Створено економіко-математичну модель формування команди проекту. Для комплексної оцінки оптимальності складу команди проекту запропоновано врахувати показники професійної, інтелектуальної, соціальної складової та знання, зацікавленість і досвід вирішення аналогічних задач. У моделі застосуються елементи комбінаторики, експертне опитування та метод безпосередньої оцінки

Ключові слова: команда проекту, економіко-математичне моделювання, вагові коефіцієнти, комплексна оцінка

Создана экономико-математическая модель формирования команды проекта. Для комплексной оценки оптимальности состава команды проекта предложено учесть показатели профессиональной, интеллектуальной, социальной составляющей и знания, заинтересованность и опыт решения аналогичных задач. В модели применятся элементы комбинаторики, экспертный опрос и метод непосредственной оценки

Ключевые слова: команда проекта, экономико-математическое моделирование, весовые коэффициенты, комплексная оценка

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ECONOMIC-MATHEMATICAL TOOLS FOR BUILDING UP A PROJECT TEAM IN THE SYSTEM OF COMPANY'S KNOWLEDGE MANAGEMENT

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1. Introduction

The key to successful functioning of enterprises, without doubt, is creation and effective use of organizational knowledge, its dissemination throughout a company and implementation in products and services. To create new organizational knowledge, the initiative of an employee is essential, as well as exchange of ideas within a group, that is, their interaction, so the main role in the process of creating knowledge belongs to a team [1]. This type of active interaction provides for the transformation of personal knowledge into knowledge of an organization.

To manage any project during its implementation, a specific temporary structure – a project team, led by a supervisor – is created.

The project team is a group of people who possess knowledge and skills necessary for effective achievement of the project goals. The main integral factor of creation and development of a team is implementation of a project as a strategic goal. In the process of achievement of the project goal, a team acquires and creates new organizational knowledge. The experience of the most successful projects demonstrates the need to consider project management as a component of the system of knowledge management.

Application of mathematical modeling allows us to formalize a variety of socio-psychological factors to describe a certain type of relationships in small groups [2]. Nowadays, description of particular phenomena of a small group that are often considered separately from one another, was substituted with understanding of group behavior as a whole process. Given this, application of economic-mathematical modeling makes it possible to solve practical problems of social and psychological compatibility [3] and of management of a group of employees in the process of creation of new organizational knowledge.

Thus, the problem of project management in the system of knowledge management of an enterprise is quite relevant. Application of economic-mathematical modeling allows us

to provide not only the practical recommendations on the selection of team members, but also to increase efficiency of the company.

2. Literature review and problem statement

At present, information and knowledge have become the most powerful means of production. Innovative and intelligent human activities are always interrelated, because as a result of their interaction, new ideas, new means of production, technologies, methods of production organization and of management of socio-economic systems are created [4]. Intellectual resources have become an object of research in economics with the aim of searching for the most effective factor of innovation development. The role of economic-mathematical modeling in this process is also important [5].

As it was noted in papers [1, 6, 7], creation of knowledge at an enterprise is possible at three levels: individual, group and organizational. In article [2], it is noted that in the hierarchy of a company, depending on the carrier of intellectual capital of the organization, it may be divided into intellectual capital of a company, a subdivision, a group, and of an individual. Studies [1, 2, 6, 7] take into consideration all levels of knowledge creation in a company. Therefore, it is necessary to consider creation of company's knowledge at the individual [8], group (project team) level, as well as at the level of a subdivision, level of an enterprise and at external [9] level.

Most scholars solve the problem of formation of target group of employees by solving the multi-criteria problem of appointment. Authors of article [10] proposed to solve multi-criteria appointment problem in the form of linear programming problem, bringing all its criteria in a single objective function and presented some of the options for optimization. Application of economic-mathematical modeling in research [10], does not fully solve the problem of formation of a target group. The optimization options include costs, time, quality and safety of project implementation. However, this approach does not take into account efficiency of employees in a team, considering intellectual, professional and social components. Paper [11] proposed the method of searching for optimal solution of multi-criteria problem of appointment through the search of admissible solution. However, the way of getting this admissible solution is not described. Each criterion is presented as an additional limitation of a general problem, and objective function as a sum of objective functions of private tasks. The solution to this problem either proves optimality of admissible solution, or gives another optimal solution. Paper [11] is more of theoretical value, because there is no practical implementation of the proposed model. The main disadvantage of application of problem of appointment and formation of a project team is focusing not on the efficiency of interaction between team members, but rather on minimizing costs and time for a project.

