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Development of a fuzzy optimization model for the formation of a portfolio of well-being program activities to increase employee productivity

Lev S. Mazelis [a]
E-mail: lev.mazelis@vvsu.ru

Gleb V. Grenkin [a]
E-mail: gleb.grenkin@vvsu.ru

Kirill I. Lavrenyuk [b]
E-mail: kir.lavrenyuk@mail.ru

Andrey A. Krasko [a]
E-mail: andrey.krasko@vvsu.ru

[a] Vladivostok State University, Vladivostok, Russia
[b] Yandex, Moscow, Russia

Abstract

This study was conducted within the framework of the urgent task of studying the processes of developing the human capital of an organization and increasing employee productivity. At the same time, the development process is viewed through the prism of creating and implementing various elements of the well-being program into the main corporate business processes of the organization. The purpose of this work is to develop a fuzzy method for forming an optimal portfolio of well-being program activities which will allow you to get as close as possible to the target values of key performance indicators (KPIs) of employees on a given planning horizon. To achieve this goal, a hypothesis is put forward about the possibility of building a tool that allows, based on the functional dependencies of influence channels, to form an optimal portfolio of well-being program activities that increases the efficiency of the organization. The method developed consists of a model representing a fuzzy programming problem and a method for finding its solution. A distinctive feature of the model is the consideration of two levels of uncertainty in the formation of an optimal portfolio of activities related to the reliability of estimates of numerical coefficients of functional dependencies of channels of influence and a set of parameters of constraints determined by experts. An integral indicator is used as the target function of the model, which characterizes the degree to which the target values of key employee performance indicators are achieved, taking into account the importance of each of them for the organization. The optimization variables in the model are binary variables that determine the inclusion of a certain event in the well-being program of an organization at a specific time within a given planning period. The limitations in the model are: the total amount of financial resources allocated for the implementation of the well-being program; the amount of investment in a specific area of the well-being program; an increase in the integral indicator of competence of each employee. From a practical point of view, the proposed method will make it possible to form a well-founded portfolio of well-being program activities, the implementation of which has the maximum possible positive impact on employee productivity.

Keywords: well-being program, employee burnout, competence development, portfolio optimization, fuzzy approach

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Introduction

In today's world, where the business environment grows more dynamic and competitive, organizations constantly seek ways to improve employee performance and efficiency. An effective approach that has captured the attention of researchers and practitioners alike is implementing comprehensive measures to improve employee well-being in business processes.

Well-being programs are popular because they help create a healthy and productive work environment,

improving the well-being of employees and increasing their productivity. Research suggests that well-being programs have a positive impact on various aspects of employees' lives, including physical health, emotional state, social connections and professional development. Companies implementing well-being programs can expect improved quality of their employees' work, lower stress levels and increased satisfaction. Organizations can achieve greater stability of their human resources and an improved emotional microclimate, boosting their competitiveness in the labor market.

Despite the growing popularity of well-being programs, the question stands as to which interventions and approaches are most effective. Studies propose different approaches to the design of well-being programs which differ in their focus, content and implementation methods. Furthermore, implementing similar well-being programs in different organizations often yields significantly different results. This testifies to the fact that the program's effects are also affected by the organization's internal and external factors, marked by high uncertainty and difficulty in forecasting. This creates the need to conduct more in-depth research focused on developing tools to create optimal well-being programs to raise employee performance.

Thus, this study is relevant due to the fact that there is a need to create tools for the formation of an optimal set of well-being program activities to maximize employee productivity. At the same time, when developing this tool, it is important to take into account the uncertainties and risks of the internal and external environment of the organization, as well as the resource constraints in it.

The subject under study is the development of employees' human capital and the reduction of their burnout through a well-being program, and the object is fuzzy tools for creating the optimal portfolio of well-being program measures to maximize employees' KPIs.

1. Literature review

We conducted a comprehensive analysis of studies that address the stages of employee development through the corporate well-being program described in the conceptual model proposed by Mazelis et al. [1]. These studies can be logically organized into several larger groups.

1.1. Research analyzing the influence of well-being programs on the development of organization employees

In [2] the authors proved that a culture rooted in respect, inclusivity, fairness and teamwork significantly increases employees' proactiveness and contributes to innovations and the organization's long-term development.

The authors [3] discovered a connection between employees' well-being and the accumulation of professional knowledge and skills in the organization.

The authors [4] showed the positive mutual influence of some personnel management practices (e.g., L&D, employee engagement management) and the development of employees' competencies.

In article [5] the authors described the effects of continuous training of managers in service enterprises and their impact on their professional competencies. The study [6] shows that the rapid spread of vocational education instead of academic education negatively affects the development of human capital.

