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Kravchenko O.

*Ph. D. in Technical Sciences, Associate Professor,
Taras Shevchenko National University of Kyiv, Ukraine;
e-mail: kravchenko_ov@gmail.com; ORCID ID: 0000-0002-9669-2579*

Stepanov M.

*Doctor of Technical Sciences, Senior Researcher, Professor,
Taras Shevchenko National University of Kyiv, Ukraine;
e-mail: 2m.stepanov@gmail.com; ORCID ID: 0000-0001-6376-4268*

Besedina S.

*Ph. D. in Technical Sciences, Associate Professor,
Cherkasy National University named after Bohdan Khmelnytsky, Ukraine;
e-mail: besedina_sv@ukr.net; ORCID ID: 0000-0002-5391-643X*

Mezentseva O.

*Ph. D. in Economics, Associate Professor,
National Aviation University, Kyiv, Ukraine;
e-mail: olga.mezentseva.fit@gmail.com; ORCID ID: 0000-0002-8430-4022*

Telichko N.

*Ph. D. in Economics, Associate Professor,
Odessa State Academy of Civil Engineering and Architecture, Ukraine;
e-mail: sklnata@ukr.net; ORCID ID: 0000-0003-1571-3364*

METHODS AND MODELS OF DETERMINING COMPATIBILITY MANAGEMENT TEAM IT-PROJECTS

Abstract. The crisis of Covid-19, in addition to the global pandemic, dealt a devastating blow to the economy and business of the company, companies suffered the most financially. The authors of the study are devoted to the means of establishing optimal roles in the process of using scientific and practical methods for the members of the project management team, as well as the optimal means of their interaction in the process of solving problems taking into account human personality psychotypes. The article considers a conceptual model for assessing competency skills of job seekers when forming the production structure of a corporate IT-organization using fuzzy sets. The analysis of the existing problems of the selection of personnel in organizations whose activity is related to the development of software of various orientations is analyzed. The conceptual model underlying the human capital management system of the project is the system model for managing the human capital of the project, the elements of which correspond to the organizational environment of the project, the identity of the team member, his professional activities in the project and the configuration of the project product being created. The most common psychotypes of employees of engineering IT-organizations are described. Their interaction has been studied in detail using the generalized method of activating the creative activity of the human capital of the project. The typological composition of roles, positions in modern IT-organizations with recommended socionic, technical, organizational types for each performer is given. A model for assessing the competence of the competitor for the role, position in the IT-organization was developed. The eligibility of a candidate for a job in an IT-organization is based on the results of testing and interviewing, without formalizing the uncertainties, risks, and the reasoned consideration of personal incomes and the potential of human capital. The authors presented the results of the study a method for forming a project software team, the concept of human resources management, which can be used in project-oriented management of enterprises in various fields of activity.

Keywords: team building, assessment of competence skills, staff selection, IT-organization, method.

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Кравченко О. В.

кандидат технічних наук, доцент,
Київський національний університет імені Тараса Шевченка, Україна;
e-mail: kravchenko_ov@gmail.com; ORCID ID: 0000-0002-9669-2579

Степанов М. М.

доктор технічних наук, старший науковий співробітник, професор,
Київський національний університет імені Тараса Шевченка, Україна;
e-mail: 2m.stepanov@gmail.com; ORCID ID: 0000-0001-6376-4268

Бесєдіна С. В.

кандидат технічних наук, доцент,
Черкаський національний університет імені Богдана Хмельницького, Україна;
e-mail: besedina_sv@ukr.net; ORCID ID: 0000-0002-5391-643X

Мезєнцева О. О.

кандидат економічних наук, доцент,
Національний авіаційний університет, Київ, Україна;
e-mail: olga.mezentseva.fit@gmail.com; ORCID ID: 0000-0002-8430-4022

Телічко Н. О.

