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METHODOLOGICAL APPROACH TO LABOR POTENTIAL ASSESSMENT BASED ON THE USE OF FUZZY SETS THEORY

Purpose. Substantiation of the methodological approach to the labor potential assessment of industrial enterprises on the basis of the fuzzy logic apparatus application in order to identify problems of using labor potential and provide relevant recommendations for their solution.

Methodology. The methodological ground of the research is the classic position and the fundamental works of foreign and domestic scholars, statistics, the results of authors' research on the problems of enterprise labor potential assessment. Methods of fuzzy sets theory, comparative analysis of abstraction, and generalization of scientific experience of modern theoretical research studies, systematic and comprehensive approach have been applied in the study.

Findings. A methodological approach to enterprise labor potential assessment was proposed, numerous experiments on the basis of the international vertically integrated company Interpipe were conducted. The analysis of the results of the enterprise labor potential assessment made it possible to determine the problems of labor potential utilization at industrial enterprises.

Originality. The methodological approach to the assessment of the enterprise labor potential utilization on the basis of the fuzzy logic apparatus is improved, which, unlike existing ones, allows integrating both qualitative and quantitative indicators in assessing the labor potential and the movement indicators, significantly improving the efficiency of decision-making under uncertainty and reducing costs upon occurrence of adverse situations.

Practical value. The use of a methodological approach to enterprise labor potential assessment on the basis of the fuzzy logic apparatus makes it possible to analyze the labor potential as a multi-elemental object that is closely related to the structured functioning of the enterprise and its capabilities; it provides more accurate assessment of labor potential and informed decision making to increase the level of its use.

Keywords: *labor potential, enterprise, fuzzy sets theory, assessment, methodological approach*

Introduction. The task on assessing the labor potential of an enterprise proves to be quite difficult due to the large number of unrelated numerical data, incomplete in some cases, which, given this, are too complicated to analyze using conventional quantitative methods. In addition, the qualitative characteristics that are applied during linguistic interpretation are difficult to quantify. One should pay attention to such an issue as the construction of a universal, reasonable system for the assessment of an enterprise's labor potential. All the existing changes and additions in a model for the estimation of an enterprise's labor potential focus only on a change and additions, concentrated on the modernization of an already existing principle of action of assessment procedures. However, solving difficult, complex problems requires greater knowledge than that used during their formation. In this case, one observes the emergence of supersystem contradictions – as, for example, the contradiction of effectiveness of macro- and microeconomies. Resolving them is characterized by the application of methods from other sciences, not related to the science within which current problems have arisen. To build a model of adequate reality, which would employ a large amount of disconnected numerical data, fuzzy logic provides effective means to represent the uncertainties and inaccuracies in the real world. The presence of mathematical means to represent fuzzy initial information makes it possible to construct a model that is adequate to reality. The theory of fuzzy sets (TFS) is the generalization and rethinking of the most important directions in classic mathematics, which has considered strict logical deductive methods for constructing conclusions to be genuinely scientific since the time of Plato and Aristotle. Underlying TFS are the ideas and achievements in the multivalued logic, which emphasized a possibility of transition from two to an arbitrary number of truth values and set the task on solving a problem related to operating the concepts with the content which changes, being characteristic of the systems that defy strict deductive methods.

Literature review. Unsolved aspects of the problem. The issue of the labor potential assessment has been addressed in the studies by many scientists-economists, specifically: N. Verkhoglyadova [1], L. Harmider [2], A. Cherep, Ya. Zubrytska [3], and others. Scientists propose different systems of indicators, as well as methods for the evaluation of an enterprise's labor potential, taking into consideration various factors to resolve the specified problem. An analysis of the above-mentioned scientific works made it possible to conclude that the existing assessment procedures do not account for the fact that a modern enterprise is a complex socio-economic system; it substantiates the feasibility and the need for the use of a systemic approach in the process of evaluation, based on the system analysis, which requires a staged implementation. Existing models and approaches are characterized by an insufficient range of the analyzed factors that are selected to describe the impact on the level of utilization of labor potential; subjectivity in choosing, ranking and assessments of the examined parameters for labor potential, which could lead to a significant decrease in the accuracy of result; the lack of formalized approaches to obtaining their cardinal estimates; weakness of the dynamic component of analysis into labor potential and support to specific management decision-making.