Despite the scarcity of studies assessing the influence of corporate well-being programs on the development of employees' competencies, all of them confirm the positive effects of such programs. However, available research considers either the influence of individual well-being elements on employee competence or the program's influence on individual competencies. Thus, it is desirable to model the influence of a comprehensive well-being program on the overarching development of employee competence.

1.2. Research analyzing the influence of well-being programs on burnout

The authors of [7] proved that a supportive work culture contributes to improved well-being, mental health, motivation and satisfaction from work.

Drawing on an analysis of data from 240 interviews with medical workers conducted in SPSS, the authors [8] reported a positive relationship between employee well-being and perceived organizational support, a negative relationship between perceived organizational support and emotional burnout, and a negative or opposite relationship between employee well-being and emotional burnout.

In [9] conclusions were made that corporate social support programs (as part of well-being programs) promote employee satisfaction, engagement, loyalty, and productivity and better management team performance in the face of uncertainty.

In [10] the authors tested hypotheses about the impact of combined measures in the workplace on employee burnout levels. However, they noted that the data used in the study are limited due to high heterogeneity, potential bias and a small sample. This warrants further exploration of these issues.

In [11] the authors described key trends in implementing the concept of well-being by organizations to incentivize employees' work. In [12] the impact of the implementation of corporate health and well-being management programs on the general condition of employees and their productivity was proven.

The studies cited prove individual elements of corporate well-being programs and their synergistic influence affect employee burnout levels. The nature of this phenomenon is still not described exhaustively. In this study, we tested the hypothesis that the level of employee burnout as an integral indicator based on the assessment of loyalty, satisfaction and engagement affects the deviation of employees' expectations regarding specific well-being program measures from reality. In turn, employees' expectations depend on their value orientations.

1.3. Research analyzing the influence of developing employee competence and their burnout on the organization's performance

The author [13] proposed an approach to improving employee satisfaction based on building a work-life balance and demonstrated its contribution to organizations' sustainable development.

In [14] the authors substantiated the influence of workplace socio-psychological background on employees' productivity through changes in their burnout levels. In [15] they demonstrated that burnout among IT specialists affects the speed and quality of their performance.

The results of [16] show that the work environment, support from higher-ups, adaptability and intrinsic motivation have tremendous impact (direct and indirect) on employee productivity. In [17] the authors described the impact of some HR management practices on the work of the entire organization through their impact on employee competencies.

The results of [18] show that employee competence and job characteristics significantly affect their motivation for work and effectiveness. The authors [19] demonstrated that developing employees' competencies has a statistically significant influence on organizations' sustainability. The works [20, 21] described the impact of various aspects of labor (e.g., professional competence, work environment, satisfaction with work, remuneration, etc.) on employee productivity.

In [22] reported on the results of research into the influence of organizational culture and employee competence on perceived stress and productivity.

In [23] the components of burnout and their relationship with employee performance indicators were studied. Using a correlation analysis of the sample, it was estimated how various factors within the company affect employee burnout, as well as how certain aspects of burnout affect their productivity.

We can conclude that the effects of employee competence and burnout as distinct phenomena on worker productivity and organizations have been thoroughly investigated. However, the combined influence of these factors is described poorly. The analyzed studies assess the effects on the integral indicator of productivity or efficiency rather than its aspects, such as KPI.

1.4. Research assessing relationships between well-being program measures, employee competence, burnout, and the organization's performance indicators calculated mathematically

The authors of [24] analyzed data from a survey of 403 employees using Path Analysis' SmartPLS functionality and refuted the correlation between employees' corporate social responsibility and well-being.

In [25] the authors developed a quantitative model for assessing the impact of the quality of workplace equipment and engagement on employee well-being in the hospitality industry.

In [26] a model is proposed that allows us to identify the relationship between elements of motivation and employee performance. The model revealed a stable and statistically significant positive relationship between the parameters.

In [27] confirmed through regression analysis that practices improving the psychological climate in the team and developing leadership qualities have a positive influence on an organization's performance.

In [28], the results obtained using the Smart PLS method indicate that a favorable working atmosphere and engagement act as resources that help prevent burnout. Furthermore, senior management should be cautious about increasing working hours.

It was demonstrated in [29] that a low level of employee engagement does not always lead to burnout, and at the same time, the more employees work, the more they feel burnout. The study used digital doubles of employees and applied the LISREL package to analyze apparent and hidden variables and quantitatively assess relationships.

Note that existing studies have not previously solved the problem of finding the optimal portfolio of well-being program activities in order to maximize the effectiveness of the organization's activities. Most of the work uses standard data analysis tools, on the basis of which conclusions are drawn about the presence or absence of relationships between various system parameters.

