parameters

Project parameters	Target value probability
Timely completion of project tasks	p_1^0
Amount and magnitude of changes	p_2^0
Achievement of goals	p_3^0
Project cost	p_4^0
Project duration	p_5^0
Level of quality	p_6^0
Losses from risks	p_7^0
Stakeholders satisfaction	p_8^0

As mentioned above, expert or statistical methods can be used to fill these tables. Typically, experienced project managers as well as scientists understand the extent of the relationship between the given parameters. The task is complicated only by the fact that each enterprise will have its own specificity, which will be expressed in different costs of the project of methodology implementation and in different influences of the same tools on the project parameters. This will be the decisive factor in selecting the tools of the project management methodology that will be appropriate in the conditions of this enterprise.

If Tables 5, 6 will be filled with specific values, they can become the basis for choosing those project management tools that will form the SPMM and will provide the planned values of the project parameters with the highest probability.

The SPMM configuration usually should not contain only one, but many tools that "help" manage various aspects of the projects. It is therefore advisable to assess the benefits of improving the project parameter for a subset of SPMM tools, which will form a certain configuration of the SPMM. To do this, we use the formula (1) but with the values of importance of various project management tools:

$$x_m^+ = \sum_{r=1}^{L\beta} \mu_r \cdot \sum_{k=1}^{L\Pi} c(\beta_{kr}) \left[p\left(\beta_{kr} \geq \beta_{kr}^0 / \Psi_m\right) - p\left(\beta_{kr} \geq \beta_{kr}^0\right) \right] - \left(\sum_{I_j \in \Psi_m} s_j - \Delta s(\Psi_m) \right), \quad (6)$$

where x_m^+ is the difference between the benefits and costs of the project activity when using the SPMM with the configuration Ψ_m; $c(\beta_{kr})$ is the benefits from the fact; that the parameter β_{kr} will be within the planned value (for example, the

project will finish on time); $\Delta s(\Psi_m)$ is the benefits of joint formation of tools that are part of the configuration Ψ_m; s_j is the plan cost of implementation of the tool I_j; $p(\beta_{kr} \geq \beta_{kr}^0 / \Psi_m)$ is the conditional probability that the project parameter β_{kr} takes the planned value with the use of tools that are the part of the SPMM configuration Ψ_m (in Table 6 – $p_1^n, p_2^n \dots p_8^n$); $p(\beta_{kr} \geq \beta_{kr}^0)$ is the statistical probability that the project parameter β_{kr} took the planned value in previous projects (in Table 5 – $p_1^0, p_2^0 \dots p_8^0$).

Table 6

Probability of the planned value of project parameters after the SPMM tools implementation

Project parameters	Target value probability
Timely completion of project tasks	p_1^n
Amount and magnitude of changes	p_2^n
Achievement of goals	p_3^n
Project cost	p_4^n
Project duration	p_5^n
Level of quality	p_6^n
Losses from risks	p_7^n
Stakeholders satisfaction	p_8^n

Therefore, in order to select the optimal configuration of the SPMM, it is necessary to consider both the benefits of improving all the parameters of project management and the project itself and the costs of implementing the set of tools included in this configuration. Let's describe the formation method of optimal configuration of the SPMM based on the costs and benefits of the implementation of individual project management tools:

1. Establishing the important parameters of the project, which will assess the feasibility of implementing the SPMM tools, on which the management of the projects and programs of the enterprise depends (an example is given in Table 4):

$$B = \{\beta_i\}, \quad i-1, L,$$

where B is the set of project parameters; β_i is the parameters for assessing the SPMM configuration; L is the number of parameters.

2. Determination of the importance of project parameters from the set B by the formula (4).

3. Formation of the empty set of SPMM tools:

$$\Psi_m = \varnothing,$$

where Ψ_m is the SPMM configuration.

4. Forming a set of tools I_d, which can be used in the SPMM.

5. Expert estimation of the importance of project parameters μ_r (Table 4 and formula 4).

6. Statistical estimation of the probability of achieving the planned project parameters $p(\beta_{kr} \geq \beta_{kr}^0)$.