Purpose. Based on all the above-specified criteria, application of the theory of fuzzy sets appears extremely promising and shows prospects for the development of methods for labor potential assessment. Therefore, the aim of this research is to substantiate a methodological approach to the evaluation of using labor potential of industrial enterprises based on the application of the apparatus of fuzzy logic, which would make it possible to improve the substantiation of appropriate management decisions to enhance the level of labor potential.

Results. The scientific literature contains publications on the application of the theory of fuzzy sets in different fields of human activities (political, social and economic processes, medicine, etc.) [4–7]. In this regard, in our view, it is expedient to use, in order to assess the labor potential, linguistic variables [5], whose variables are not numbers but words in the natural or formal language. The article suggests a model for the estimation of an enterprise's labor potential, using the apparatus of fuzzy sets.

In the general case, an inference engine involves four steps [5]:

Step 1. Operation of blurring/fuzzification.

It is necessary to formalize fuzzy information about incoming data using membership functions (MF) based on direct expert assessments; to assign values for term sets in order to describe linguistic variables.

Step 2. Operation to construct a fuzzy knowledge base.

It is necessary, based on the *a priori* knowledge of experts, to design and build a fuzzy base of rules. In order to adequately describe the object of modeling, it is required to determine the necessary and sufficient number of logical rules.

Step 3. Operation of fuzzy inference.

1. Select a rule of fuzzy implication.
2. Apply one of the methods for a fuzzy composition.

Step 4. Operation of reducing to certainty/defuzzification.

Reduce the derived fuzzy set to a definite value, that is, it is necessary to specify a method of defuzzification and apply it.

Step 5. Operation of obtaining a value for the membership function of the defined defuzzified magnitude for the estimation of labor potential to a fuzzy set.

A meaningful interpretation of the fuzzy model accepts the selection and specification of input and output variables for the corresponding system of fuzzy conclusion. Consider the process of modeling a fuzzy conclusion using the software package MatLab. Fuzzy modeling in the MatLab programming environment is performed using the extension package Fuzzy Logic Toolbox, which employs dozens of functions related to fuzzy logic and fuzzy inference [4, 5] and which is the simplest technique to conduct fuzzy modeling.

The model includes relative indicators for using labor potential, for which there are standard and recommended values within a sector and a region. That made it possible to establish functional dependences between them and the factors that influence labor potential in the form of a structural-logical scheme. In addition, in order to determine the factors, it is necessary to avoid the collinear ones among them, inverse to each other, correlated, and those that overlap.

Given the fact that input information is inaccurate or blurred in character, we actually have a fuzzy model for the labor potential assessment. According to the set problem, the mathematical statement can be formulated as follows. It is required to obtain the assessment of labor potential:

$R = r(F_1, F_2, F_3)$ is the functional for the assessment of labor potential, which depends on three functions, specifically:

$F_1 = f(x_1, x_2, x_3)$ is the function of three variables, which includes a group of indicators for quantitative estimation:

x_1 is the coefficient of utilization of accounted staff;

x_2 is the coefficient of utilization of working time;

x_3 is the coefficient of mean age of employees; $F_2 = g(x_4, x_5, x_6, x_7)$ is the function of four variables, which includes a group of indicators for a qualitative estimation:

x_4 is the coefficient of training;

x_5 is the coefficient r of education;

x_6 is the coefficient of rationalization activity;

x_7 is the coefficient of acquired experience;

$F_3 = h(x_8, x_9, x_{10}, x_{11})$ is the function of four variables, which includes a group of indicators for an estimation of turnover intensity:

x_8 is the turnover ratio;

x_9 is the coefficient of rotation;

x_{10} is the coefficient of turnover of those who quitted;

x_{11} is the coefficient of turnover of those hired.

Here, variables $x_i = [x_i^-; x_i^+], (i = \overline{1,11})$ are the fuzzy magnitudes; each varies in its respective range $[x_i^-; x_i^+]$. There is no analytical assignment for functions *f, g, h, r*.

An object of modeling, based on the stated problem, can be conditionally represented in the form of a "black box" (Fig. 1).