At the same time, it is worth noting that the instrumental part of portfolio optimization is quite developed. For example, the fundamental principles and approaches in the field of mathematical programming were laid down in [30]. There are also other approaches that are often used to form optimal portfolios and sets of projects in industry and the financial sector, for example, quadratic programming [31] and genetic optimization algorithms [32]. Previously, the authors have already worked in the field of portfolio optimization, for example, in [33] models of fuzzy multi-period optimization were developed to support decision-making when choosing a portfolio of projects within the framework of the institution's strategic development program, allowing for step-by-step planning of a portfolio of projects taking into account the interests and risks of stakeholders.

Additionally, it is worth noting that due to the presence of uncertainties associated with data collection based on a subjective assessment of an employee or his supervisor, the lack of unified approaches to assessing burnout, competence and other entities, there is a need to use a fuzzy approach to model the existing uncertainties of the internal environment and minimize possible risks.

* * *

In conclusion, we can draw attention to the following drawbacks of existing research, which our study aimed to mitigate:

- the effects stemming from the multiperiodicity of the implementation of corporate well-being program measures and the possibility of rolling planning are not considered;
- the optimization aspects of developing the portfolio of measures under the corporate well-being program

given the effects of its implementation are not addressed;

- uncertainties and risks generated by the collection of subjective raw data, a vital component in building mathematical models, are unaccounted for;
- the effects of the comprehensive influence of the corporate well-being program on employee burnout and competence are understudied;
- the comprehensive influence of employee competence and burnout on performance and efficiency is not fully explored.

Thus, we can conclude on the lack of a proper toolkit, which would allow:

first, to describe the impact of the well-being program on the development of professional and personal competencies of employees, their burnout and performance, and, consequently, on the effectiveness of the organization as a whole;

second, with limited resources, high competition for personnel, risks and uncertainties, to form an optimal set of well-being program activities that will contribute to maximum approximation to the target values of performance indicators for both an individual employee and the organization as a whole.

2. Research goals and objectives

This study aimed to develop a fuzzy method for creating the optimal complex of measures under the corporate well-being program to maximize progress toward employees' target KPIs over a given planning horizon.

The hypothesis is that it is possible to develop a method to create the optimal portfolio of well-being program measures to improve an organization's performance based on competency development and reduction of burnout balanced across staff and time slots.

To achieve the goal, we addressed the following objectives:

1. To develop a fuzzy dynamic model for creating the optimal portfolio of well-being program measures accounting for the organization's resource limitations. The implementation of program measures depends on their direction and affects the development of workers' professional and personal competencies, which makes it possible to maximize progress toward the target KPIs of employees and the goals of the organization.

2. To develop a method for finding the solution of the fuzzy optimization model that would allow us to determine the set of program measures for each time interval on the planning horizon and each employee considering the organization's resource constraints.

3. Fuzzy optimization model for creating the optimal portfolio of measures under the corporate well-being program

Let us consider the work of organization employees on the planning horizon T. At each time point $t \in \{0, 1, ..., T\}$, the company invests in various measures within its well-being program, which affect the development of employees' personal and professional competencies and reduce their burnout at time point $(t + 1)$. Employees, considering their competence, influence the achievement of their and the organization's KPIs at time point $(t + 1)$. A critical aspect is that in commercial companies, the achievement of goals at time point t directly affects the volume of investment in the well-being program at time point $(t + 1)$.

The same employees with the same level of competence and preservation of business processes at different time intervals can achieve different KPIs in the organization. This relates to the fact that workers' productivity and efficiency are affected by their burnout level. Under employee burnout level, we understand their combined physical and emotional state, which affects how quickly they perform their work and how often they make mistakes in the business processes for which they are responsible. Mazelis et al. [34] demonstrated that burnout is a consequence of the deviation of employees' expectations about well-being program measures in the organization from what the company offers.

Mazelis et al. [1] proposed a conceptual model of employee competence development and burnout reduction by implementing the well-being program. Under conditions of uncertainties, risks, and limited resources, the management faces the task of optimally allocating financial resources between measures within the corporate well-being program to improve the performance of employees and the company through direct or indirect impact on employee competence development and the reduction of burnout (*Fig. 1*). The indicators of productivity used in this study are employees' KPIs.

Mazelis et al. [34–36] built the functional relationships of the influence channels provided in the conceptual model (*Fig. 1*).

Let us consider the work of organization employees on the planning horizon T. At each time point $t = 0, 1, ..., T$, the company invests resources in measures under the well-being program. Each measure can apply to different employees. Introducing these measures affects employee competence and changes in the deviation of employees' expectations regarding the well-being program elements from their implementation, which in dynamics leads to changes in their burnout level.