кандидат економічних наук, доцент,
Одеська державна академія будівництва та архітектури, Україна;
e-mail: sklnata@ukr.net; ORCID ID: 0000-0003-1571-3364

МЕТОДИ І МОДЕЛІ ВИЗНАЧЕННЯ СУМІСНОСТІ УПРАВЛІННЯ КОМАНДОЮ ІТ-ПРОЄКТІВ

Анотація. Криза Covid-19, окрім світової пандемії, завдала нищівного удару по економіці і бізнес-компанії, підприємства постраждали найсерйознішим фінансовим чином. Присвячено засобам установам оптимальних ролей у процесі використання наукових і практичних методів для членів команди управління проектами, а також оптимальним засобам їх взаємодії у процесі розв'язання проблем з урахуванням психотипів особистості людини. Розглядається концептуальна модель оцінки компетентнісних навичок шукачів роботи при формуванні виробничої структури корпоративної ІТ-організації з використанням нечітких наборів. Проаналізовано аналіз наявних проблем підбору персоналу в організаціях, діяльність яких пов'язана з розробленням програмного забезпечення різної спрямованості. Концептуальна модель, що лежить в основі системи управління людським капіталом проекту, — це системна модель управління людським капіталом проекту, елементи якої відповідають організаційному середовищу проекту, особі члена команди, його професійній діяльності у проекті та конфігурації продукту проекту, що створюється. Описано найпоширеніші психотипи працівників інженерних ІТ-організацій. Їхня взаємодія детально вивчена із використанням узагальненого методу активізації творчої діяльності людського капіталу проекту. Наведено типологічний склад ролей, посад у сучасних ІТ-організаціях із рекомендованими соціонічними, технічними, організаційними типами для кожного виконавця. Розроблено модель оцінки компетентності конкурента за роль, позицію в ІТ-організації. Право кандидата на роботу в ІТ-організації базується на результатах тестування і співбесід, без формалізації невизначеності, ризиків та обґрунтованого врахування особистих доходів та потенціалу людського капіталу. Представлено результати дослідження методу формування проектної команди програмного забезпечення, концепції управління людськими ресурсами, яка може бути використана у проектно-орієнтованому управлінні підприємствами різних сфер діяльності.

Ключові слова: командоутворення, оцінка компетентнісних навичок, підбір персоналу, ІТ-організація, методи.

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Introduction. Of all the project's human resources groups, the project team has the greatest influence on its success. It is this group that shapes the vision of the project, so the quality of its work depends largely on the personality of each member of the project team and the use of the potential of the people involved in the project work. How well the management team works will depend on the end results of the business idea implementation. Of all the human resources classification teams, staff, team, have the greatest influence on the success of the whole project. One of the components of such a chain is psychological compatibility. But having the experience of successfully managing a project industry in a particular industry that has been implemented in that environment does not always guarantee the same success when moving to a project in another industry or environment.

Analysis of research and problem statement. According to the task of this article, the directions of domestic and foreign research of authors are of interest: Streletsky [1], Lukyanov and Kolesnikov [2], Zamula et al. [3], Reva [4], Higgs [5], Myers-Briggs et al. [6], Gordeeva [7], Nitsenko et al [8], Terepyshchyi and Khomenko [9], Muravetskiy and Kramskoy [10] and others [11—22]. A number of individual team-building works have an integral character. For example, Gordeeva considers the formation of a complementary team for risk management of innovative projects [7], Cherepakha a productive and environmental approach to project team formation is proposed, based on taking into account the product features and the project context (contains), as well as the professional, role and psychological balance of team members. Scientific and practical approaches to the selection of human resources of the project. These team roles for Raymond Meredith Belbin are divided into four groups: leadership, activity, thinking and socialization according to the criterion of the main role function [12]. In confirming the correctness of his method Fatkhutdinov and Bazaluk cite the statement of Raymond Meredith Belbin, that teams that had more than one idea generator performed no better than those teams that had no idea generators at all [14]. Lukiyanov considers the application of the method of role analysis, in its original form, in accordance with the methodology of Markov chains. The scope of this method is software projects, with this in mind it is proposed to divide groups of roles according to three indicators: strategy, sensorics, ethics [2]. For the authors in this distribution, there is a hint — how the team members should interact, representing certain roles that in the process of applying psychophysiological methods contain a heuristic technique of «collective discussion» [4]. This paper is a continuation of a series of articles on the modeling of personnel management processes [13; 22], and details the previously proposed conceptual socio-system model and management mechanisms for teams of software projects [8; 20].

The purpose of the article. Development of project team formation tools based on the compatibility of psychotypes and roles of team members that take into account the features of the software product and project implementation environment. The task is to improve the vector model based on the Hans Jürgen Eysenck method, taking into account the possibility of forming coordinated project teams as a balanced composition of software project personnel management.