There are also studies when scientists solve problems of formation of project teams [12, 13]. In paper [12], the main criterion for selection is technical competence of employees in terms of tasks being solved. To solve a problem, linear programming is applied. Minimization of costs of payments for work to project members is used as objective function. Indicator of compatibility between a task and a team member is taken into account and matrix of incidents is constructed (process of agreement). Function of costs depends on individual salary, multiplied by indicator of compatibility of a team member and a task. It is considered that the lower an indicator of compatibility, the longer it takes to perform a task. That is, the composition of a team could be selected through minimizing the project costs. The shortcoming of this approach is consideration of agreement between a project member and the task he performs and complete lack of consideration of compatibility between individual members of a project team. Moreover, neither professional, no intellectual component and existing synergistic effects are considered. Besided, a disadvantage of the developed economic-mathematical model is the condition that every team member works full-time for one project.

Paper [13] proposed to solve the problem of formation of a project team with regard to interpersonal relationships of employees using the methods of sociometric measurements. To assess optimality of the composition of a project team, the criterion, characterizing contribution of employees to the group interaction, was proposed. In addition, the algorithm for solving the problem of selection of candidates for a team project by the criterion of total contribution of employees to group interaction was proposed. However, in this paper, results of modeling demonstrate probability of several options for the composition of a project team with equal values of objective criterion. This aspect greatly complicates the process of selecting the team. In addition, the model does not take into account individual, professional and intellectual characteristics of employees and synergistic effect of interpersonal relationships of employees.

Article [14] explores the influence of strategy of company's knowledge management on its ability to create knowledge at individual and group level. Empirical results show that strategy of company's knowledge management has a significant impact on its individual or team capacities for creating knowledge. Individual or group knowledge is able to make a positive impact on activities in the field of R&D. Strategy of company's knowledge management has a significant impact on performance R&D of individuals through enhancing capabilities of creating individual or group knowledge.

Despite scientific achievements of scientists, little attention was paid to an integrated approach to evaluation of creation of knowledge on the following levels: individual, group, department, company, and external level. Especially acute is the problem of economic-mathematical modeling of formation of company's knowledge on the group level of a company considering professional, intellectual and social components.

3. The aim and objectives of the study

The aim of present research is the development of economic-mathematical model of building up a project team's composition and its practical implementation. This model should take into account the professional, intellectual component, the level of social and psychological compatibility and interaction effectiveness of project participants (group) as a component of the knowledge management system of a company.

To achieve the set goal, the following tasks had to be solved:

– development of an algorithmized model of solving the problem of formation of a project team;

– choice of the methods of research for implementation of the developed algorithmized model;

– practical implementation of the developed model on a particular example.

4. Materials and methods of examining the formation of group of employees for the generation of new organizational knowledge

4. 1. Setting the problem on the formation of group of employees for the generation of new organizational knowledge

According to the generally accepted definition, a small group is a small number of individuals who contact directly and are united by common purpose and tasks. Given this, a small group is a system, the elements of which are people and their relationships [3].

In companies, quite a significant role is played by the groups, which have considerable influence on behavior of other employees. That is why it is necessary to study the peculiarities of emergence, functioning and management of groups.

In management, they traditionally distinguish two classes of groups: formal and informal. Formal groups are the groups that are created by order of chief executives for implementation of specific industrial or management functions. The basis for the formation of such groups is the vertical work division (management levels) and horizontal (units, departments, services on the same management level). Informal groups are the groups, creation and functioning of which was not planned. The specified groups form spontaneously.

There are three types of formal groups: a team (group of managers), a working group (target) and committees. A working (target) group consists of people who work to complete the same task. A target group, as a rule, exists for a specific project or a task. Many companies believe that small, less formal target groups work more efficiently and faster than traditional directive groups. Members of a target group have an opportunity to communicate and collaborate.

Application of economic-mathematical modeling makes it possible to predict effectiveness of the created group for generation of new knowledge, helps prevent undesirable conflicts and allows group members to get maximum satisfaction from working in the group. In other words, application of economic-mathematical modeling allows choosing the optimal composition of a project team.

The unity of intellectual potentials of employees in the process of performing a creative task is characterized by a constructive synergetic effect. Intellectual potential of employees, as totality of knowledge, experience, and creative abilities is a means of production in the process of formation and development of intellectual capital. Therefore, efficiency of intellectual activity depends primarily on the intellectual potential of employees [3].

The problem of formation of a group of employees (project team) for generation of new organizational knowledge will be considered in the following statement.

It is assigned: E={E1, E2,..., En} is the set of candidates to be selected to a project team for the generation of new organizational knowledge. It is necessary to determine the optimal composition of the group of employees that consists of m employees.

Therefore, we modeled a problem, in which the manager of a department of a company must select 3 (m=3) from 10 employees (n=10) of the same hierarchy level to form a project team. Accordingly, it is necessary to take into account all criteria of compatibility and effective interaction of selected employees in the process of generation of new organizational knowledge.