Each measure under the well-being program that requires financial investment relates to a particular direction (the program is divided into K directions) and focuses on a set of employees. The volume of investments attributable to the i-th employee in the

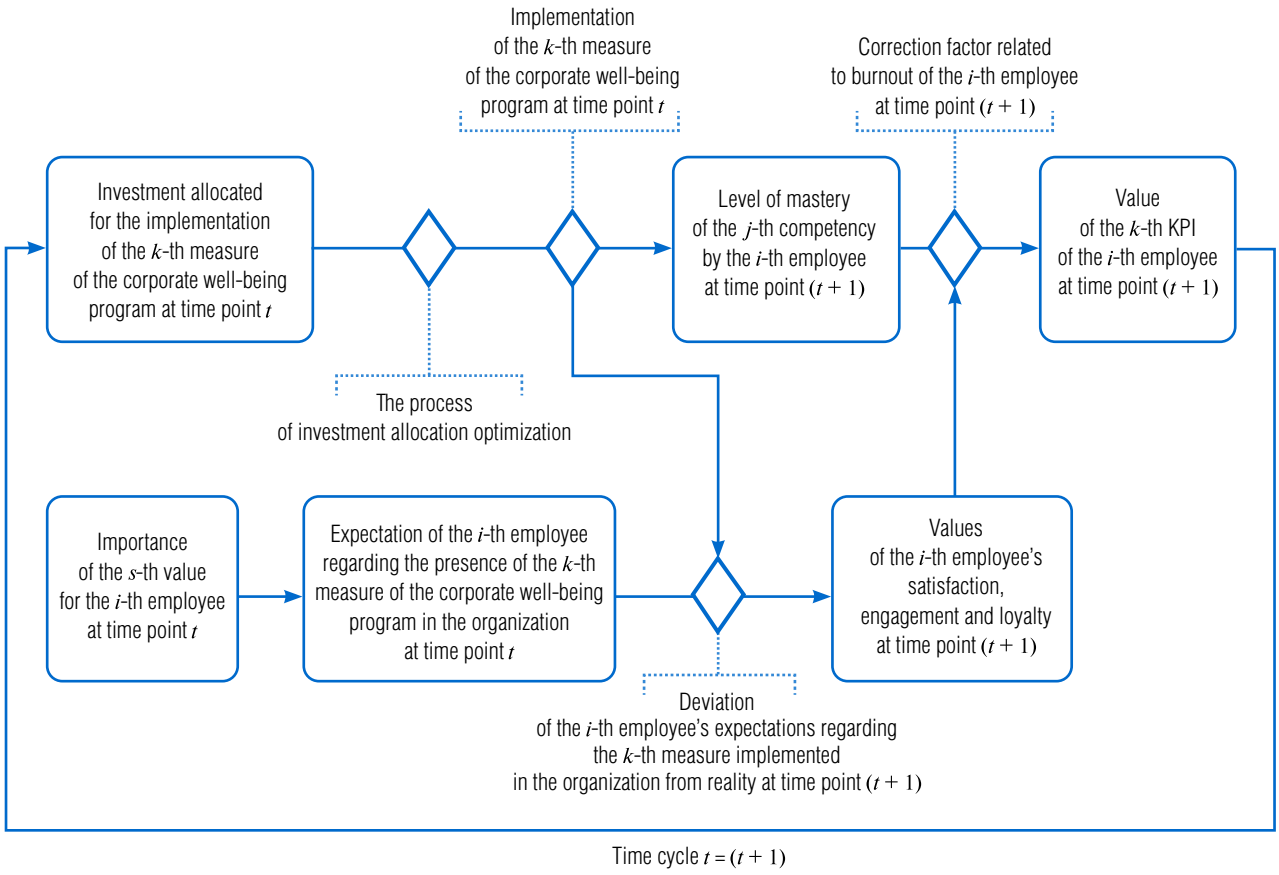

Fig. 1. Conceptual model for describing the process of developing the competence of organization employees.

implementation of all program measures belonging to the k-th direction of well-being shall be denoted by $z_{ik}(t)$.

The goal of optimization as part of our study is to maximize the integral indicator V, which describes the attainment of employees' target KPIs:

$$V = \frac{1}{I}\sum_{i=1}^{I}\left(\sum_{m=1}^{M}\beta_m \cdot \frac{y_{im}(T)}{\tilde{y}_{im}}\right) \to \max, \qquad (1)$$

where

$y_{im}(t)$ is the value of the m-th KPI of the i-th employee at time point t;

β_m is the importance coefficient of the m-th KPI;

$\tilde{y}_{im}$ is the target value of the m-th KPI for the i-th employee;

i is the number of the company employee, $i = 1, 2, ..., I$;

m is the number of the employee's KPI, $m = 1, 2, ..., M$.

Let us consider the constructed functional descriptions of the influence channels given in the conceptual model (*Fig. 1*).