7. Definition of the project management tool, which will be included in the SPMM configuration ($j=1$).

8. If j is greater than the number of elements in the set I_d – turn to item 17.

9. Expert estimation of the probability of achieving the value of the planned parameter β_r for all projects $p(\beta_{kr} \geq \beta_{kr}^0 / I_j)$.

10. If for all projects $p(\beta_{kr} \geq \beta_{kr}^0 / I_j) \leq p(\beta_{kr} \geq \beta_{kr}^0)$, turn to item 13.

11. Calculation of the cost-benefit from the project activity with the use of the tool I_j.

$$e(I_j) = \sum_{r=1}^{L\beta} \mu_r \cdot \sum_{k=1}^{L\Pi} c(\beta_{kr})[p(\beta_{kr} \geq \beta_{kr}^0 / I_j) - p(\beta_{kr} \geq \beta_{kr}^0)] - s_j,$$

where $e(I_j)$ is the difference between the cost and benefit from the project activity with the use of the tool I_j.

12. If $e(I_j) \leq 0$ turn to item 16.

13. I_j to be included in the set Ψ_m.

14. Calculation of the cost-benefit from the project activity with the use of the SPMM with the configuration Ψ_m (formula 6).

15. If $x_m^+ \leq 0$, exclude I_j from the set Ψ_m.

16. Increment of j by 1: $j=j+1$. Turn to item 8.

17. Finalizing the calculation.

The resulting set of tools for managing projects and programs creates the SPMM with an optimal configuration. The method of forming the SPMM configuration is the basis of the project management meta-methodology in terms of the design of the product of the project of creation and implementation of the project management methodology at a project-oriented enterprise.

6. Practice of using the PMMM for the creation of specified project management methodologies

The proposed concept and field of knowledge of the PMMM was used to create project management systems at the enterprises: TOV Karbon, PAT Tutkovsky and ICD Investments (Kyiv, Ukraine). Within the framework of such systems, a new organizational structure for project management, a specified project management methodology, project management information technology, which included the MS Project tools and the PrimaNad functional add-on were developed [19]. In order to identify methodological tools, which are the most demanded for these enterprises, research was conducted in accordance with the concept of building the specified project management methodology. In particular, the following is an example of the formation of SPMM in TOV Karbon.

On the basis of expert research (in the process of initiation of projects for the creation of corporate project management systems), expert estimation tables for the probability of obtaining satisfactory project parameter values (Table 7) and a table of expert estimation of the importance of project parameters were developed (Table 8).

On the basis of the values in Table 8 and using the formula (5), the significance of the project parameters was obtained (Table 9).

The impact of SPMM tools on projects is determined by the formula (4). TOV Karbon has implemented one project for the construction of mobile base stations. At the same time, about 1000 stations of Greenfield type were built in 6 branches. Therefore, in the formula $L_\Pi = 1$. The cost of the project management tools proposed by the contractor – PMBK (Ukraine) (in relative units) is shown in Table 10. The cost was formed by Oracle Primavera and add-on software for resource, risk management and project monitoring. Substituting the values from Tables 7, 9 and 10 into the for-

mula 4, we obtain a new table (Table 11) – table of influence of SPMM tools on projects.

Table 7

Probability of obtaining satisfactory values of project parameters without implementation, and after implementation of SPMM tools at TOV Karbon

Project parameters	Desig-nation	Initial subjective probability	SPMM tools			
			Sched-uling	Resource manage-ment	Risk Man-agement	Moni-toring
Timely completion of project tasks	β_1	0.2	0.4	0.3	0.2	0.4
Amount and magnitude of changes	β_2	0.3	0.6	0.8	0.7	0.5
Achievement of goals	β_3	0.4	0.5	0.8	0.5	0.5
Project cost	β_4	0.2	0.3	0.8	0.4	0.3
Project duration	β_5	0.2	0.6	0.4	0.3	0.5
Level of quality	β_6	0.7	0.8	0.8	0.7	0.7
Losses from risks	β_7	0.5	0.5	0.6	0.9	0.5
Stakeholders satisfaction	β_8	0.1	0.2	0.5	0.2	0.2