4. 2. Economic-mathematical model for the formation of a group of employees and methods used for its construction

To solve this problem is possible by application of economic-mathematical modeling; therefore, the following stages were suggested:

Stage 1. Determining a number of combinations of employees.

First of all, it is necessary to determine the possible number of combinations of employees. For this, we used a formula from combinatorics, in particular, the number of combinations (C_n^m) from n elements to m elements is equal to:

$$C_n^m = \frac{n!}{m!(n-m)!}. \quad (1)$$

Stage 2. Determining all possible combinations of employees.

To automate the process of finding all possible combinations, we used the programming language Python and the itertools library, which contains a feature of combinations. Variable combo includes all of the 120 possible combinations of employees to be examined.

Stage 3. Practical implementation of the model of employee evaluation in the system of knowledge management of a company.

In study [8], while selecting an employee for a vacant position, experts selected the following indicators:

– professional component of P (P1 – professional knowledge, P2 – education, P3 – working experience);

– intelligent component I (I1 – intelligence of perception, I2 – logical (system) intelligence, I3 – creative intelligence, I4 – self-organization);

– social component S (S1 – correspondence of socionic personality type to sphere of activity and profession, S2 – level of interaction of socionic personality type with other team member).

The authors formed the evaluation of EA employee in the system of knowledge management of an enterprise, where P_{inf}, I_{inf}, S_{inf} are the level of relationships between the corresponding component and other components of integrated assessment:

$$EA = P + P_{inf} + I + I_{inf} + S + S_{inf}, \quad (2)$$

where

$$P=(0{,}11215\ P1+0{,}140187\ P2+0{,}11215\ P3);$$

$$P_{inf}=(1{,}0218\ P1\ (P2+P3+I2)+ +1{,}0685\ P2\ (P1+P3+I2)+1{,}0608\ P3\ (P1+P2+I1+I2));$$

$$I=0{,}084112\ I1+0{,}102804\ I2+0{,}084112\ I3+0{,}11215\ I4;$$

$$I_{inf}=1{,}1901\ I1\ (P1+P2+P3+I2+I4)+1{,}0505\ I2\ (P1+P2+P3)+ +1{,}1082\ I3\ (P1+P2+P3+I1)+1{,}4199\ I4\ (P1+P2+P3+I1+I2);$$

S=0,121495 S1+0,130841 S2;

S_{inf}=2,3802 S1 (P1+P3+I1+I2+I3+S2)+
+1,5440 S2 (P1+P3+I2+I3+S1).

Indicator S_2 is calculated by formula:

$$S_2 = \sum h_n k_n, \quad (3)$$

where h_n is the indicator, which represents the level of close cooperation of an employee (En) with the others; k_n is the effectiveness of interaction of employees (En) with the others.

Stage 4. Selection of indicators for integrated assessment of a group of employees of a company, created to generate new knowledge.

To select indicators, we used the opinions of experts who were engaged in evaluation of an employee in the system of company's knowledge management with the use of the same method [8].

Stage 5. Determining weight coefficients.

To determine weight coefficients, we chose the method of direct evaluation. Experts gave points by a certain scale to indicators (from 1 to 3). Subsequently, points were added on every indicator and average point (C_i) was defined:

$$C_i = \frac{\sum_{i=1}^{N} C_{ij}}{N}, \quad (4)$$

where N is the number of questioned experts; C_{ij} is the total points by every indicator.

The given expression is used to calculate weights (S_i):

$$S_i = \frac{C_i}{\sum_{i=1}^{m} C_i}. \quad (5)$$

Stage 6. Formation of integrated assessment of the group of company's employees, created to generate new knowledge.

Having examined a group of employees as an additive model, it is possible to offer the formula for calculation of integrated assessment using selected indicators, and found weight coefficients.

Stage 7. Selection of employees for formation of a small group with the aim of creation of new organizational knowledge.

For all possible combinations of employees, it is necessary to find integrated assessment and select the group with the highest score.

5. Results of research into the process of formation of a group of employees for generation of new organizational knowledge

5. 1. Determining the number of combinations of employees

In our case, according to formula (1) n=10, m=3, so the number of combinations is calculated as:

$$\frac{10!}{3!(10-3)!} = \frac{3628800}{6 \cdot 5040} = 120. \quad (6)$$

That is, 120 combinations of employees are possible.

