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INCREASE IN COMPETITIVE CAPACITY OF INDUSTRIAL ENTERPRISE THROUGH CREATION OF AUTOMATION SYSTEM OF THE PROCESS OF WORK DISTRIBUTION AMONG EMPLOYEES

Statement of the problem. Nowadays the theory and practice of management dictate a new approach to personnel managing. Within its context manpower resources of enterprises and organizations are considered as the most valuable resource and the development of their potential as an important strategic task of enterprises to reach a success [1].

The modern market of information technologies offers a wide range of program products to solve actual problems of personal control and optimize business-processes at enterprises with different levels of organizational development and different tendencies of their activity.

Automatic personnel management systems allow to record employees, issue and register orders, follow the course of holidays, get various analytical information, and decide a lot of other problems.

At present there are quite a lot of managerial systems of personnel presented as complex programs covering the whole range of tasks for managing manpower resources and strictly specialized solutions. The cost of such systems can reach hundreds of thousands dollars [2].

The task of personnel selection to fulfill work is an important part of enterprise operation. The right nomination of an employee for doing work can not only raise labour productivity and personnel loyalty but also enterprise income and can substantially influence its competitive capacity.

In spite of the fact that there are a lot of program products for solution of actual problems on personnel management, the appointment of employees is mainly carried out "by hand", that is by heads of departments, shops, and other divisions whose decisions are based on their professional experiences and common sense. However, the given base is not sound enough and with the growth of task volumes, decrease in admissible time of reaction to external influence, increase in the number of criteria, which must be taken into consideration while making an optimal decision, the problem situations for managers are possible.

Work distribution among employees is fixed in the existing program products on personnel managing but

decision making concerning personnel appointments is strictly based on head's preferences. In this connection automation of the process of work distribution among employees with the help of mathematical methods is urgent.

Analysis of the latest investigations and publications. During automation of the processes of manpower management the automation of personnel placement in accordance with jobs and tasks on the basis of employee's potential but not of his post plays an important part.

From mathematical point of view the task of personnel appointments by jobs with consideration for their professional, socio-communicative, personal, generally cultural, and other criteria is formulated as multi-criterion appointment problem.

The problem is stated as the problem of distribution of different subjects by different objects taking into consideration the characteristics of the subjects, which to a certain extent must correspond to the objects' requirements.

There are a lot of approaches to the solution of certain problems. These approaches are considered in the papers by O.I. Larichev [3], S.V. Levin, A.A. Petrik [4], O.Y. Nikonov, O.A. Podolyak, E.V. Skakalina, V.I. Protasov [5], A.V. Lotov, I.I. Pospelova [6], etc.

These works offer the solution of the problem concerning distribution of subjects by different objects but the effectiveness of the given method is not checked in any software.

The purpose of this article is to work out a mathematical model of manpower distribution by the tasks at an enterprise with possible realization of this model in a program product.

Basic material of research. Among all resources available at any enterprise manpower resources, which are called personnel, occupy special place. Personnel is the most important element of productive forces of an enterprise. All members of the staff belong to it. All employees of the enterprise contribute their individual work to the process. Therefore, the labour of each employee and the staff as a whole must be planned and organized beforehand.

The content of the work of all members straightly depends on a certain working place and a post of the employee, his economic role in the production process and organizational structure. The better the functions of each working place and the post are determined, the more precisely it is possible to set a range of responsibilities, the content of work of each category of employees. The right differentiation of labour allows to place all participants of the production process to the given working places in terms of their personal duties and professional business qualities. The differentiation of labour means separation of different kinds of labour and appointing people to fulfill these kinds of work.

Computerization of personnel work of any enterprise in modern conditions is one of the key tendencies of its development and competitiveness in the market.

As the automatic processing of personal data, making personal decisions, automation of separate personnel procedures and technologies provide not only considerable gain in time and advantage over competitors but also decrease in material expenses and other risks.

In order to automate the process of optimal appointment of employees to fulfilling their work a mathematical model is used.