Table 8

Matrix of expert assessments of project parameters importance

Project parameters	β_1	β_2	β_3	β_4	β_5	β_6	β_7	β_8
β_1	0	–	–	–	–	–	–	–
β_2	−1	0	–	–	–	–	–	–
β_3	+1	+1	0	–	–	–	–	–
β_4	+1	+1	+1	0	–	–	–	–
β_5	+1	+1	−1	−1	0	–	–	–
β_6	−1	−1	−1	−1	−1	0	–	–
β_7	−1	+1	−1	−1	−1	−1	0	–
β_8	+1	+1	+1	+1	+1	+1	+1	0

Table 9

Matrix of expert assessments of project parameters importance

Project parameter	Project parameter importance
Timely completion of project tasks	0.43
Amount of changes	0.14
Achievement of goals	0.71
Project cost	1.00
Project duration	0.43
Level of quality	0.14
Risks influence	0.14
Stakeholders satisfaction	0.86

Table 10

Relative cost of SPMM tools

Scheduling	Resource management	Risk management	Monitoring
1	0.5	0.3	0.2

Table 11

Assessment of influence of SPMM tools on projects

Scheduling	Resource management	Risk management	Monitoring
0,071	0.364	0.214	0.3125

The obtained assessment of influences of SPMM tools allowed determining the main strategic line when implementing the project management system at TOV Karbon. The system included the company-focused methodology and the information technology for project management. The main element of the methodology and information technology has become the resource management component. It included tools:

1. Planning the resource requirements of the headquarters of TOV Karbon, the resources of the Customer and the resources procured by the branches of the enterprise. Planning was carried out using Oracle Primavera. Information on the need for resources, terms of order, prices was input into the information system in accordance with the developed regulations.

2. Budgeting. Executed only through resource planning. From the resource management plan, a daily need for funds was calculated, and these funds were sent to a branch. Rigid financial discipline. Money only under the project plan.

3. Cost control. For all branches and base stations, a comparison of the actual prices of material resources with the corresponding administrative conclusions was made.

4. Formation of knowledge in the field of project management in the groups of project management branches.

5. Knowledge control (testing). Those who did not pass the exam were fired from work.

6. Package of supplies. The relationship between the availability of material resources at headquarters warehouses and the needs of branches.

In general, the duration of the project of SPMM implementation was 1 year. After its completion, it was possible to increase the number of mobile base stations that were commissioned monthly from 40 to 75.

The case was the same in other enterprises, where the proposed concept and method were approved. In particular, it was found that in the ICD Investments company, the greatest need is in the tools for administering development projects. And in PAT Tutkovsky, there was an urgent need to implement project information management tools. Implementation of the relevant methodological tools showed the correctness of the proposed way of developing the science of project management through the creation of project management meta-methodology.

7. Discussion of the results of the development of the concept and method of forming the configuration of project management meta-methodology

Given facts are the result of changes in the strategy in the implementation of project management methodologies at project-oriented enterprises. A new concept for creating specified project management methodologies focusing on specifics of project-oriented enterprises was developed. The concept is based on the view on the process of implementation of such methodologies as a specific project implemented in accordance with the proposed project management meta-methodology. The proposed concept differs from traditional approaches, which are mainly focused on raising the

level of technological maturity in the field of project management. The basic element of the proposed methodology is the "POTOC" model, in which tools of different methodologies form the enterprise-oriented specified project management methodology. The developed method of forming the optimal configuration of the project management meta-methodology provides a selection of project management tools aimed at increasing the probability of obtaining the planned results of projects in a specific project-oriented enterprise.

The main advantage of the described approach is that the transition to a professional project management is considered not only just as a process of improving the work and interaction of all services, not only as the development of technological maturity, but as a specific project with clear responsibilities, terms, resources, configuration, customer and performers.

The topical issue of this study is the question of an adequate assessment of the state of the enterprise and its projects, for which it is proposed to use expert methods. But in enterprises with significant experience in implementing projects, it would obviously be possible to use statistical methods.

The development of this study is to create other methodological tools (and not only the concept and method of forming the SPMM configuration), for example, methods for planning SPMM implementation projects, models and methods for the development of an effective environment for information interactions, and others that would facilitate the adoption of new project management tools by the company's employees.