5. 2. Determining all possible combinations of employees

Code:

```
import itertools
indata = [10,1,2,3,4,5,6,7,8,9]
combo = itertools.combinations(indata, 3)
print(list(combo))
```

Result:

[(10, 1, 2), (10, 1, 3), (10, 1, 4), (10, 1, 5), (10, 1, 6), (10, 1, 7), (10, 1, 8), (10, 1, 9), (10, 2, 3), (10, 2, 4), (10, 2, 5), (10, 2, 6), (10, 2, 7), (10, 2, 8), (10, 2, 9), (10, 3, 4), (10, 3, 5), (10, 3, 6), (10, 3, 7), (10, 3, 8), (10, 3, 9), (10, 4, 5), (10, 4, 6), (10, 4, 7), (10, 4, 8), (10, 4, 9), (10, 5, 6), (10, 5, 7), (10, 5, 8), (10, 5, 9), (10, 6, 7), (10, 6, 8), (10, 6, 9), (10, 7, 8), (10, 7, 9), (10, 8, 9), (1, 2, 3), (1, 2, 4), (1, 2, 5), (1, 2, 6), (1, 2, 7), (1, 2, 8), (1, 2, 9), (1, 3, 4), (1, 3, 5), (1, 3, 6), (1, 3, 7), (1, 3, 8), (1, 3, 9), (1, 4, 5), (1, 4, 6), (1, 4, 7), (1, 4, 8), (1, 4, 9), (1, 5, 6), (1, 5, 7), (1, 5, 8), (1, 5, 9), (1, 6, 7), (1, 6, 8), (1, 6, 9), (1, 7, 8), (1, 7, 9), (1, 8, 9), (2, 3, 4), (2, 3, 5), (2, 3, 6), (2, 3, 7), (2, 3, 8), (2, 3, 9), (2, 4, 5), (2, 4, 6), (2, 4, 7), (2, 4, 8), (2, 4, 9), (2, 5, 6), (2, 5, 7), (2, 5, 8), (2, 5, 9), (2, 6, 7), (2, 6, 8), (2, 6, 9), (2, 7, 8), (2, 7, 9), (2, 8, 9), (3, 4, 5), (3, 4, 6), (3, 4, 7), (3, 4, 8), (3, 4, 9), (3, 5, 6), (3, 5, 7), (3, 5, 8), (3, 5, 9), (3, 6, 7), (3, 6, 8), (3, 6, 9), (3, 7, 8), (3, 7, 9), (3, 8, 9), (4, 5, 6), (4, 5, 7), (4, 5, 8), (4, 5, 9), (4, 6, 7), (4, 6, 8), (4, 6, 9), (4, 7, 8), (4, 7, 9), (4, 8, 9), (5, 6, 7), (5, 6, 8), (5, 6, 9), (5, 7, 8), (5, 7, 9), (5, 8, 9), (6, 7, 8), (6, 7, 9), (6, 8, 9), (7, 8, 9)]

The aim of the study was to select the best combination (the best combination of three employees for generation of new organizational knowledge), i.e., to form integrated assessment of each group and to select the group with the maximum (most effective) forecasted result.

5. 3. Practical implementation of the model of evaluation of an employee in the system of knowledge management of a company

Below we illustrated practical implementation of the proposed model (2) for 10 employees (E1-E10) of a unit, from which it is necessary to choose 3 to generate new knowledge in the group.

Consider that each employee belongs to a different socionic personality type (Table 1).

Table 1

Socionic personality type of 10 employees of a company's department

Employee	Official name	Pseudonym	Social role
E1	Intuitive-logical extrovert (ILE)	«Don Quixotis»	«Seeker»
E2	Sensory-ethical introvert (SEI)	«Dumas»	«Mediator»
E3	Ethic-intuitive extrovert (EIE)	«Hamlet»	«Tutor»
E4	Logic-sensory introvert (LSI)	«Maxym Gorky»	«Inspector»
E5	Sensory-logical extrovert (SLE)	«Zhukov»	«Marshal»
E6	Intuitive-logical introvert (ILI)	«Balsac»	«Critic»
E7	Ethic-sensory introvert (ESI)	«Dreiser»	«Keeper»
E8	Logic-sensory extrovert (LSE)	«Shtirlits»	«Administrator»
E9	Ethic-intuitive introvert (EII)	«Dostoievskyi»	«Humanist»
E10	Sensory-logical introvert (SLI)	«Gabin»	«Master»

For each employee, original indicators were modeled (Table 2).

Additionally, the following indicators were added to Table 2:

– EA (P, I) – integrated assessment of an employee in the system of knowledge management of a company taking into account only two components (professional and intellectual);

– rating (P, I) is the rating of employees according to EA (P, I);

– EA (P, I, S) is the comprehensive evaluation of an employee in the system of knowledge management of a company taking into account three components (professional, intellectual, social);

– rating (P, I, S) is the rating of employees according to EA (P, I, S).

These indicators enable us to display differences between assessment and division of employees into group.