The appointment of employees to the jobs with regard to their professional, socio-communicative, personal, cultural and other criteria from mathematical point of view is called multi-criterion appointment problem (MAP). Structure and composition of indices necessary for recording labour potential of employees are presented in fig. 1.

There are all possible mathematical approaches to the solution of specific problems such as: theoretical and play approach to the solution of a multi-criterion appointment problem, approaches based on the methods of genetic consultation, indistinct logic, approaches based on algorithms of ordinal normalization of criteria, on man-machine procedures, etc.

There are several variants for work and employees distribution.

1. Number of employees coincides with number of tasks.
2. Number of tasks is fewer than number of employees.
3. Number of tasks is more than number of employees.

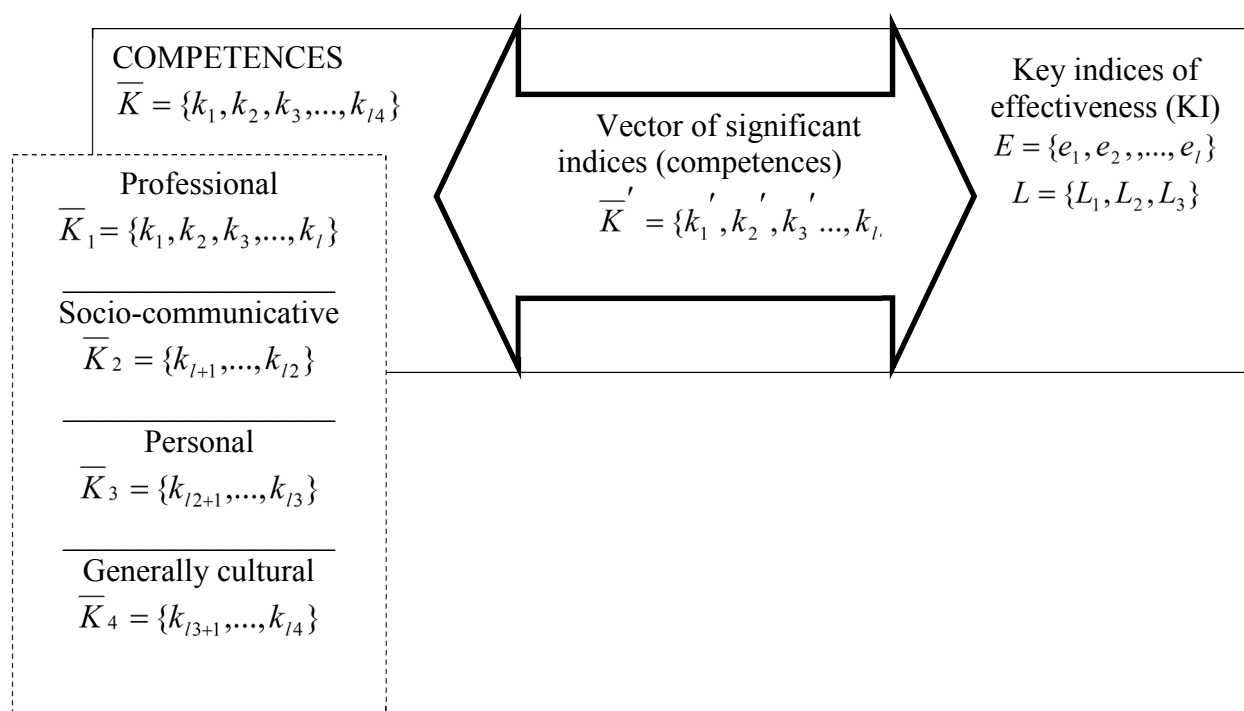


Fig. 1. Composition and structure of indices of employees' potential

To solve the variant when the number of tasks is more than the number of employees it is necessary to take into account the operation flow chart. While drawing up a chart it is necessary to have regard to the availability of man-power resources as simultaneous fulfillment of some operations due to restrictions may turn out impossible.