1. Mazelis et al. [36] provided the econometric models of panel data, which functionally describe dependencies between the structure and volume of financial investments into measures under different directions of the well-being program and employee's levels of competencies:

$$x_{ij}(t+1) = \gamma_j x_{ij}(t) + \sum_{k=1}^{K}\alpha_{jk} z_{ik}(t), \qquad (2)$$

where

x_{ij} is the level of development of the j-th competency in the i-th employee at time point t;

$z_{ik}(t)$ is the volume of investments in the *i-th* employee of the company in the *k-th* direction of well-being at time point *t.*

To eliminate multicollinearity and reduce dimensionality while preserving information as much as possible, we used principal component analysis, in which a rotation-free method was employed to overcome difficulties in interpreting the loading matrix.

2. The channel of influence of investments in the implementation of the program measures on changes in the deviations of employees' expectations from the actual state of the corporate program is described as follows:

$$q_{ik}(t+1) = \max\left\{\min\{q_{ik}(t) + 2\frac{z_{ik}(t) - \mu_k}{v_k - \mu_k}, 1\}, -1\right\}, \qquad (3)$$

where

$q_{ik}(t)$ is the deviation of the i-th employee's expectations regarding the k-th direction of well-being from reality, $q_{ik}(t) \in [-1,1]$;

μ_k is the minimal investment in the k-th direction per employee per quarter beginning from which expectations start to change;

v_k is the maximum investment in the k-th direction per employee per quarter after which changes no longer occur.

3. Mazelis et al. [34] proposed a fuzzy model of the dependence of employee burnout on the discrepancy between their expectations about the company's corporate environment and the actual content of the well-being program, which includes several stages:

i) forming an integral indicator of expectations E_i^{INT}, equal to the weighted sum of $a_{ik}q_{ik}$, where a_{ik} (from 0 to 1) is the importance coefficient of the k-th direction of well-being measures for the i-th employee and q_{ik} is the degree of the employee's satisfaction with the implementation of the k-th measure (from −1 to 1);

ii) presenting the areas of the set of values of burnout indicators and the integral expectation indicator as a union of non-intersecting intervals of different lengths, each of which is considered as some category of the respective indicator; optimal weighting factors and fuzzy category boundaries are found by minimizing the partitioning quality functional

$$J = \sum_{i=1}^{I}\sum_{s=1}^{S} u_{is} d_s^2\left(E_i^{INT}\right), \qquad (4)$$

where

d_s is the distance from a point on the axis of the integral expectation index to the s-th interval;

u_{is} is the degree of the i-th point's membership in the s-th interval;

iii) the solution to the optimization problem is found iteratively: a) finding the optimal partitioning of points into classes by minimizing the functional at fixed weight coefficients w_k, b) finding weighting coefficients at the given division of points into classes by solving the problem of unconditional optimization of the functional

$$\frac{J}{\|w\|^2}, \text{ where } w = (w_1, w_2, ..., w_k);$$

iv) building a matrix of correspondence between fuzzy categories of the integral indicator of expectations and burnout levels.

After the defuzzification of the fuzzy piecewise constant regression based on the correspondence matrix, we obtain the dependence of the burnout index of the i-th employee on the integral expectation indicator:

$$b_i(t) = \psi\,(a_{i1}q_{i1}(t), \ldots, a_{iK}q_{iK}(t)). \qquad (5)$$

The graph of this dependence is presented in *Fig. 2*.

4. Mazelis et al. [35] provided a fuzzy model that allows assessing the influence of employee competencies and burnout levels on the achievement of KPIs. The model includes several stages:

i) forming an integral indicator of employee competence as a weighted sum of individual professional and personal competencies with optimal values of weighting coefficients;

ii) building fuzzy categories for the integral competence indicator and each KPI:

- representing the area of values of each indicator as a combination of non-overlapping intervals of different lengths, each of which is considered a category of employee competence (KPI);
- the categories are constructed based on the minimization of the cross-entropy function, and each element of the sample is described by a fuzzy number characterizing the degree of the element's membership in the constructed categories;

iii) adjusting KPI values for burnout by calculating the reduced KPI based on the solution of the de-