To find indicator S2, we used indicators h_n, which show the level of closeness in collaboration of an employee (E1–E10) with the others, which is determined by the head of a department. Let us assume that indicators h_n are the following (Table 3).

To find indicator S2, indicator k_n (Table 4) was used. k_n reflects the degree of efficiency of cooperation between employees of different sociotypes (Table 5). We considered generally accepted points of comfort in relationships between sociotypes, which were brought to scale [–1; 1]. For normalization, the indicators had to be brought to scale [0; 1], but indicator S2 will be an exception and will take into account both as positive and negative synergic effect.

Table 2

Values of component elements of integrated assessment of employees of department in the system of knowledge management of a company

Indicator	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
P1	0.7	0.6	0.8	0.5	0.5	0.9	0.7	1	0.9	0.6
P2	1	1	0.8	0.6	0.2	1	0.6	0.8	0.6	1
P3	0.20	0.27	0.40	0.53	1.00	0.13	0.47	0.67	0.27	1.00
I1	0.5	0.7	0.9	1	0.4	0.2	0.8	0.3	0.9	0.7
I2	0.6	0.8	0.7	0.9	1	0.2	0.6	1	0.2	0.8
I3	0.8	0.7	0.6	0.2	0.8	0.3	0.4	0.9	0.7	0.6
I4	0.6	0.9	1	0.7	0.4	0.6	0.8	0.7	0.8	0.3
S1	0.8	0	0.1	0.35	0.55	0.85	0.6	1	0.25	0.75
S2	–0.525	–0.65	–0.4	–1.2875	0.2	–0.538	0.1875	–1.063	–1.9	1.025
P	0.241	0.237	0.247	0.200	0.196	0.256	0.215	0.299	0.215	0.320
Pinf	3.484	3.925	4.535	3.976	3.886	2.869	3.661	6.992	2.607	7.570
I	0.238	0.301	0.310	0.272	0.249	0.130	0.252	0.282	0.245	0.225
Iinf	7.726	10.833	12.474	9.488	6.884	3.917	8.863	10.582	8.670	9.208
EA (P, I)	11.689	15.297	17.566	13.935	11.215	7.172	12.992	18.156	11.737	17.322
rating (P, I)	8	4	2	5	9	10	6	1	7	3
S	0.0285	–0.085	–0.04	–0.1259	0.09299	0.0329	0.09743	–0.018	–0.2182	0.22523
Sinf	1.8191	–2.375	–0.892	–3.3989	6.29441	0.4414	5.30548	–0.817	–6.1692	14.3696
EA (P, I. S)	33.227	32.133	36.200	29.346	37.817	24.819	37.387	36.477	24.087	52.240
rating (P, I, S)	6	7	5	8	3	9	2	4	10	1

Table 3

Level of closeness of collaboration in pairs between employees of company's department

Employee	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
E1		0.5	0.8	1	0.7	0.6	0.3	0.4	0.9	0.1
E2	0.5		0.5	0.7	1	0.9	0.1	0.8	0.6	0.6
E3	0.8	0.5		0.2	0.5	0.1	0.8	0.9	1	0.1
E4	1	0.7	0.2		0.6	0.6	0.2	0.3	1	0.8
E5	0.7	1	0.5	0.6		1	1	0.4	0.7	0.8
E6	0.6	0.9	0.1	0.6	1		0.3	0.5	0.6	0.7
E7	0.3	0.1	0.8	0.2	1	0.3		0.2	0.8	0.6
E8	0.4	0.8	0.9	0.3	0.4	0.5	0.2		0.1	0.9
E9	0.9	0.6	1	1	0.7	0.6	0.8	0.1		0.4
E10	0.1	0.6	0.1	0.8	0.8	0.7	0.6	0.9	0.4	

Tables 4

Level of effectiveness of cooperation between employees of company's department

Indicator	E1	E2	E3	E4	E5	E6	E7	E8	E9	E10
E1	0.000	1.000	0.750	–0.625	0.375	–0.500	–1.000	–0.125	–0.750	0.625
E2	1.000	0.000	–0.750	–0.125	0.250	–0.875	–0.250	–0.625	0.125	0.500
E3	0.750	–0.750	0.000	1.000	0.875	–0.750	0.250	–0.875	–0.500	–1.000
E4	–0.625	–0.125	1.000	0.000	0.750	–0.125	0.375	–0.500	–0.875	–0.250
E5	0.375	0.250	0.875	0.750	0.000	0.625	–0.625	–0.250	–1.000	–0.500
E6	–0.500	–0.875	–0.750	–0.125	0.625	0.000	0.875	–0.750	–0.125	0.375
E7	–1.000	–0.250	0.250	0.375	–0.625	0.875	0.000	0.625	0.500	0.125
E8	–0.125	–0.625	–0.875	–0.500	–0.250	–0.750	0.625	0.000	1.000	0.750
E9	–0.750	0.125	–0.500	–0.875	–1.000	–0.125	0.500	1.000	0.000	0.875
E10	0.625	0.500	–1.000	–0.250	–0.500	0.375	0.125	0.750	0.875	0.000

