UDC 658.51:517.977.5
DOI https://doi.org/10.32782/tnv-tech.2023.2.11

INCREASING THE EFFICIENCY OF IT PROJECT MANAGEMENT WITH THE APPLICATION COMPLEX METHODOLOGY DISTRIBUTION OF PERFORMERS FOR WORK

Nechvoloda L. V. *– Ph.D.,*
Associate Professor at the Department of Intelligent Systems of Decision Making
Donbas State Engineering Academy
ORCID ID: 0000-0002-7584-6735
Researcher ID: HPB-8625-2023

Shevchenko N. Yu. *– Ph.D. in Economics,*
Associate Professor at the Department of Digital Technologies
and Project-Analytical Solutions
Metinvest Polytechnic Technical University LLC
ORCID ID: 0000-0002-3085-7107
Researcher ID: IRZ-2827-2023

Project management is the application of knowledge, skills, tools and methods of project performance analysis to meet their key needs. Such project management is based on a systematic approach implemented by the project team. In the IT sphere, the project has signs of temporality and uniqueness. The project is temporary, because it has a defined beginning and limitations on the time of implementation, which determine its scope and resources. The project is unique because it is a certain set of operations designed to achieve a singular goal. Therefore, the project team should include people who will ensure the optimal execution of the specified operations in terms of time and financial resources, focusing on achieving the business goal of the project.

The article considers the main factors of IT project team formation, including the compliance of the employee's knowledge with the requirements of the task, the employee's workload for a certain period of time, the time and cost of completing a certain task. Mathematical methods and models that allow effective selection of alternatives in decision-making were considered. In particular, among such methods, the multi-criteria task of appointing potential members of the development team based on the expert method of assessing professional skills was considered. The specificity of this methodology involves comparing employees of the same or similar professions among themselves. The comparison is made according to one or several parameters of the evaluation of employees' competencies. These parameters are chosen depending on the specific content of the task that the employee must perform, since different types of work make different, and sometimes diametrically opposed, demands on the performers. The practical value of such a method lies in providing managers with the possibility of a simplified project management process, when the allocation of executors to work is considered as a multi-criteria assignment task, which can be expanded due to the formation of a calendar plan of tasks and redistribution of workload. The project calendar reflects the main obligations regarding the content, terms and main stages of project implementation and becomes mandatory after signing contracts with customers

Key words: *IT project management, multi-criteria optimization, assignment task, software development, team, calendar plan.*

Нечволода Л. В., Шевченко Н. Ю. Підвищення ефективності управління ІТ-проєктами із застосуванням комплексної методики розподілу виконавців на роботи

Управління проєктами – це застосування знань, навичок, інструментів та методів аналізу виконання проєктів для задоволення їх ключових потреб р. Таке управління проєктом базується на системному підході, який реалізує команда проєкту. В ІТ-сфері проєкт має ознаки тимчасовості та унікальності. Проєкт тимчасовий, бо має визначений початок і обмеження за часом реалізації, що визначають його обсяг та ресурси. Проєкт унікальний, бо являє собою певний набір операцій, призначених для досягнення сингулярної мети. Тому команда проєкту повинна включати людей, які забезпечать оптимальне виконання зазначених операцій з точки зору часу та фінансових коштів з фокусуванням на досягнення бізнес-мети проєкту.

В статті розглядаються основні фактори формування команди ІТ-проєкту, включаючи відповідність знань працівника вимогам завдання, завантаженість робітника за визначений період часу, час та вартість виконання певного завдання. Були розглянуті математичні методи та моделі, що дозволяють здійснювати ефективний вибір альтернатив у прийнятті рішень. Зокрема серед таких методів було розглянуто багатокритеріальну задачу про призначення на базі експертного метода оцінювання професійних навичок потенційних членів команди розробників. Специфіка даної методики передбачає порівняння працівників однієї або схожих за змістом професій між собою. Порівняння проводиться по одному або декільком параметрам оцінки компетенцій працівників. Ці параметри обираються в залежності від конкретного змісту завдання, яке працівник повинен виконати, оскільки різні види робіт висувають різні, а іноді – діаметрально протилежні вимоги до виконавців. Практична цінність такої методики полягає у наданні менеджерам можливості спрощеного процесу управління проєктом, коли розподіл виконавців на роботи розглядається як багатокритеріальна задача призначення, що може бути розширена за рахунок формування календарного плану завдань та перерозподілу робочого навантаження. Календарний план проекту відображає основні зобов'язання щодо змісту, строків та основних етапів реалізації проекту та стає обов'язковим після підписання контрактів з замовниками.