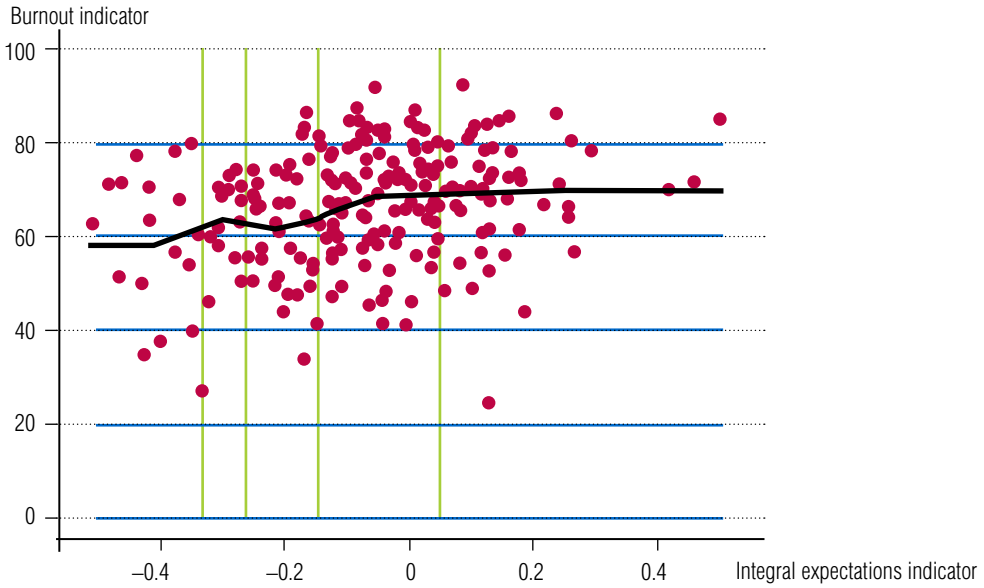

Fig. 2. Dependence of the burnout indicator of the i-th employee on the integral expectations indicator.

viation minimization problem using the weighted least squares method, considering the fuzzy membership of points to categories;

iv) building a sample distribution of KPIs for each category of the integral competence indicator based on the constructed correspondence matrix, which determines the distribution of points belonging to a competence category. This will allow us to estimate the probability of possible KPI values for specific values of competence and burnout.

Defuzzifying the dependence found; we obtain:

$$\frac{y_{im}(t)}{\tilde{y}_{im}} = \varphi_m\left(x_{i1}(t),\ldots,x_{iJ}(t)\right) + W_{m0} + W_{m1}b_i(t), \qquad (6)$$

where x_{ij} is the level of development of the j-th competency of the i-th employee at time point t;

$b_i(t)$ – the integral burnout indicator of the i-th employee.

The dependence of the i-th employee's KPI on the integral competence indicator is presented in *Fig. 3*.

The limits used in the optimization model are as follows.

1. The total amount of financial resources invested into the well-being program is limited by the company's budget and is defined by its C-level as part of human resources management strategy:

$$\sum_{k=1}^{K}\sum_{i=1}^{I} z_{ik}(t) \le Z(t). \qquad (7)$$

The budget is determined by top management as part of forming the human resources plan depending on certain cycles in the company.

2. Let us assume that investments in each well-being direction are formed as a sum of measures in which an employee participates. Each measure is characterized by its cost per person. Therefore, $z_{ik}(t)$ equals the total cost of the selected activities related to the k-th direction. There is a maximum allowable amount of investment that a company can allocate in a well-being direction:

$$\sum_{i=1}^{I} z_{ik}(t) \le Z_k(t), \qquad (8)$$

where $Z_k(t)$ is the limit on investments in the k-th direction of well-being, which is a trapezoidal fuzzy number expertly set by the company's managers.

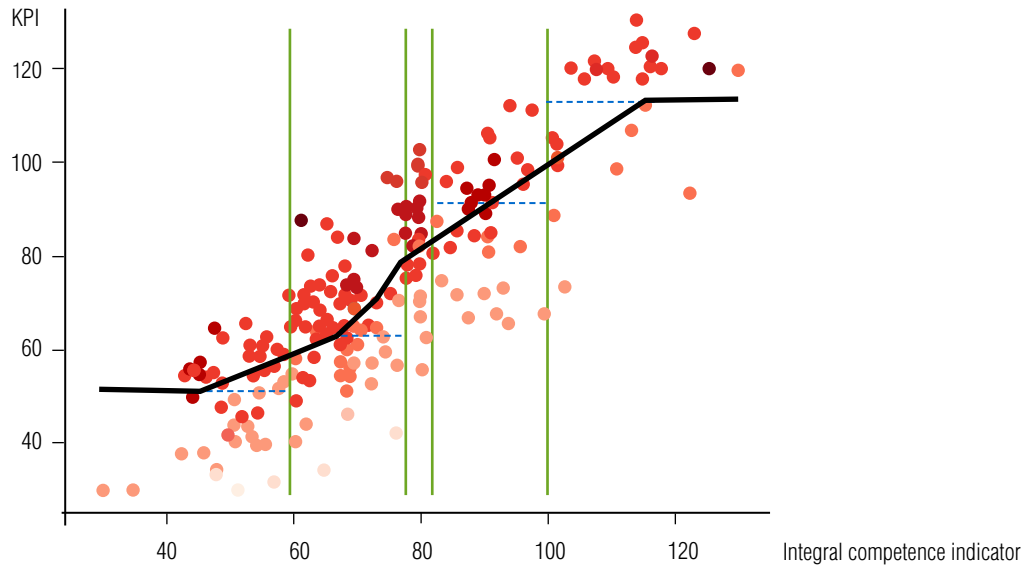

Fig. 3. Dependence of the KPI of the i-th employee on the integral competence indicator.