Table 5

Table of intertype relationships

Socionic type	ILE	SEI	ESE	LII	EIE	LSI	SLE	IEI	SEE	ILI	LIE	ESI	LSE	EII	IEE	SLI
ILE	Id	Du	Ac	Mr	Rq+	Sv+	Cp	Mg	Se	Ex	QI	Cf	Rq–	Sv–	Cg	Sd
SEI	Du	Id	Mr	Ac	Sv+	Rq+	Mg	Cp	Ex	Se	Cf	QI	Sv–	Rq–	Sd	Cg
ESE	Ac	Mr	Id	Du	Cg	Sd	Rq–	Sv–	QI	Cf	Se	Ex	Cp	Mg	Rq+	Sv+
LII	Mr	Ac	Du	Id	Sd	Cg	Sv–	Rq–	Cf	QI	Ex	Se	Mg	Cp	Sv+	Rq+
EIE	Rq–	Sv–	Cg	Sd	Id	Du	Ac	Mr	Rq+	Sv+	Cp	Mg	Se	Ex	QI	Cf
LSI	Sv–	Rq–	Sd	Cg	Du	Id	Mr	Ac	Sv+	Rq+	Mg	Cp	Ex	Se	Cf	QI
SLE	Cp	Mg	Rq+	Sv+	Ac	Mr	Id	Du	Cg	Sd	Rq–	Sv–	QI	Cf	Se	Ex
IEI	Mg	Cp	Sv+	Rq+	Mr	Ac	Du	Id	Sd	Cg	Sv–	Rq–	Cf	QI	Ex	Se
SEE	Se	Ex	QI	Cf	Rq–	Sv–	Cg	Sd	Id	Du	Ac	Mr	Rq+	Sv+	Cp	Mg
ILI	Ex	Se	Cf	QI	Sv–	Rq–	Sd	Cg	Du	Id	Mr	Ac	Sv+	Rq+	Mg	Cp
LIE	QI	Cf	Se	Ex	Cp	Mg	Rq+	Sv+	Ac	Mr	Id	Du	Cg	Sd	Rq–	Sv–
ESI	Cf	QI	Ex	Se	Mg	Cp	Sv+	Rq+	Mr	Ac	Du	Id	Sd	Cg	Sv–	Rq–
LSE	Rq+	Sv+	Cp	Mg	Se	Ex	QI	Cf	Rq–	Sv–	Cg	Sd	Id	Du	Ac	Mr
EII	Sv+	Rq+	Mg	Cp	Ex	Se	Cf	QI	Sv–	Rq–	Sd	Cg	Du	Id	Mr	Ac
IEE	Cg	Sd	Rq–	Sv–	QI	Cf	Se	Ex	Cp	Mg	Rq+	Sv+	Ac	Mr	Id	Du
SLI	Sd	Cg	Sv–	Rq–	Cf	QI	Ex	Se	Mg	Cp	Sv+	Rq+	Mr	Ac	Du	Id

Note: Du – duality; Ac – activation; Sd – semi-duality (semi-complement); Mg – mirage; Mr – mirror; Id – identity; Cp – business; Cg – consanguinity; QI – quasi-identity; Ex – extinguishing (opposition); Se – super-ego; Cf – conflict; Rq+ request: I – requester; Rq– – request: I – requestee; Sv+ – supervision: I – supervisor; Sv– – supersivion: I – supervised

So, according to Table 2 and indicator EA (P, I), it is possible to group employees: group 1 (the highest indicators of integrated assessment) – employees No. 8, No. 3, No. 10; group 2 (medium indicators) – No. 2, No. 4, No. 7, No. 9, No. 1, No. 5; group 3 (low indicators) – No. 6.

According to EA (P, I, S), it is possible to group employees: group 1 (the highest indicators of integrated assessment) – employee No. 10; group 2 (medium indicators) – employee No. 7, No. 5, No. 8, No. 3, No. 1, No. 2, No. 4; group 3 (low indicators) – employees No. 6 and No. 9.

According to rating of employees by EA (P, I), the best employer in the system of knowledge management is employee No. 8, and the worst is No. 6. According to the rating of employees by EA (P, I, S) the best employee in the system of knowledge management is employee No. 8, and the worst is No. 9 (Fig. 1).

Without taking into account the social component, one can make a mistake in the selection of personnel and its evaluation in knowledge management system of the enterprise.