Ключові слова: *управління ІТ-проєктами, багатокритеріальна оптимізація, задача про призначення, розробка програмного забезпечення, команда, календарний план.*

Introduction. The competitiveness of any IT company is directly proportional to the effectiveness of project management that it implements. Therefore, the increase in the complexity of projects, the increase in requirements for the terms of their implementation, the quality of work, technical and technological complexity make it necessary to find new methods of effective project management [1]. The project team is the driving force of the project, and therefore needs special attention when defining the project management strategy. . The correct assignment of team members to perform certain tasks will contribute to increasing not only labor productivity, but also the loyalty of team members, their interest in achieving the value of the developed product [2].

The Ukrainian market of information technologies offers a large number of software products for solving urgent personnel management problems and assigning employees to tasks. However, in these software products, the assignment is usually fixed "manually" by managers who are guided by professional experience and logic. Automating the appointment process will speed up the duration of this stage and significantly reduce the costs of forming teams, and reduce the likelihood of incorrect selection.

Analysis of recent research and publications. In general, the following mathematical methods and models can be used to solve labor resource allocation problems:

- linear optimization models;
- methods of dynamic programming;
- methods of network programming;
- methods are based on transport networks;
- methods of dichotomous programming;
- heuristic methods;
- methods of solving the multi-criteria assignment problem [3].

To date, the works of famous foreign and domestic scientists, such as A. Marshall, M. Porter, A. Voronin, O. I. Zamora, E. P. Kachan, A. Pastukh, V. A. are devoted to the problem of effective use of labor resources. Romanyshin, V. V. Travin, V. M. Geetsya, M. I. Dolishniy, V. V. Onikiyenko, L. I. Abalkin, N. A. Gorelov, T. I. Zaslavska, A. P. Kochetkov, D. Bella, V. L. Inozemtseva, E. Toffler.

The task of assigning performers, which takes into account professional, personal, socio-communicative and other criteria, is called a multi-criteria assignment task (MCAT) from a mathematical point of view. The scientific article by S. V. Levin [4] describes the method of solving the assignment problem with an arbitrary number

of linear criteria. The approach consists in solving single-criteria assignment problems in the form of linear programming problems separately for each criterion and then obtaining a compromise solution that deviates minimally from private solutions. The criteria are assumed to be of equal importance.

In the work of O. E. Skvorchevsky [5] presents the analysis of methods for solving assignment problems with several optimality criteria using the method of sequential optimization for each of the criteria with the subsequent introduction of economically justified concessions for the extreme values of each of the objective functions.

In the model of V. A. Lotov and I. I. Pospelova [6], the solution of the MCAT is proposed using methods of fuzzy logic, namely, using fuzzy binary relations. Compositions of the original fuzzy relations are used to determine the suitability of candidates for assignment.

Therefore, much attention is paid to the problem of MCAT and approaches to its solution in the scientific literature. However, the issue of using these approaches to managing IT teams still requires methodological development and modification to the specifics of the industry.

The aim of research. The purpose of the study is to develop a methodology for forming the composition of the IT team as an element of the management strategy to increase the effectiveness of the implementation of the IT project.

Methods, subject and object of research. The object of research is the IT project management process.

The subject of research is methods and models of project team formation.

Proposed mathematical model. From a mathematical point of view, the task of forming the composition of the IT team will be presented as a multi-criteria assignment task. The task consists in the distribution of different subjects by different objects, taking into account the characteristics (indicators) of the subject, which must meet the requirements of the objects to a certain extent [7].

In our case, the object is a project, depending on the type, the composition of the team is formed according to a different template.

A team template is a team construct that consists of a list of roles and role requirements:

$$P(i) = p1, p2, \ldots, pn, \tag{1}$$

where $P(i)$ – an array of requirements for the i-th role;

$p1,p2,\ldots,pn$ – a requirement for a candidate for role.

After determining the team template, the process of selecting candidates for each role begins:

1) selection of potential team members;
2) checking for overloading of a team member by other projects;
3) calculation of criteria according to knowledge;
4) determination of the final coefficient of conformity to the role.

A task is a complex set of activities aimed at achieving a business goal. Depending on the size of the project, the team may consist of different numbers of participants.

For the performance of each task there are certain requirements for knowledge that can be submitted in the form of some data array:

$$Q(j) = q1, q2, \ldots, qn, \tag{2}$$

where $Q(j)$ – the array of the j-th task;

$q1, q2, \ldots, qn$ – criterion by a defined skill.

A similar array with criteria for the task is formed for a set of knowledge assessments of each team member:

$$K(i) = q1, q2, \ldots, qn, \tag{3}$$

where $K(i)$ – the array of i-th skill scores team member,

$k1$, $k2$, … , kn – the assessment of a defined skill.