Unsolved aspect of the problem. At the same time, the problem of compatibility of software project team members is very complex and important in today's globalized world, which poses new challenges to the management of enterprises and authorities, therefore permanent research is needed. To date, as practice shows, despite the careful selection and formation of small groups, such projects end in failure because they are realized by the human resources of a particular project. At the same time, given the increasing role of human resources management in projects, the situation becomes a trivial problem for many software projects — the solution of personnel management problems.

Research results. It is known that the effective work of the project management team is based on the stage of its formation. However, even if you manage to select the most optimal composition of the software project team, the tasks of managing the team not only do not become simpler, but on the contrary — complicated. Managing software professionals is much more difficult than managing ordinary software professionals. They are more ambitious, independent in judgment, less disciplined, do not take the command tone very much and are characterized by other

qualities that complicate the activity of an software project manager [11]. In addition, sometimes the project manager has limited powers to select members of the project team. Especially when the project has a large number of stakeholders, they insist on including their representatives in the software team [13]. Effective management in the context of such dual subordination is often a critical factor in the success of an software project implementation. It also requires the project manager to have strong human resource skills, knowledge of basic standards and project management techniques [10]. The typology of team roles by the method of personality psychotypes. An effective software team can be defined by the overall performance criteria of any organizational structure. But it is possible to point out some specific features that are unique to the team only [9]. The team role should take into account the psychological characteristics of the project team member.

Basic studies of personality psychotype belong to Karl Gustav Jung. He argued that every person was oriented from the outset to the perception of external or internal aspects of life. Most commonly used in management is the Myers-Briggs typology. Psychotype, according to the Myers-Briggs typology, reflects the psychological characteristics of the person, less dependent on external circumstances and experience, and to a greater extent — on the innate features of the nervous system. From the point of view of spontaneous expression of ideas inherent in heuristic analysis, the innate abilities of man are important [4].

The connection between the psychotype of the individual, in accordance with the Myers-Briggs tests, and the natural, optimal role when using heuristic methods, on the example of the method of brainstorming, as well-known, as well as the proposed «generalized method of activating creative activity» is considered. It should be noted that the results obtained for psychotypes by Myers-Briggs typology can, to some extent, be used for the classifications of R.M. Belbin and MTRs. Another MTR-i (Management Team Roles Indicator) typology of teams roles is described mainly in English-language literature [5]. According to MTR-i: there are eight roles: coach — leads the whole team to agreement and harmony, creating a positive atmosphere of the team and reaching consensus, knight (crusader) — feels priorities, emphasizes the most important issues and selects the most valuable topics for discussion, explorer — discovers and explores new possibilities in situations and people, innovator — using imagination, proposing new and alternative ideas and seeing new perspectives, sculptor — completing the work, solving the most acute in the dew help his tools and skills, the curator — explains ideas and information, retains better knowledge, has a clear understanding of any situation, conductor — structures and logically organizes ways of doing the work, scientist — explains the situation and its causes, builds models that demonstrate how it works [6].

One, the pragmatic type, prefers a practical, «life-like» approach. Another type, creative, often works with global ideas. Representatives of both types are extroverts in relationships, so they are sociable and easy to get in touch with. In addition, they have an analytical view of the problems, and any solution to them is subject to the laws of rigid logic. In all other respects, these people are different [8].

Pragmatic type: may have a sufficiently practical attitude to problem solving; prefers to have complete information, knowing examples of successful situations; bases its opinion on experience; mainly works with what is, so you need to be well prepared to work with it.

The creative type, being an extrovert and possessing analytical capabilities, takes a more flexible and practical approach. Communicative, creative, prone to analysis and systematic work, such a person will prove well in projects that: require focus on meeting market needs; use their ideas and plans; require a well-organized system [9].

Analysis of conventional classification shows that each temperament can be found both positive and negative properties. Good upbringing, control and self-control make it possible to show: melancholic — as a vulnerable person with deep emotions and emotions; phlegmatic — as sustained, without hasty decisions to the person; sanguine — as highly sensitive to any person's work; choleric — as a passionate, frantic and active in the work of the individual.