This limit is intended to ensure that those responsible for well-being do not direct all investments to the simplest and most costly activities, but try to address as many aspects of well-being as possible.

3. In one unit of time, the increase in the integral competence indicator due to investment in the corporate program does not exceed the fuzzy value c:

$$\sum_{k=1}^{K}\left(\sum_{j=1}^{J} w_j \alpha_{jk}\right) z_{ik}(t) \le c. \quad (9)$$

Thus, the optimization model of creating the corporate program influencing employees' KPIs through developing their competencies considering burnout takes the following form:

$$\begin{cases} f(T) = \frac{1}{I}\sum_{i=1}^{I}\begin{bmatrix}\varphi\left(x_{i1}(T),\ldots,x_{iJ}(T)\right)+W_0+\\ +W_1\psi\left(a_{i1}q_{i1}(T),\ldots,a_{iK}q_{iK}(T)\right)\end{bmatrix}\to\max \\ q_{ik}(t+1) = \max\left\{\min\left\{q_{ik}(t)+2\frac{z_{ik}(t)-\mu_k}{v_k-\mu_k},1\right\},-1\right\}, \\ t=0,\ldots,T-1 \\ x_{ij}(t+1) = \gamma_j x_{ij}(t) + \sum_{k=1}^{K}\alpha_{jk} z_{ik}(t), t=0,\ldots,T-1 \\ \sum_{k=1}^{K}\sum_{i=1}^{I} z_{ik}(t) \le Z(t), t=0,\ldots,T-1 \\ \sum_{i=1}^{I} z_{ik}(t) \le Z_k(t), t=0,\ldots,T-1, k=1,\ldots,K \\ \sum_{k=1}^{K}\left(\sum_{j=1}^{J} w_j\alpha_{jk}\right) z_{ik}(t) \le c,\ k=1,\ldots,K,\ i=1,\ldots,I \end{cases} \quad (10)$$

The limits on investment in the k-th direction of well-being and the competence increment of an individual employee are fuzzy inequalities.

The proposed model constitutes a fuzzy programming problem because some parameters are fuzzy numbers. To solve this problem of finding the optimal portfolio of program activities, we applied the approach described by Anshin et al. [37] and Wang and Hwang [38] to reduce it to a non-fuzzy problem at given confidence levels.

Let us specify the confidence levels λ_{Zk}, λ_c for limits on investment in the k-th direction of well-being and the growth of the integral employee competence indicator, respectively. In this case, the system of model limits will take the following form:

$$\begin{cases} N_{\sum_{i=1}^{I} z_{ik}(t)}\left(Z_k(t)\right) \ge \lambda_{Zk} \\ N_{\sum_{k=1}^{K}\left(\sum_{j=1}^{J} w_j\alpha_{jk}\right) z_{ik}(t)}(c) \ge \lambda_c, \end{cases} \quad (11)$$

where $N_A(B) > \lambda$ means that A satisfies limit B with a confidence level λ. This condition is equivalent to the inequality:

$$\min_x \max\left(1-\mu_A(x), \mu_B(x)\right) > \lambda, \quad (12)$$

where $\mu_Y(x)$ is the membership function of the fuzzy number Y.

Let the volume of investment in the k-th direction of well-being program measures at time point t be specified by the trapezoidal number $\sum_{i=1}^{I} z_{ik}(t) = (z_1, z_2, z_3, z_4)$ and the limit on the maximum amount of investment in the k-th direction of the well-being program – by the fuzzy trapezoidal number $Z_k(t) = (0, 0, r_3, r_4)$. Then the limit $N_{\sum_{i=1}^{I} z_{ik}(t)}\left(Z_k(t)\right) \ge \lambda_{Zk}$ is equivalent to:

$$\left[\left(1-\lambda_{Zk}\right)\cdot z_3 + \lambda_{Zk}\cdot z_4\right] \le \lambda_{Zk}\cdot r_3 + \left(1-\lambda_{Zk}\right)\cdot r_4. \quad (13)$$

Similarly, fuzzy inequalities are transformed into non-fuzzy ones, allowing one to obtain a non-fuzzy problem of Boolean programming, where the variables define whether the measure is included in the program.