8. Conclusions

1. The concept of constructing the project management meta-methodology, which is focused on the improvement of project management processes of implementation of project management standards in project-oriented enterprises was formed. The concept is based on the model of the project-oriented technological organization of the company ("POTOC" model), which describes the process of selection and implementation of those project management tools that are most suitable for the specifics of activities of enterprises and projects.

2. The method of forming a project management meta-methodology configuration is developed, which provides the selection of project management tools aimed at increasing the probability of obtaining planned project results in a specific project-oriented enterprise. In order to implement the method, an algorithm for evaluating the effectiveness of SPMM tools using expected changes in the values of project parameters after the implementation of these tools is proposed.

3. The results of the use of the concept and method for creating a management system for the project of construction of mobile base stations at TOV Karbon are presented. It is shown that on the basis of the proposed concept and method, the SPMM was implemented, which allowed increasing the number of monthly commissioned mobile base stations from 40 to 75.

References

1. Rukovodstvo k Svodu znaniy po upravleniyu proektami (Rukovodstvo PMBoK). 5-e izd. Moscow: Olimp-Biznes, 2013. 790 p.

2. A guide to the Scrum Body of Knowledge (SBOK Guide). SCRUMstudy, a brand of VMEdu, Inc., Phoenix, Arizona USA, 2016. 361 p.

3. Schwaber K. Agile Project Management with Scrum. Microsoft Press, 2004. 192 p.

4. Fitsilis P. Comparing PMBOK and Agile Project Management software development processes // Advances in Computer and Information Sciences and Engineering. 2008. P. 378–383. doi: https://doi.org/10.1007/978-1-4020-8741-7_68

5. Bagashova N. V. Foreign and domestic trends of project management development // Efektyvna ekonomika. 2015. Issue 6. URL: http://www.economy.nayka.com.ua/?op=1&z=4154

6. Rach V. A. Metodologicheskie metriki nauki upravleniya proektami // Upravlinnia proektamy ta rozvytok vyrobnytstva. 2014. Issue 3 (51). P. 19–26.

7. Project Management Methodology: Definition, Types, Examples. URL: http://www.mymanagementguide.com/basics/project-methodology-definition/

8. Upravlenie proektami: Fundamental'niy kurs: ucheb. / Aleshin A. V., An'shin V. M. et. al. Moscow, 2013. 620 p.

9. Bushuev S. D., Bushueva N. S. Upravlenie proektami: osnovy profesial'nyh znaniy i sistema ocenki kompetentnosti proektnyh menedzherov (National Competence Baseline, NCB UAVersion 3.1). izd. 2-e. Kyiv, 2010. 208 p.

10. Shyshkovskyi S. V., Yakymiv A. I., Samuliak V. Yu. Proekty i prohramy yak instrumenty rozvytku pidpryiemstv // Visnyk Odeskoho natsionalnoho universytetu im. I. I. Mechnykova. Seriya: Ekonomika. 2013. Vol. 18, Issue 2/1. P. 231–234.

11. Bushuev S. D., Bushueva N. S., Neizvestniy N. I. Mekhanizmy konvergencii metodologiy upravleniya proektami // Upravlinnia rozvytkom skladnykh system. 2012. Issue 11. P. 5–13.

12. How to Build Your Own Project Management Methodology. URL: http://seanwhitaker.com/how-to-build-your-own-project-management-methodology

13. PM GUIDE 01. Selecting a project management methodology // Enterprise Solutions // Victorian Government Cio Council. URL: https://ofti.org/wp-content/uploads/2013/08/PM-GUIDE-01-Project-management-methodology-selection-guideline.pdf

14. Teslya Yu. N. Kak sdelat', chtoby metodologiya upravleniya proektami rabotala na praktike // Upravlinnia proektamy: stan ta perspektyvy. 2013. Issue 9. P. 336–338.