The interpretation of this Hans Jürgen Eysenck test for a group of persons, in particular for the project team, on the scales on which the interpretation of the test for the person is followed, will have its own peculiarities. These features relate to the interpretation of scales. The interpretation of the fidelity scale in this case will indicate the correlation of the directions of the command «in itself» (ie, on internal team goals, tasks, relationships), or in the external world (ie, on supra-system goals and tasks, on solving problems arising «at the junction» the team and the external environment, relationships and communication outside the team), or the balance of these areas.

The interpretation of the same scale of neuroticism, as in the case of one person, will reflect the intensity of the team response to external stimuli.

Testing, according to our proposed methodology, is conducted by each member of the project team separately. Then their results are placed in a single field of test interpretation (Fig. 1).

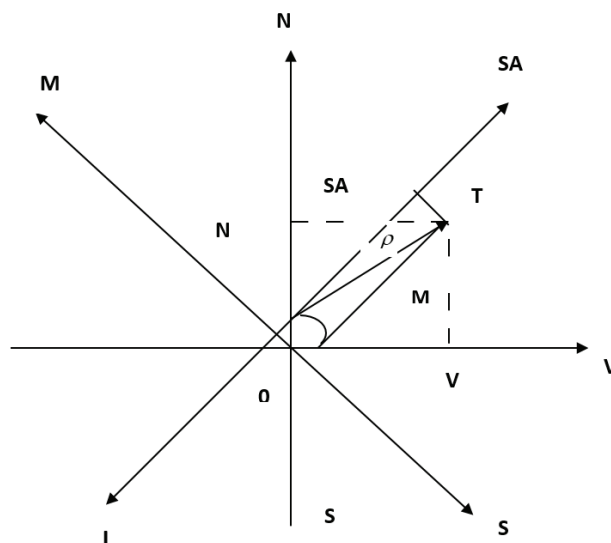


Fig. 1. Graph scales and vectors for command interpretation of H. J. Eysenck test

This determines the degree of tension between any project team member, identifies the capabilities and limitations of each team member, and identifies team members with the same response.

Very interesting data were obtained using vector algebra, projecting the results on the diagonal of the testing space. Production on the rising diagonal, as it turned out, shows the relative speed of activity. In the direction of the right — uphill, on the left — to the bottom, on the contrary, the infallibility increases. But by reducing the speed. Thus, it turned out that the requirements of speed and error are incompatible. If the execution of the project requires the work to be done quickly and efficiently, it is necessary to decide what will take more time — to delay the work or to correct the mistakes that will be if work quickly and appropriately place the employees. However, it seems that the conflicts will in any case be the same in terms of topics and intensity. The specificity of personnel management will depend only on the management style of its manager. Now let's move on to evaluating the team as a whole. For this purpose, we will need to pay attention to intra-team communications [11].

Part of the Hans Jürgen Eysenck test space, which is responsible for extraversion during the testing of one person, will be responsible for this [8]. And, to reflect the contacts of the team with the outside environment, it is necessary to expand the scale of «fidelity» by another 6 positions (strictly speaking, the measure of «stretching» depends on the number of persons in the team, but for a team with considered limitations of quantitative composition it is advisable to adopt this kind of simplified test space). Regarding the neuroticism scale, we assume that the behavior «within normal limits» is the same for a person as well as for a small team of 3 to 9 people [18].

The projection of the result onto the descending diagonal of the projection also makes sense and is also different in two directions. Therefore, if it is expected to work in conditions of strong obstacles — it is necessary to take, to form «obstacle-resistant staff», but to achieve the task will

not be easy. And if a subtle response to small incentives is important, then it is worth considering the highly managed staff.

True to such staff, it will be necessary to create special, standard, unobstructed conditions for work, and in no case to give him «extra» commands, orders [14].

Imagine a vector of temperament \vec{T} in polar coordinates, $\vec{T} = T(\rho, \varphi)$, therefore, version and neuroticism can be determined from expression; $V = \rho \cdot \cos \varphi$; $N = \rho \cdot \sin \varphi$.

In the polar coordinates you can get other parameters of temperament, character of the tested personality of the staff:

- speed of activity: $SA = \rho \cdot \cos\left(\frac{\pi}{4} - \varphi\right); \tag{1}$

- infallibility: $I = -\rho \cdot \cos\left(\frac{\pi}{4} - \varphi\right); \tag{2}$

- stability: $S = \rho \cdot \cos\left(\frac{\pi}{4} + \varphi\right); \tag{3}$

- manageability: $M\gamma - S = -\rho \cdot \cos\left(\frac{\pi}{4} + \varphi\right). \tag{4}$

The peculiarity of the formation of staff, small groups is the advisability of including in the team of an additional group member to equalize the temperament of the group [15]. In addition, the situation in the labor market today, the situation of supply shortages in demand allows us to form a team not only by professional qualities, but also by the psychological characteristics of the individual [16].