As an object of modeling, we have selected a labor potential of the international vertically integrated company "Interpipe" (the city of Dnipro, Ukraine). The study involved 5 steel-making enterprises: – Interpipe NTZ (the city of Dnipro, Ukraine); – Interpipe Niko Tube (the city of Nikopol, Ukraine); – Interpipe NMTZ (the city of Novomoskovsk, Ukraine); Interpipe DS (the city of Dnipro, Ukraine); – Interpipe DVM (the city of Dnipro, Ukraine).

The structural diagram for the assessment of labor potential can be represented as follows (Fig. 2).

It is obvious that independent variables can vary in certain ranges, then the values for functions F_1, F_2, F_3 at such input indicators will be fuzzy, and, consequently, the output data on the functional of labor potential assessment R will be blurred.

Formally, a fuzzy mathematical model of labor potential assessment can be represented as

$$\left.\begin{array}{l} \tilde{X}^1 = \{[x_1^-;x_1^+];[x_2^-;x_2^+];[x_3^-;x_3^+]\} \xrightarrow{f} \tilde{F}_1 \\ \tilde{X}^2 = \{[x_4^-;x_4^+];[x_5^-;x_5^+];[x_6^-;x_6^+];[x_7^-;x_7^+]\} \xrightarrow{g} \tilde{F}_2 \\ \tilde{X}^3 = \{[x_8^-;x_8^+];[x_9^-;x_9^+];[x_{10}^-;x_{10}^+];[x_{11}^-;x_{11}^+]\} \xrightarrow{h} \tilde{F}_3 \end{array}\right\} \xrightarrow{r} \tilde{R}, \quad (1)$$

where $\tilde{X}^j, (j = \overline{1,3})$ are the input fuzzy vectors for the groups of coefficients; *f, g, h* are the unknown laws that transform fuzzy sets of input vectors into the sets of groups of fuzzy indi-

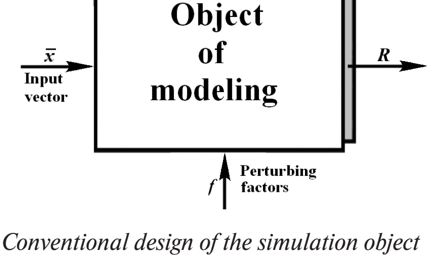

Fig. 1. Conventional design of the simulation object

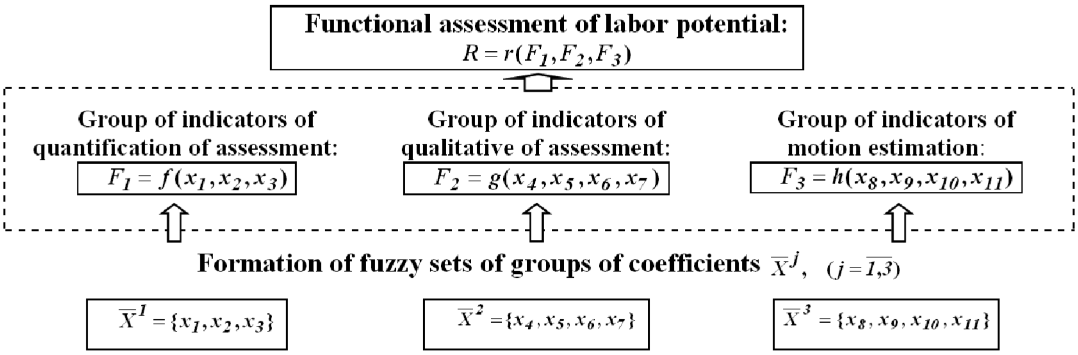

Fig. 2. Structural representation of labor potential assessment model

cators $\tilde{F}_1, \tilde{F}_2, \tilde{F}_3$, respectively; *r* is the unknown law, which transforms the sets of groups of fuzzy indicators into the fuzzy set for labor potential assessment $\tilde{R}$.

It is known that the formalization of fuzzy information employs different approaches that use a mathematical apparatus of the theory of fuzzy sets or interval analysis [5]. The choice of approach depends only on the problem being solved. Application of an interval analysis is based on the well-designed algorithmic support, though it requires the analytical form of functions *f, g, h* and of the law *r* itself of the functional *R*. It is possible to derive their analytic representation, but it is beyond the task of this work. The statement provided only the limits of variation for input data and the linguistic description of output data. A possibility to build and assign the analytical form for functions *f, g, h, r,* as well as to apply the operations from interval arithmetic, is not ruled out, but such an approach is quite complex and computationally intensive.