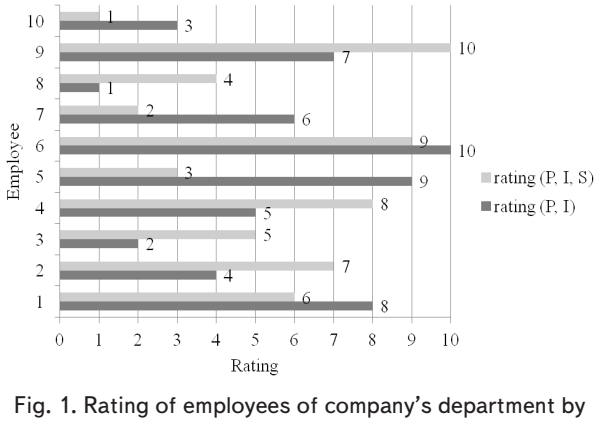

Fig. 1. Rating of employees of company's department by EA (P, I) and EA (P, I, S)

5. 4. Selection of indicators for integrated assessment of the group of company's employees, created for the generation of new knowledge

At present, description of separately taken phenomena of a small group, which are usually considered in isolation from one another, has been replaced with understanding of group behavior as an integral process. Thus, the experts have chosen the following indicators: individual figures (EA_n (P, I) and knowledge, interest and experience in solving similar problems (EX_n) and group indicators (social interaction between group members S_2n).

To establish indicator EX_n, the head of the unit applied the Harrington scale, which shows relationships between the quantitative values of non-dimensional scale and psychological perception of a person. Desirability scale is divided in the range from 0 to 1 into five sections: [0; 0.2) is "very bad", [0.2; 0.37) is "bad", [0.37; 0.63) is "satisfactory", [0.63; 0.8) is "good", [0.8; 1] is "very good".

Thus, the following indicators EX_n for employees were obtained: EX_1=1; EX_2=0,4; EX_3=0,6; EX_4=0; EX_5=0,3; EX_6=0,2; EX_7=0,5; EX_8=0,4; EX_9=0,8; EX_{10}=0,7.

5. 5. Determining the weight coefficients

Results of a survey of experts are given in Table 6 (using formulas (4), (5)).

Table 6

Weight coefficients of indicators of complex estimation, obtained with the use of knowledge of experts

Indicator	Number of expert										Average point	Weights of indicators
	1	2	3	4	5	6	7	8	9	10		
EA	1	1	3	2	3	1	3	1	2	1	1,8	0,300
S	2	3	2	1	1	3	1	3	3	3	2,2	0,367
EX	3	2	1	3	2	2	2	2	1	2	2	0,333
Total											6	1

Table 6 shows that the highest weight factor of 0.367 belongs to indicator S and the lowest of 0.3 belongs to indicator EA.

5. 6. Formation of integrated assessment of a group of employees of a company, created for the generation of new knowledge

We obtained integrated assessment of a group of company's employees, created for generation of new knowledge:

$$EG = 0,3(EA_1 + EA_2 + EA_3) + \\ +0,367(S_{1,2} + S_{1,3} + S_{2,3}) + 0,333(EX_1 + EX_2 + EX_3). \quad (7)$$

The indicators were normalized (brought to one scale [0; 1]). The exception was indicator S, which is brought to the scale of [–1; 1]. This is due to the fact that S is responsible for a synergistic effect of employees' interaction, which may be both positive and negative.

Calculation values of the indicators for different combinations of employees are given in Table 7.

Analysis of Table 7 and its ranging by a decrease in indicator EG gives a possibility to determine the best combination of employees.

Table 7

Values of indicators EA, S, EX, and EG for different groups of employees

Combination of employees			EA	S	EX	EG
10	1	2	0.463	0.708	0.700	0.632
10	1	3	0.487	0.125	0.767	0.447
10	1	4	0.449	–0.083	0.567	0.293
10	1	5	0.420	0.167	0.667	0.409
10	1	6	0.378	0.167	0.633	0.386
10	1	7	0.439	–0.083	0.733	0.345
10	1	8	0.493	0.417	0.700	0.534
...	...	...	...	...	...	...
10	8	9	0.493	0.875	0.633	0.680
1	2	3	0.466	0.333	0.667	0.484
1	2	4	0.428	0.083	0.467	0.314
1	2	5	0.399	0.542	0.567	0.507
1	2	6	0.357	–0.125	0.533	0.239
1	2	7	0.418	–0.083	0.633	0.306
1	2	8	0.472	0.083	0.600	0.372
...	...	...	...	...	...	...
5	7	8	0.443	–0.083	0.400	0.235
5	7	9	0.376	–0.375	0.533	0.153
5	8	9	0.430	–0.083	0.500	0.265
6	7	8	0.400	0.250	0.367	0.334
6	7	9	0.333	0.417	0.500	0.419
6	8	9	0.387	0.042	0.467	0.287
7	8	9	0.448	0.708	0.567	0.583