Thus, if a group consists of three people two of whom have temperaments $(V_1; N_1)$ and $(V_2; N_2)$, then their total temperament will have the coordinates $(V_1 + V_2; N_1 + N_2)$. Since the optimal value of the vector of temperament of the group must have coordinates $(6; 0)$, then the coordinates of the vector of temperament of the third member of the group $(V_3; N_3)$, then we can determine by the formulas: $V_3 = 6 - (V_1 + V_2)$, $N_3 = 0 - (N_1 + N_2)$. The problem is solved similarly in the case of using polar coordinates [19] (Fig. 2).

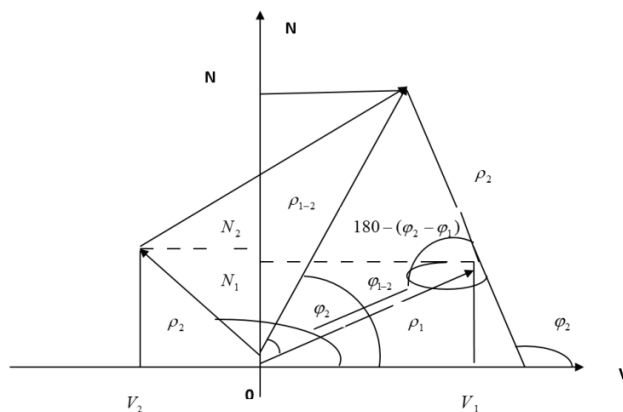


Fig. 2. Graph and vector method of determination of temperament of small groups of software project

The influence of the quality team of the software project on the magnitude of risk, damage. Optimization of the formation of the qualitative composition of the command was carried out based on an analysis of the temperaments of individuals and functional groups of the software project.

The control parameters for the team were the quantities $\Delta\rho$ — the deviation of the length of the vector of the total temperament from the optimal value and $\Delta\varphi$ — the angle between the actual and optimal temperament of the functional group performing certain tasks on the project.

The relative values of the objective function were plotted along the coordinate axis $\bar{R} = R/R_{opt}$, where R_{opt} is the value of the objective function with an optimally formed project team

[13]. As can be seen from Fig. 3, the additional risk or damage to the head / director of the project organization can reach = 15%.

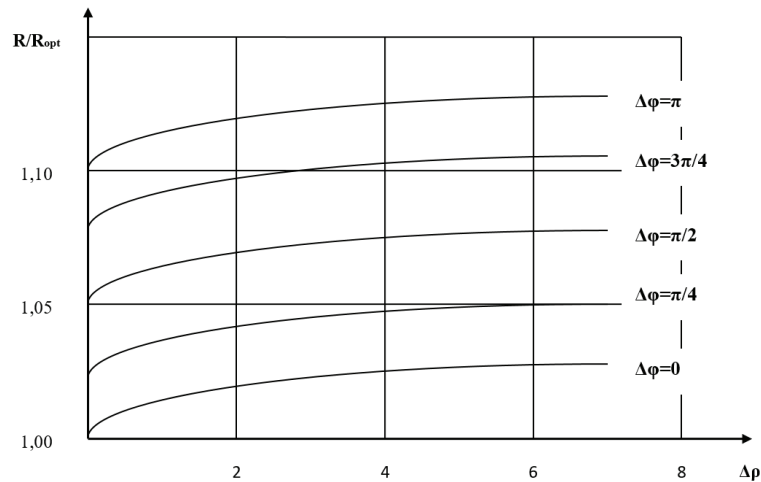


Fig. 3. Analysis of the qualitative composition of the project software team

The basis of a productive environmental approach to software project team management is to uncover the systematic impact of project uniqueness factors on the team workflow [12]. The productive environmental approach to managing an software project team is based on the following points:

1. The uniqueness of the project in the team management.
2. The quality of the project team formation.
3. The professional qualities of members of the software project team, the unlocking of the team’s potential and the choice of the means of development of the project team.
4. The motivation of a project team member.