Based on the problem statement and the a priori expert information, it is expedient to use a mathematical apparatus of the theory of fuzzy sets, specifically, fuzzy logic and fuzzy inference.

Hereafter, the material will be laid out according to the described general algorithm of fuzzy conclusion.

It is known that depending on the choice of operations of implication and composition based on a general fuzzy inference, there are algorithms by Mamdani, Sugeno, Tsukamoto and Larsen [6].

Applying one of them entirely depends on the designer of a fuzzy inference system and the form of the problem being solved. One of the most widely used and common is the Mamdani algorithm, which will be considered further. It is quite common among the developers of fuzzy systems [6].

As noted above, the formalization of fuzzy input information will exploit the membership functions. It is known that there are indirect (using statistical data, pairwise comparison, ranking assessment, etc.) and direct approaches to their construction. When choosing a method, one should take into consideration the difficulty of obtaining expert information, its reliability, and the labor-intensity of the algorithm to process this information. In the case when there is a possibility to apply direct methods by relying on expert data, then such an approach is appropriate as it significantly reduces computational cost. It was used in this work.

Based on the expert information and their *a priori* knowledge, a space of input data was split into three subsets that will be used as values for a linguistic variable [5] for each input vector $\overline{X}$ and for functions F_1, F_2, F_3: "low" (L), "medium" (M), and "high" (*H*). One of the variants to represent input information in the form of values for term-sets is given in Table 1.

For the functional to assess labor potential *R,* we decided to split a set of its fuzzy values into five subsets: "low", "below medium" (BM), "medium", "above medium" (AM) and "high" (Table 2).

The next step of the algorithm described above is to assign the membership functions analytically. It is required that they should describe the variables in the system sufficiently enough and should not have a large, so-called, overlay of terms.

Using the expert estimates, we conducted modeling involving the trapezoidal and sigmoid MF. Note that the obtained results of numerical experiments do not differ essentially, so it was decided to use only the trapezoidal functions and their variations (2–3).

$$\mu(x,a,b,c,d) = \begin{cases} 0, & x \le a \\ \dfrac{x-a}{b-a}, & a < x \le b \\ 1, & b < x \le c \\ \dfrac{d-x}{d-c}, & c < x \le d \\ 0, & x > d \end{cases}. \quad (2)$$

Formula (2) is applied to the values for terms M, BM, AM; formulae (3, 4) – to, respectively, for terms H and L.

Table 1

Matrix of values for term sets of input data

x_1	x_2	x_3	F_1	x_4	x_5	x_6	x_7	F_2	x_8	x_9	x_{10}	x_{11}	F_3
H	H	M	H	H	H	H	H	H	L	L	L	H	H
H	M	M		M	M	M	M		M	M	L	H	
M	H	M		M	H	H	M		L	L	M	M	
H	H	H	M	M	H	M	M	M	M	M	M	M	M
M	M	M		M	M	M	M		M	M	L	M	
H	H	L		M	M	M	H		M	M	M	H	
L	L	L	L	L	L	L	L	L	H	H	H	H	L
L	L	H		M	M	L	L		H	H	M	M	
M	L	L		L	M	L	M		H	H	M	L	

Table 2

Matrix of values for term sets for functional R

F_1	F_2	F_3	R
H	H	H	H
H	M	H	
H	H	M	
M	H	H	AM
M	H	M	
H	M	M	M
L	M	M	
M	M	M	
M	M	L	BM
M	L	L	
M	L	M	L
L	L	M	
L	L	L	

$$\mu(x,a,b)=\begin{cases}0, & x\le a\\ \dfrac{x-a}{b-a}, & a<x\le b;\\ 1, & b>c\end{cases} \quad (3)$$

$$\mu(x,c,d)=\begin{cases}1, & x\le c\\ \dfrac{d-x}{d-c}, & c<x\le d.\\ 0, & x>d\end{cases} \quad (4)$$

Here, parameters a, b, c, d for the membership functions are assigned separately for each variable according to expert information.

Thus, the first step of the algorithm is completed, specifically, a process of fuzzification – fuzzy information is formalized using MF and the functions themselves are assigned in the analytical form.

The next, rather responsible step implies the construction of a fuzzy knowledge base, which must mandatorily have a fuzzy base of rules and a data storage of parameters for the membership functions. The latter condition of the algorithm is satisfied, so we proceed to the description of rule construction.