This paper deals with the method of solution of multi-criterion appointment problem based on man-machine procedures, which offers the solution for the first and the second variants without considering the operation flow chart.

The person, who makes a decision (PMD), whom to appoint to a definite kind of work interacts with the

system placing his/her preferences as weight coefficients, and the system in its turn helps PMD (enterprise manager) make a choice.

There are two initial sets with n elements in each. Each of them is characterized on the basis of estimations by N criteria:

- $C (C_1, C_2, \dots, C_i, \dots, C_n)$ – a set elements of which are called subjects (employees);
- $O (O_1, O_2, \dots, O_j, \dots, O_n)$ – a set elements of which are called objects (jobs);
- $K = (K_1, K_2, \dots, K_N)$ – a set of estimation criteria of subjects and objects.

Based on the preferences of PMD (manager) it is necessary to find an effective solution with maximum possible number of best, from the PMD point of view, appointments. Each estimation on the criterion scale has two definitions reflecting mutual demands and possibilities of elements of two sets. The criterion scales are ordinal as a rule with a few number of evaluations adjusted from better to worse. The evaluations can be both verbal and numerical.

One part of the criteria reflects demands of subjects and possibilities of objects, the other one – demands of objects and possibilities of subjects by their satisfaction.

Criterion correspondence is the difference by one of the criteria between demands of a subject (an object) and possibilities of an object (a subject). The demands of i -element by k -criterion (T_{ikp}) are satisfied by the possibilities of j -element by k -criterion (V_{jkq}) if $p > t$. In so doing the criterion correspondence is ideal.

Let's call pair $\{C_i, O_j\}$ an ideal appointment, all their mutual demands are completely satisfied by all criteria, that is all criterion correspondences are ideal.

Let's call any pair $\{C_i, O_j\}$ formed of two elements belonging to different initial sets an appointment. There is a set of $(n \cdot n)$ appointments $\{C_i, O_j\}$, $i, j = 1, 2, \dots, n$, for two initial sets with n elements C and O .

Let's call the unit diagonal matrix $M(n \cdot n)$ diagonal elements of which correspond to the appointments forming a decision as a solution of a multi-criterion appointment problem. Notice that the number of possible solutions for dimensionality of the initial sets $C \{n\}$ and $O \{n\}$ comes to $n!$.

Then the appointments are ranked, that is each possible appointment must have a rank reflecting its quality from the point of view of PMD. In that case any solution of MAP can be characterized by a complex of ranks of separate appointments having formed the decision.

On the basis of PMD preferences it is necessary to determine and choose out of a great number of effective decisions such a decision for which the sum of ranks of the best quality S appointments ($S \leq n$) is minimum.

The algorithm for solution of the problem of work distribution among employees is as follows.

1. It is necessary to carry out a formal data analysis without PMD participation. Formally the relationship between elements of the two sets (subjects and objects)

may be characterized by correspondence vector R_{ij} ($i, j = 1, 2, \dots, n$), where k component defines the degree of correspondence of elements characteristics by k criterion. So at the stage of data analysis the concept "criterion correspondence by N -criterion" is an equivalent to the component of correspondence vector which is calculated in the following way:

$$R_{ijk} = \begin{cases} 0, & \text{if } T_{ikp} \leq V_{jkq} (p \geq q) \\ r_k, & \text{if } T_{ikp} > V_{jkq} \end{cases}, \quad (1)$$

where T_{ikp} – demand of i -element of one set (subject or object) expressed by p -evaluation on the demand scale by k -criterion;

V_{jkq} – corresponding possibilities of j -element of another set expressed by q -evaluation on the possibility scale of the same k -criterion;

r_k – number of evaluations on the k -criterion scale, where demands exceed possibilities.