5. 7. Selection of employees for formation of a small group with the aim of creating of new organizational knowledge

From 120 possible combinations of employees, the rating of each of them was assessed (Fig. 2):

– group (E8; E9; E10) ranks first with values of EG=0,680;

– group (E1; E2; E10) ranks second with values of EG=0,632;

– group (E7; E8; E9) ranks third with values of EG=0,583;

– group (E1; E3; E5) ranks fourth with values of EG=0,582;

– group (E3; E4; E5) ranks fifth with values of EG=0,555.

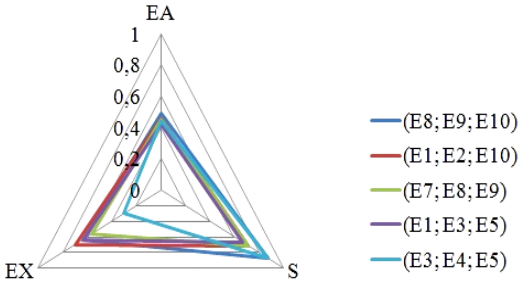

Fig. 2. The best combinations of employees when forming a small group for creation of new organizational knowledge

Thus, the best small target group (a project team) for generation of new organizational knowledge is the group that consists of employees No. 8–10. This group also has the highest indicator of social interaction that plays an important role in the formation of a project team.

6. Discussion of results of research into formation of a target group of employees in the system of company's knowledge management

Management of company's knowledge is the process of information exchange between two or more participants. The key to success is improvement of interpersonal relationships in the process of information exchange, creation of information channels between individual employees and teams. Created economic-mathematical model of evaluation of a group of employees for forming a project team takes into account professional and intellectual components of employees, as well as their social interaction.

The developed model is devoid of shortcomings of works [10–12], where objective function is minimization of project's costs or time, but while forming a group of employees, it does not take into account their professional, intellectual qualities, as well as their social interaction. In the proposed model, we considered criteria of compatibility and synergy of selected employees in the process of generation of new organizational knowledge.

In contrast to paper [12], which takes into account only agreement between a project participant and a task that he performs, the present model also considers interaction between project participants themselves.

Unlike article [13], where results of modeling demonstrate the probability of several options for the composition of a project team with equal values of objective criterion, the developed model gives a single optimal result of the composition of a project team. The model in work [13] also does not take into account individual, professional and intellectual characteristics of employees and synergistic effect of interpersonal relationship of employees, which are used in the proposed model. The present model enabled us to select one group with the highest indicator of integrated assessment out of 120 possible groups.

The limitation of the developed model is the situation, when an employee belongs at the same time to several socionic personality types, and his professional level and intellectual component may change. So to avoid inefficient results of modeling in practice, it is necessary to use the most relevant information regarding results of testing of a particular employee. The advantage of the model is the ease of implementation and low computational costs.

The present model is one of the constituent models in the system of knowledge management of a company, along with assessment at the level of an employee, a department, a company and at the external level. Therefore, subsequent research may be directed to construction of economic-mathematical models of knowledge evaluation at the department or the company level as well as external level, taking into account external factors.

7. Conclusions

1. Economic-mathematical model for the formation of a group of employees (project team) for the generation of new organizational knowledge was created. The model implies construction of a integrated assessment for possible project teams and selection of the best one. The model allows taking into account both individual and group indicators of employees. Individual indicators include professional knowledge, education, working experience, intelligence, logical intellect, creative intelligence, self-organization and knowledge, interest and experience in solving similar tasks. The group indicators include social interaction in pairs between group members. The developed model allows taking into account both positive and negative synergistic effect of social interaction. Therefore, considering not only professional and intellectual components, but also synergic effect of social interaction of team members allows formation of the optimal composition of a project team. The specified feature distinguishes the present model from other analogues. The model includes seven stages: from determining the number and all the possible combinations of employees to formation of a project team.

2. The model implies the application of elements of combinatorics to determine the number of possible combinations of groups. In addition, we used expert knowledge and the method of direct assessment for selecting indicators of integrated assessment and selection of weight coefficients. The Harrington scale enabled us to establish the level of experience and knowledge in solving similar tasks. A group of employees was considered as an additive system, so for each group, integral indicator was calculated.

3. The model was implemented on the example, in which 3 employees were selected out of 10 employees of a department. Each of the employees had their indicators of professional, intellectual and social component. According to results of modeling, the highest effectiveness in generation of new organizational knowledge was demonstrated by the group, which has a positive synergistic effect of interaction between employees in a project team.

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