5. Evaluation of the actions of the manager to activate the professional activity of the IT project team should take into account not only the quality of work of the team members, but also preserve their psychophysical ability to perform such activities throughout the project, taking into account the peculiarities of the software project implementation [11].

In order to evaluate the quality of team formation in the developed mathematical model, an indicator of the balance of the project team ET_{Team} was introduced, which reflects the suitability of the team with the recruitment of candidates $Team$ for the execution of a specific project [14]. This indicator is determined by the balance of the professional ($ETprs_{Team}$), role ($ETrs_{Team}$) and psychological ($ETpss_{Team}$) structures of the project team, taking into account the priority of each of these structures for successful implementation of the project (weighting factors $PRprs$, $PRrs$ and $PRpss$ in accordance):

$$ET_{Team} = PRprs \cdot ETprs_{Team} + PRrs \cdot ETrs_{Team} + PRpss \cdot ETpss_{Team}. \quad (5)$$

The balance of the professional structure of the project team is suggested to be determined by the team members having the knowledge and skills Eks_{Tfun}^C , necessary to perform the functions of the project team $Tfun$, and taking into account the weight coefficients of this knowledge and skills for the project implementation $PRks_{Tfun}$:

$$ETprs_{Team} = \sum_{Tfun=1}^{NTfun} \left(PRks_{Tfun} \cdot \max_{C \in [1; NM_{Team}]} (Eks_{Tfun}^C) \right). \quad (6)$$

The balance of the role structure of the project team is proposed to determine the quality of each role in the team $\max_{C=1}^{NM_{Team}} (Erole_{Trole}^C)$ taking into account their priority for the implementation of the project $PRrole_{Trole}$, and the complementarity of these roles:

$$ETrs_{Team} = \sum_{Trole=1}^7 \left(PRrole_{Trole} \cdot \max_{C \in [1; NM_{Team}]} (Erole^C_{Trole}) \right). \tag{7}$$

It is proposed to determine the balance of the psychological structure of the project team on the basis of an analysis of the suitability of the nature of the interaction of the team members for the project implementation.

Based on the analysis of the professional diagrams developed for each role in the project team, sets of professionally important qualities for these roles $PIQtm_{Trole}$ were formed (see Fig. 2). Analyzing the impact of project uniqueness factors on changing requirements for professionally important qualities required to fulfill certain roles in the project team, the dependencies of these requirements on the critical process in the project Cp , the control system in the executive organization Ocn , the field of product creation Ro , its novelty Rn and the scientific intensity Rs are determined. The dependence of a set of professionally important qualities for a particular role on the following indicators of professional activity, which is most characteristic for this role in the project, is determined as well: from the objective system of professional activity Wos_{Trole} , its operational purpose Woa_{Trole} , the urgency of its implementation Wu_{Trole} , and the average number of contacts during the working day Wns_{Trole} :

$$PIQtm_{Trole} = f(Trole, Cp, Ocn, Ro, Rn, Rs, Wos_{Trole}, Woa_{Trole}, Wu_{Trole}, Wns_{Trole}). \tag{8}$$

These dependencies, formalized by several systems of equations, became the basis for determining the candidate's ability to qualitatively fulfill a specific role in the project team $Erole^C_{Trole}$. Such ability will be determined by the difference of its manifestation of professionally important qualities $PIQtc_C$ from the requirements established for this role in the terms of a specific project $PIQtm_{Trole}$:

$$Erole^C_{Trole} = 1 - |PIQtm_{Trole} - PIQtc_C|. \tag{9}$$

Using the project team balance score as the criterion for selecting the team most suited to the project, the product-environmental approach is based on selecting a pool of candidates for whom the team balance is maximized. This allows to plan the achievement of synergistic effect due to the complementarity of the abilities of different project team members, which is not possible with the separate selection of project team members [14].