According to expert information, each rule can be represented and assigned as a hierarchy of rules:

If $(x_1 = H \,\&\, x_2 = H \,\&\, x_3 = M)$, then $F_1 = H$.
If $(x_4 = M \,\&\, x_5 = H \,\&\, x_6 = H \,\&\, x_7 = M)$, then $F_2 = H$.
If $(x_8 = M \,\&\, x_9 = L \,\&\, x_{10} = L \,\&\, x_{11} = L)$, then $F_3 = H$.
$R^{(1)}$: If $F_1 = H \,\&\, F_2 = H \,\&\, F_3 = H$, then $R = H$.

Once the structure of the rules is defined, a designer of the fuzzy inference system faces an issue on the volume of a rule base. It is obvious that it should contain all the necessary rules to adequately describe the system, but also must not contain excess information. Thus, we initially created a knowledge base according to Tables 1 and 2, which contained thirty-six and eleven rules.

Modeling results allow us to draw the following conclusion: the base of thirty-six rules is almost exhaustive of all possible variants, which is impractical for a fuzzy inference system as the total number of active rules of fuzzy products is much smaller.

As a result of conducted experiments, the base of eleven rules demonstrated that this number of rules is sufficient, and the base of five rules is its necessary volume. Thus, upon the analysis, we decided on the rational volume of a rule base and reduced it to five (Table 3).

Given the fact that we have chosen the algorithm of Mamdani-type fuzzy inference, the issue on implication and composition is resolved, namely: a logical minimum operation is accepted as implication, and a logical maximum operation is adopted as the operation of composition.

In fact, the system of fuzzy inference has been designed and built; the only step of the algorithm left is the operation of defuzzification. Methods for obtaining a definite value from a fuzzy set are well-known enough; we note that in this work we have used a centroid method for certainty

$$\mu(r)=\frac{\int_{\underline{u}}^{\bar{u}} u\mu_{\Sigma}(u)du}{\int_{\underline{u}}^{\bar{u}} \mu_{\Sigma}(u)du}, \quad (5)$$

where μ_{Σ} is the membership function of the obtained fuzzy set as a result of the operations of implication and composition; $\underline{u}, \bar{u}$ are, respectively, the left and right boundaries of a given fuzzy set.

Thus, one can proceed to the process of modeling a system and an analysis of the results obtained. Table 4 gives some of the values for input variables; Table 5 provides results of the conducted numerical experiments.

By analyzing the obtained numerical results, one can argue that the system of fuzzy inference works adequately and describes the object of modeling sufficiently enough. The values for membership functions in almost all experiments are close or equal to unity, which indicates a sufficient number of values for a linguistic variable in the functional.

At all examined plants we observed a medium level of using the labor potential, except for Interpipe DVM, where the level of usage is below medium (Table 6).

The largest negative impact on the level of using the labor potential at the enterprise was exerted by the turnover indicators, describing the intensity of the labor potential turnover. The results of the conducted estimation of turnover coefficient allow us to draw the following conclusions: the enterprise Interpipe DVM demonstrated a very high rate of employee turnover (64.9 in 2016). At other enterprises, over 2016: Interpipe Niko Tube –19.6, Interpipe DS – 23.3, Interpipe NTZ – 17.3, Interpipe NMTZ –13.1. The calculations show that the situation is very critical. As estimated by specialists, a coefficient of turnover should be in the range of 3–5 %. However, this indicator is strongly interconnected with the indicator of "mobility of hiring", "mobility of quitting".

Table 3

A fuzzy rule base for logical conclusion

x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}	F_1	F_2	F_3	R
H	H	M	M	H	H	M	M	L	L	L	H	H	H	H
M	M	M	M	M	M	M	M	M	M	M	M	M	M	M
L	L	L	L	M	L	L	H	H	M	M	L	L	L	L
H	H	M	L	M	L	L	H	H	M	M	M	L	L	BM
H	H	M	M	H	H	M	M	M	M	M	H	H	M	AM