To evaluate the knowledge requirements, it is suggested to use the method of expert evaluations [8] on a scale from 1 to 10 (where 10 is the greatest difficulty in the task). Each team member is tested to assess their skills.

Selection of participants is done sequentially for each role in the team. The algorithm includes 6 stages:

- formation of a calendar plan;
- selection of potential team members;
- overload check;
- calculation of criteria according to knowledge;
- forming the economic feasibility of involving a participant;
- calculation of the final coefficient.

Project and technological documents that establish a complete list of project works, their interrelationship, sequence and deadlines, duration requirements, as well as resources necessary for the implementation of works are called calendar plans. Calendar plans are drawn up for the entire life cycle of the project and separately for its stages, for different levels of management and project participants [9].

Stages of calendar planning:

- drawing up a structural decomposition of works (SDW);
- determination of the list of project tasks based on SDW;
- determining the sequence of works and their interrelationships using organizational and technological models;
- clarification of time limits;
- determining the duration of works;
- optimization of the project work schedule with time criteria;
- approval of calendar plans.

The determination of the early start of work is carried out according to the formula:

$$D_i = D_{i-1} + t_{i-1}, \tag{4}$$

where D_i – early start of work;

D_{i-1} – early start of the task preceding D_i;

t_{i-1} – the duration of the task D_i.

If the task has several predecessors, the following formula is used:

$$D_i = Max(D + t), \tag{5}$$

where $D+t$ – the set of the early start and duration sums of the tasks preceding the given one.

In the next step, the time reserve is calculated, which appears when several tasks are performed in parallel:

$$T_i = D_i - D_{i+1} + t_i, \tag{6}$$

where T_i – time reserve for the *i*-th task;

D_i – early start of execution for the *i*-th task;

D_{i+1} – early start of execution for the *i+1* task;

t_i – execution time for the *i*-th task [10].

At the stage of selecting potential team members, a pairwise comparison of task requirements and skill ratings of each participant is performed:

$$e_j = \begin{cases} 0, if\ q_j > k_j, \\ 1, in\ other\ cases, \end{cases} \tag{7}$$

where e_j – the result of comparing the requirements of the task and the skills of *p* team members according to the *j*-th criterion.

If all e_j are equal to 1, then the participant is admitted to the stage of involvement in the team.

The stage of checking the employment of a potential participant involves calendar planning (Table 1).

Table 1

Calendar plan

Date	**Team member**			
	***w*1**	***w*2**	**…**	***wk***
*d*1	*e*11	*e*12	...	*e*1*k*
*d*2	*e*21	*e*22	...	*e*2*k*
...	...	...	...	...
dl	*el1*	*el2*	...	elk

The table shows:

- set *W* = (*w1, w2, ... , wk*) – set of participants, *k* – number of participants;
- set *D* = (*d1, d2, ... , dl*) – a time interval of *l* days;
- *elk* – employment of the *k*-th participant on the *dl*-th day.

If the potential member of the team does not have a task-free interval of sufficient length, then he is not included in the team.

To calculate the criteria for matching the potential participant's knowledge to the requirements of the task, it is advisable to use metrics from the theory of measurements [8; 10].

The metric makes it possible to compare how close the potential participant's knowledge is to the requirements of the task.

The metric in the space R^n of the vectors *Q* = (*q1, q2 ,... , qn*) and *K* = (*k1, k2,... , kn*) is calculated according to the following formula:

$$d(k,q) = \sqrt{\sum_{j=1}^{n} \left(k(j) - q(j)\right)^2}\ . \tag{8}$$

At the stage of formation of the economic feasibility of involvement, criterion G is calculated – the workload criterion of a potential team member. The criterion determines

how much a potential participant was loaded during a certain period of time (for example, during a week):

$$G[i]=(F+E+A)/P, \tag{9}$$

where P – Is the number of scheduled hours for the selected time period;

F – the actual number of hours worked;

E – the number of hours missed due to illness;

A – the number of hours missed due to the fact that the participant's registration has passed after the start of a certain period of time.

The final coefficient of "inclusion" of a potential participant in the project team is calculated according to the formula:

$$N[i]=R[i]+\frac{1}{G[i]}, \tag{10}$$

where $N[i]$ – the final coefficient.

Participants with the lowest final coefficient are selected for project implementation.

Based on the described methodology, an informational one was created using the Laravel framework and the PHP language (Fig. 1). In order to view information about the worker, you need to click on the line with the worker's name on the main page (Fig. 2).