2. An aggregated criterion – curtailment of the correspondence vector (G_{ij}) is formed for each vector of correspondence. The value of the curtailment is calculated as a sum of declinations of each component of the correspondence vector.

$$G_{ij} = \text{SUM} (R_{ijk}), \quad (2)$$

3. The set, which is not included in the ideal appointment $G_{ij} \neq 0$, is divided into three subsets: I^+ – subset of criteria according to which A (employee 1) is preferable to B (employee 2); $I^=$ – subset of criteria according to which A is equal to B ; I^- – subset of criteria according to which B is preferable to A .

4. PMD allocates points (weight coefficients) of importance for the criteria (W_i) for each subject. The index of agreement with the hypothesis about superiority of A over B is formulated.

The index of agreement is calculated on the basis of weight criteria:

$$C_{AB} = \frac{\sum_{i \in I^+} W_i}{\sum_{i \in I^-} W_i}. \quad (3)$$

5. The index of disagreement d_{AB} with the hypothesis about superiority of A over B is defined on the basis of the most "contradictory" criterion – the criterion by which B to the greatest extent excels A .

$$d_{AB} = \max_{i \in I^-} \left| \frac{l_B^i - l_A^i}{l_i} \right|, \quad (4)$$

6. The levels of agreement (a) and disagreement (d) are designated and the calculated indices for each alternative pair are compared with them. If $CAD \geq a$ and

$dAB \leq d$, then alternative A (employee 1) excels alternative B (employee 2).

7. One alternative is selected out of multitude of alternatives, it excels all the others. The given alternative wins and is put on the first place (the employee who suits best), the second place is occupied by the alternative that excels less quantity of alternatives and so on.

Conclusion. Computerization of personal work of any enterprise in modern conditions is one of the key tendencies of its development and competitive capacity in the market. Automation of the process of manpower resources management stipulates an important role of automation of personnel placement in accordance with jobs and tasks reasoning from employee's potential but not from the occupied post.

As a result of the analysis of the existing mathematical methods for optimal work distribution among employees a new mathematical method has been proposed. It is based on man-machine procedures, calculating a correspondence vector, agreement and disagreement matrices, allowing an enterprise manager to simplify making a decision.

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Нечволода Л. В., Івченкова О. Ю., Пилипенко К. В. Підвищення конкурентоспроможності промислового підприємства за рахунок створення системи автоматизації процесу розподілу робіт між співробітниками

У статті розглянуто роль автоматизації при розподілі робіт між співробітниками підприємства, запропоновано математичний метод для розподілу робіт між співробітниками підприємства, заснований на розрахунку компонентів вектора відповідності, матриць згод і незгоди і виведення прийняття рішення, що дозволяє полегшити роботу керуючому.

Ключові слова: багатокритеріальна задача про призначення, критерії, альтернатива, ЛПР, індекс згоди, індекс незгоди, множина, вагові коефіцієнти, конкурентоспроможність.

Нечволода Л. В., Івченкова Е. Ю., Пилипенко Е. В. Повышение конкурентоспособности промышленного предприятия за счет создания системы автоматизации процесса распределения работ между сотрудниками

В статье рассмотрена роль автоматизации при распределении работ между сотрудниками предприятия, предложен математический метод для распределения работ между сотрудниками предприятия, основанный на расчете компонентов вектора соответствия, матриц согласий и несогласия и вывода принятия решения, позволяющий облегчить работу управляющему.

Ключевые слова: многокритериальная задача о назначениях, критерии, альтернатива, ЛПР, индекс согласия, индекс несогласия, множество, весовые коэффициенты, конкурентоспособность.

Nechvoloda L., Ivchenkova E., Pylypenko K. Increase in competitive capacity of industrial enterprise through creation of automation system of the process of work distribution among employees

The paper deals with the role of automation of work distribution among employees of an enterprise. The proposed mathematical method for work distribution among enterprise employees is based on calculation of components of correspondence vector, matrices of agreement and disagreement and resulting in decision making that simplifies manager's work.

Keywords: multi-criterion, appointment, alternative, decision making, correspondence, agreement index, disagreement index, weight coefficient, competitive capacity.

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