Table 4

Input data for the fuzzy inference system

Number	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	x_{10}	x_{11}
1	0.2313	0.6397	14.71	0.2348	0.7426	17.54	2.91	0.1831	0.15	0.1963	0.236
2	0.7836	0.9044	51.18	0.2348	0.7426	17.54	2.91	0.15	0.15	0.1963	0.2216
3	0.7836	0.9044	51.18	0.2348	0.7426	17.54	2.91	0.1301	0.15	0.1963	0.236
4	0.8134	0.9632	38.24	0.2348	0.7426	28.73	2.91	0.15	0.15	0.1963	0.2216
5	0.7836	0.9485	32.35	0.2348	0.7426	39.18	2.91	0.08603	0.1037	0.1257	0.236

Table 5

Results of numerical experiments

Sample number	Number of the rule in a fuzzy knowledge base	Value of term for functional *R*	Defuzzified value for functional *R*
1	3	L	2.45
2	4	BM	10.9
3	2	M	12.8
4	5	AM	18.0
5	1	H	22.4

Table 6

Results of calculating the functional R at the examined enterprises

Enterprise	Number of the rule in a fuzzy knowledge base	Value of term for functional *R*
Interpipe NTZ	2	M
Interpipe Niko Tube	2	M
Interpipe NMTZ	2	M
Interpipe DS	2	M
Interpipe DVM	4	BM

In large cities with a big labor market, average rates for a turnover coefficient range from 0.1 to 0.2, specifically at the enterprises of metallurgical industry – from 0.1 to 0.15 [8]. A personnel turnover exceeding 0.15 is considered excessive. Excessive turnover is observed at almost all the examined enterprises (from 0.17 to 0.63). Results of the analysis reveal that all the examined enterprises are characterized by a medium and high level of the indicator for mobility of quitting and a high level of the indicator for mobility of hiring. Within a metallurgical sector of Dnipropetrovsk Oblast, a medium level of the indicator for mobility of hiring is within 0.12–0.19; the indicator for mobility of quitting – 0.20–0.24 [9, 10]. The excessive level of leaving is at the enterprise Interpipe DVM; at other examined enterprises this indicator is at a medium level. In addition, Interpipe DVM demonstrates a high level of the indicator for mobility of hiring (0.42). If there is a high indicator for employees quitting against a background of a high coefficient for the turnover of employees hired, then we can talk about the high turnover of staff.

It should be noted that the company includes 5 enterprises, which are located in Dnipropetrovsk Oblast, though at different distance from the headquarters. Therefore, it is necessary to calculate indicators for staff turnover at the same time; that would make it possible to understand the reason why people are quitting, either they are transferred to other enterprises within the company (that is, a rotation of staff) or an enterprise faces a "poor" prospect. In the course of the analysis we have proven that there occurs the rotation of personnel among enterprises. The excessive level of rotation is observed at the enterprise Interpipe DVM (0.32).

Thus, we can conclude that the indicator for the mobility of hiring characterizes the fact that businesses operate efficiently, that is, they fully utilize their labor potential. Specialists are promoted as they move between the enterprises. At present, labor mobility is one of the key factors that makes it possible for an enterprise to respond quickly to challenges that arise in the course of commercial activities. The causes of rotation at the examined enterprises are in most cases the usual mechanical transfer of human resources, predetermined by the lack of qualified staff and a production necessity. Such an understanding of rotation, at first glance, promises an easy and quick solution to the arising problems. However, experience shows that such decisions could lead to the turnover of employees reduced authority of leadership rather than to the stabilization of staff, as well as to the integration of negative phenomena into other groups of employees rather than to their localization. That is why the rotation is aimed at enhancing the professional level of employees, rather than the eradication of negative trends in the structure of human resources.

Thus, by having analyzed the dynamics in the indicators for utilizing labor potential over 2014–2016, one can follow changes in the situation at the examined enterprises in general.

Conclusions. The constructed mathematical model and the method for its formalization, based on TFS, make it possible to assess the level of labor potential at an enterprise, which allows further justification of measures to improve the efficiency of its use. The built system of fuzzy inference might be considered intelligent, as it employs the elements of computational intelligence, specifically the theory of fuzzy sets.