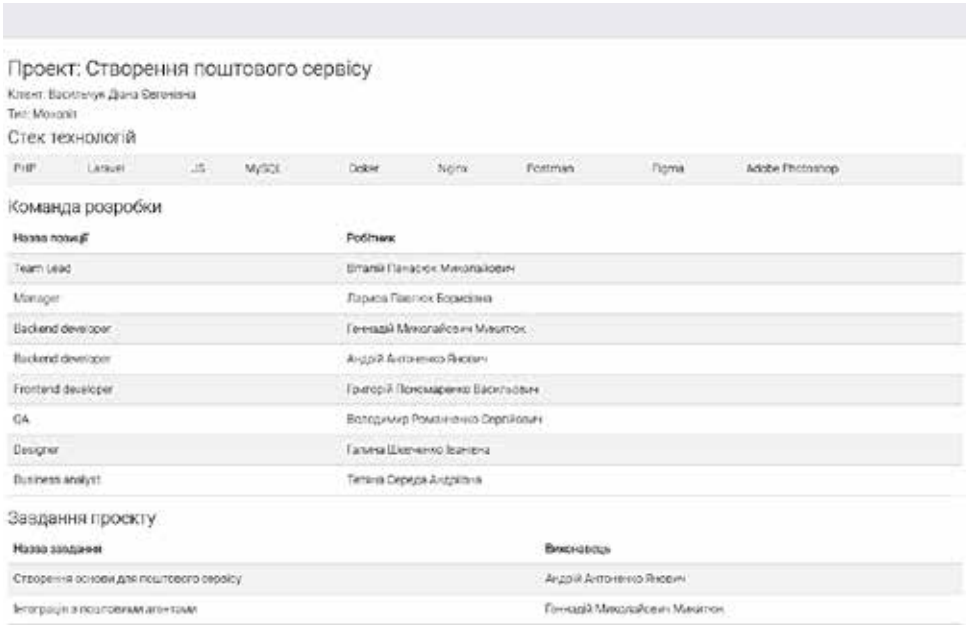

Fig. 1. The task detail view page

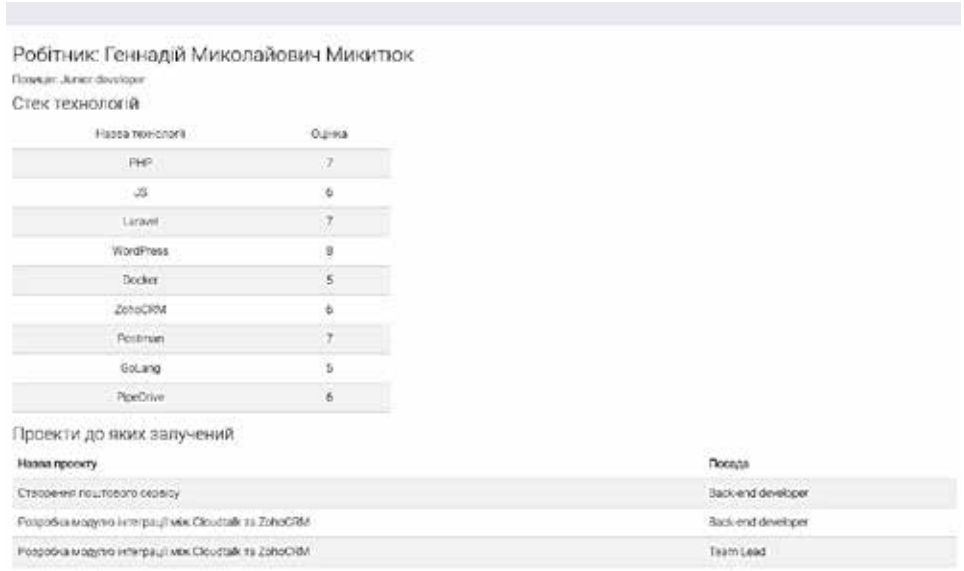

Fig. 2. Detailed information about the worker

Conclusions. The proposed complex method of forming the composition of the IT project team is based on the solution of the multi-criteria assignment problem using metrics, calendar planning and calculating the workload of workers. Two templates of team formation were proposed: for the project and for the task within the project. The difference is that when forming a development team for a project, an analysis of the company's employees is performed, and for a task – among members of the project team. The critical path method was chosen to form the calendar plan, which consists in calculating the early start of work, late start of work and determining the time reserve for each task. The selection of the composition of the development team is based on an assessment of the knowledge and workload of potential team members. Such a comprehensive approach allows to reduce the time of formation of the project team and eliminates the risk of wrong assignment.

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