15. Vaníčková R. Application of PRINCE2 Project Management Methodology // Studia Commercialia Bratislavensia. 2017. Vol. 10, Issue 38. P. 227–238. doi: https://doi.org/10.1515/stcb-2017-0021

16. Teslia Yu. M., Khlevna Yu. L., Khlevnyi A. O. Naukovo-metodolohichni zasady meta-metodolohiyi vplyvu na upravlinnia proektamy na osnovi kontseptsiyi nesylovoi vzaiemodiyi // Tezy dopovidei III Mizhnarodnoi naukovo-praktychnoi konferentsiya «Informatsiyni tekhnolohiyi ta vzaiemodiyi». Kyiv, 2016. P. 113–115.

17. Metodolohiya vprovadzhennia tekhnolohiyi elektronnoho menedzhmentu heolohichnykh proektiv / Khlevna Yu. L., Yehoorchenkova N. Yu., Kubiavka L. B., Ivanova O. M. // Heoinformatyka: teoretychni ta prykladni aspekty. 2017.

18. Teslia I. N., Khlevna I. L., Oberemok N. V. Creation management of customized project management methodology // Project Management, System Analysis and Logistics. 2016. Issue 18.

19. Development of principles and method of electronic project management / Teslia I., Yehorchenkova N., Yehorchenkov O., Kataieva Y., Zaspa H., Khlevna I. // Eastern-European Journal of Enterprise Technologies. 2017. Vol. 5, Issue 3 (89). P. 23–29. doi: https://doi.org/10.15587/1729-4061.2017.109534

Запропоновано моделі темпоральних правил виконання дій бізнес-процесу, що застосовуються у випадку відсутності в процесній моделі повної інформації про причини виконання цих дій внаслідок втручання виконавців робіт. Правила формуються на основі аналізу порядку подій в журналі бізнес-процесу, що дозволяє визначити темпоральні умови й обмеження на виконання відповідних дій. Моделі правил можуть бути застосовані як елемент представлення знань для системи процесного управління, оскільки вони відображають записаний у журналі досвід реалізації бізнес-процесу. Використання правил дозволяє обмежити кількість можливих варіантів виконання бізнес-процесу з урахуванням його поточного стану. В результаті скорочується час прийняття рішень із процесного управління для випадку невідповідності поточного екземпляру бізнес-процесу та його моделі.

Запропоновано новий метод ймовірнісного виведення, який використовує представлені правила для того, щоб сформувати нові, допустимі послідовності дій у нетиповій ситуації, що виникла внаслідок коригування бізнес-процесу його виконавцями. Метод застосовує представлення знань на основі марківської логічної мережі, що дозволяє упорядкувати нові послідовності дій за ймовірністю їх реалізації з використанням зважених темпоральних правил. Використання комбінації правил для пар послідовних та пар віддалених в часі дій дозволяє підвищити точність обчислення ймовірності реалізації нових варіантів бізнес-процесу. Метод враховує інформацію із журналу подій при доповненні правил, що дозволяє забезпечити безперервне поповнення правил при виконанні бізнес-процесу. Зазначене обумовлює можливість практичного застосування методу при автоматизованій побудові та розширенні бази знань системи процесного управління у реальному часі

Ключові слова: бізнес-процес, марківська логічна мережа, ймовірнісне виведення, обмеження на виконання дій, журнал подій

DEVELOPMENT OF A METHOD FOR THE PROBABILISTIC INFERENCE OF SEQUENCES OF A BUSINESS PROCESS ACTIVITIES TO SUPPORT THE BUSINESS PROCESS MANAGEMENT

V. Levykin
Doctor of Technical Sciences, Professor*
E-mail: levykinvictor@gmail.com

O. Chala
PhD, Associate Professor*
E-mail: oksana.chala@nure.ua

*Department of Information Control Systems
Kharkiv National University of Radio Electronics
Nauky ave., 14, Kharkiv, Ukraine, 61166

1. Introduction

Enterprise process management is realized by means of managing business processes. The business process contains a sequence of actions in manufacture of products or creation of services that are of value to consumers. The business process management is performed using models of these processes [1].

The business process model contains all possible sequences of actions with indication of constraints, conditions and admitted results of these actions. As usual, terms and constraints specify resources (materials, executors, equipment) required for execution of actions. As a result of each action, state of the business process changes [2].

Effectiveness of process management is determined by completeness of knowledge about possible sequences of the business