Revealing the potential of the team in the proposed approach is seen as an increase in the level of balance of the professional, role and psychological structures of the project team, and the priority of the development of a certain team structure is determined by the weight of development of this structure [17]. The weights of the development of the professional ($PDtprs$), role ($PDtrs$) and psychological ($PDtpss$) structures of the project team in the developed mathematical model are proposed to determine the impact of the imbalance of the relevant structure on the overall imbalance of the project team, taking into account the priority of this team structure for project implementation:

$$\begin{cases} PDtprs = PRprs \cdot \frac{1 - ETprs_{Team}}{1 - ET_{Team}}; \\ PDtrs = PRrs \cdot \frac{1 - ETrs_{Team}}{1 - ET_{Team}}; \\ PDtpss = PRpss \cdot \frac{1 - ETpss_{Team}}{1 - ET_{Team}}. \end{cases} \tag{10}$$

Considering that of all the structures of the software project team, the state of the psychological structure of the team depends to a large extent on the choice of the means of its development. To determine the balance of the psychological structure of the project team (based on the social and psychological research Myers-Briggs and Hans Jürgen Eysenck) a model of its relationship with the structure of the basic level of personality of the team member and the processes of project team management was developed (see Fig. 3).

Based on this model, the balance of the psychological structure of the project team $ETpss_{Team}$ is determined by the conformity of each of its elements to the state necessary for the successful implementation of the project and acceptable for work with the team $Team$. Each element of the psychological structure of the team (decision-making style $Tsol_{Team}$, value-oriented unity of the team Tem_{Team} , emotional identification of the team, its creative potential $Tcreat_{Team}$, deterministic behavior in the team Tdt_{Team} and its psychological stability $Tpst_{Team}$) is included in the indicator considering the significance of this element for the project (weighting factors $PRsol, PRvu, PRem, PRcreat, PRdt, PRpst$ in accordance):

$$ETpss_{Team} = PRsol \cdot Tsol_{Team} + PRvu \cdot Tvu_{Team} + PRem \cdot Tem_{Team} + PRcreat \cdot Tcreat_{Team} + PRdt \cdot Tdt_{Team} + PRpst \cdot Tpst_{Team} \quad (11)$$

In order to activate the professional activity of an information technology project team, it is necessary to solve two problems — formation of motivation of each team member to activate his work in the project and ensure the ability of that team member to activate his activity, which is largely determined by his psychophysical state [14; 15; 17]. According to the results of the study of the impact of project uniqueness factors on the team members' motivation process, an indicator of the project's motivational potential for the project team member ($Vproj_M$) was introduced.

$$Vproj_M = Vst_M + Vteam_M + Vpwork_M + Vorg_M + Vprod_M. \quad (12)$$

Then, the motivation of the individual when engaging in the work of the project team $Eproj_M$ will be determined by the motivational potential of the project $Vproj_M$, taking into account the urgency of achieving personal goals [18], which influenced the subjective significance of the motivational potential of the project $QAim_M$, and the attractiveness of alternative ways to achieve personal goals other than participation in the project $AltW_M$:

$$Eproj_M = Vproj_M \cdot QAim_M \cdot (1 - AltW_M). \quad (13)$$

In the developed mathematical model for predicting the professional burnout of a team member, the psychophysical activity of a team member is considered as the sum of his physical (Aph_M), intellectual (Ath_M) and emotional (Aem_M) activity. The professional burnout of a team member is a consequence of his exhaustion in the process of work in the project, and is considered as a decrease in physical or intellectual activity to zero mark and the transition of emotional activity to negative values:

$$\begin{cases} Aph_M \rightarrow 0 \text{ or } Ath_M \rightarrow 0; \\ Aem_M < 0. \end{cases} \quad (14)$$

Predicting the professional burnout of team members (at first approximation) becomes possible with the known values of physical, intellectual and emotional load characteristic of the project team work process [19; 21]. According to the results of the study of the influence of factors of project uniqueness on the process of psychophysical burnout of team members, the dependence of physical, intellectual and emotional load in the process of work of a team member on the indicators of the content of his professional activity and indicators of elementary operations of his activity [12; 14; 22]. Thus, the typology of Myers-Briggs psychotypes is the most sophisticated and optimal in defining the roles of project management teams in commercial enterprises and organizations.

Conclusions. Thus, the implementation of world best practices in project team formation will help improve approaches to the selection of a compatible software project team, which will ultimately contribute to more effective implementation of programs, portfolios and projects. We believe that the best interaction of project team members in the process of applying psychophysiological methods is described by the Myers-Briggs typology, since the method of Raymond Meredith Belbin does not take into account the psychotype and temperament of the project team member. The Myers-Briggs technique identifies four even-numbered groups of personality temperaments, whose consideration in modern multitasking helps the software project team to achieve the best result by fulfilling the project's goal.

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