The application of such an automated system for the assessment of labor potential allows us to assert that it produces a series of positive effects that contribute to improving the efficiency of labor potential. The model demonstrates that model parameters of the Mamdani type are easily interpreted and typically provide for a higher accuracy. Thus, in order to model the assessment of labor potential, it is convenient and effective to apply methods from the theory of fuzzy sets. They make it possible to describe qualitative characteristics that are difficult or impossible to assign quantitatively. The technology of fuzzy simulation enables managers to take management decisions on the utilization of labor potential under conditions of uncertainty and at the stage of conceptual planning. An analysis of the indicators allows us to conclude that the most critical situation is observed for the indicators of turnover, which reduces the efficiency of labor potential use. Development of a toolkit to manage the labor potential of an enterprise taking into consideration the key factors of its turnover is the next stage of our research.

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Методологічний підхід до оцінювання трудового потенціалу на основі використання теорії нечітких множин

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Мета. Обґрунтування методологічного підходу до оцінювання трудового потенціалу промислових підприємств на основі застосування апарату нечіткої логіки з метою виявлення проблем використання трудового потенціалу та надання відповідних рекомендацій щодо їх вирішення.

Методика. Методологічною основною дослідження є класичні положення та фундаментальні праці зарубіжних і вітчизняних учених, статистичні дані, результати авторських досліджень проблем оцінки трудового потенціалу підприємств. Використані методи теорії нечітких множин, порівняльного аналізу, наукової абстракції, узагальнення наукового досвіду сучасних теоретичних досліджень, системно-комплексний підхід.

Результати. Запропоновано методологічний підхід до оцінювання трудового потенціалу підприємства, проведені чисельні експерименти на базі міжнародної вертикально-інтегрованої компанії „Інтерпайп“. Аналіз результатів оцінки трудового потенціалу підприємств дозволив визначити проблеми використання трудового потенціалу на промислових підприємствах.

Наукова новизна. Удосконалено методологічний підхід до оцінювання використання трудового потенціалу підприємств на базі апарату нечіткої логіки, що, на відміну від існуючих, дозволяє інтегрувати облік як якісних і кількісних показників при оцінці трудового потенціалу, так і показників руху, істотно підвищити ефективність ухвалення рішень в умовах невизначеності й понизити витрати при виникненні несприятливих ситуацій.

Практична значимість. Використання методологічного підходу до оцінювання трудового потенціалу підприємств на базі апарату нечіткої логіки дає можливість аналізувати трудовий потенціал як багатоелементний об’єкт, що тісно пов’язаний зі структурованістю функціонування підприємства та його можливостями; забезпечує більш точне оцінювання трудового потенціалу та прийняття обґрунтованого рішення щодо підвищення рівня його використання.

Ключові слова: *трудовий потенціал, підприємство, теорія нечітких множин, оцінка, методологічний підхід*

Методологический подход к оцениванию трудового потенциала на основе использования теории нечетких множеств

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Цель. Обоснование методологического подхода к оценке трудового потенциала промышленных предприятий на основе применения аппарата нечеткой логики с целью выявления проблем использования трудового потенциала и предоставления соответствующих рекомендаций по их решению.

Методика. Методологической основной исследования являются классические положения и фундаментальные труды зарубежных и отечественных ученых, статистические данные, результаты авторских исследований проблем оценки трудового потенциала предприятий. Использованы методы теории нечетких множеств, сравнительного анализа, научной абстракции, обобщения научного опыта современных теоретических исследований, системно-комплексный подход.

Результаты. Предложен методологический подход к оценке трудового потенциала предприятия, проведены многочисленные эксперименты на базе международной вертикально-интегрированной компании „Интерпайп“. Анализ результатов оценки трудового потенциала предприятий позволил определить проблемы использования трудового потенциала на промышленных предприятиях.

Научная новизна. Усовершенствован методологический подход к оценке использования трудового потенциала предприятий на базе аппарата нечеткой логики, который, в отличие от существующих, позволяет интегрировать как качественные и количественные показатели при оценке трудового потенциала, так и показатели движения, существенно повысить эффективность принятия решений в условиях неопределенности и снизить затраты при возникновении неблагоприятных ситуаций.

Практическая значимость. Использование методологического подхода к оценке трудового потенциала предприятий на базе аппарата нечеткой логики дает возможность анализировать трудовой потенциал как многоэлементный объект, который тесно связан со структурированностью функционирования предприятия и его возможностями; обеспечивает более точное оценивание трудового потенциала и принятие обоснованного решения по повышению уровня его использования.

Ключевые слова: *трудовой потенциал, предприятие, теория нечетких множеств, оценка, методологический подход*

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