To find the suboptimal solution, we performed the linearization of the dependencies:

1. To linearize the function φ in point x, we need to find the slope coefficient of the dependence. At the boundary between classes, the value of the slope coefficient is calculated as the angular coefficient of the corresponding segment of the piecewise linear function. At the remaining points x, the slope coefficient is linearly interpolated.

2. In linearizing the dependence of $q_{ik}(t + 1)$ on $z_{ik}(t)$, we should note that the number of possible values of $z_{ik}(t)$ is small (averaging at about 25 based on real data). Therefore, if we introduce binary variables corresponding to each i, each k, and each of the possible values of $z_{ik}(t)$ and calculate how much the degree of KPI achievement changes with this investment, we obtain an integer linear programming problem. In this case, it will be necessary to limit the variables attributable to a specific i and a specific k: their sum must equal 1. The set of possible values of the variables $z_{ik}(t)$ is found through dynamic programming.

In solving the integer linear programming problem, we used the *scipy.optimize.milp* package in Python. Software implementation available in the repository https://github.com/lapkin25/fuzzy-data-clustering in the folder "fuzzy_optimization."

4. Results of approbation of the method based on the example of subdivisions of a commercial company

Let us consider creating the optimal portfolio of measures under the well-being program to achieve maximum progress toward employees' target KPIs over one year divided into four periods (quarters).

We examined the IT and HR structural subdivisions of a commercial organization with a total headcount of 95 employees. The raw data collection for this example is described in previous papers by Mazelis et al. [1, 34, 36]. At the starting point in time $t = 0$ the average values of staff competence in terms of personal qualities is the fuzzy number {61; 68; 84; 91}, in terms of professional qualities in the context of HR functions – {49; 55; 67; 73}, and in the context of IT functions – {38; 43; 53; 58}. The values of indicators characterizing burnout level are as follows: loyalty $b_1(0) = \{46; 52; 64; 70\}$; engagement $b_2(0) = \{57; 64; 78; 85\}$; satisfaction $b_3(0) = \{57; 64; 78; 85\}$.

KPIs and their target values within the loss function are chosen in accordance with the company's strategic goals. The initial value of the integral indicator of employee KPI is 71.4%.

Each measure has a set of characteristics used to decide whether it should be included in the well-being program: minimum and maximum costs; minimum and maximum number of employees that can participate in it simultaneously; and the intended duration of the measure. An example of measures is given in *Table 1*.

The model allows us to form the optimal portfolio of measures of the corporate well-being program and the corresponding structure of financial resources distribution across program investment directions, employees and time points after finding the numerical solution. The model is updated for each upcoming quarter based on the results achieved in the current one.

Let us consider the results of the model solution under the condition of limiting the volume of investments in the program to 12.5 million rubles/quarter. Importantly, the results depend on the confidence level (λ), which is assigned by the company's management and represents some measure of rigidity when specifying parameters in a fuzzy form, i.e., the closer the value is to 1, the more rigid the parameter (0.5 corresponds to the default value). *Table 2* shows examples of confidence levels depending on the scenario.

Scenario 1 describes a situation where the organization strives to allocate a more rigidly defined amount of financial resources to develop its employee competence to provide for their career growth in the organization (this structure characterizes an HR strategy focused on nurturing internal human capital). This scenario encompasses such program directions as "Environment," "Career development" and "Development of skills." Investments in other blocks of directions have a gap and are mainly driven by the features of the team working in the company.

Scenario 2 arises if the organization deems it important to create a positive and transparent corporate environment (i.e., the HR strategy focuses on creating a positive employer brand and attracting experts from the external market). This scenario covers such blocks of program directions as "Financial well-being," "Healthy lifestyle" and "Corporate infrastructure."

Table 1.

Examples of well-being program measures

Direction of well-being	Measure	Mode of costs, thousand rubles	Number of employees, people	Time period
Implementing corporate benefits	Voluntary medical insurance	80	1	12
	Corporate discounts from partners	6	1	1
	Contributions to a non-profit pension fund	10	1	1
	Additional vacation days	25	1	12
	Corporate bonus program	10	1	1
Integrating employees into industry processes	Participation of speakers in industry conferences	60	1	1
	Publication of original articles	40	1	1
	Organization of industry communities	1300	100	3
	Organization of team days	7000	500	6
…	…	…	…	…

Scenario 3 creates a situation where the organization prioritizes neither of the directions. This scenario is appropriate if the company wishes to create a mixed HR strategy and identify the most effective directions depending on the team's features.

Next, let us consider the structure of financial resource allocation for the year according to the three scenarios (*Fig. 4*).

Analyzing *Fig. 4*, we should highlight the following:

1) in scenario 1, the priority directions of the well-being program receiving about 43% of the investments are "External development of SOFT competencies" (10.7%), "Implementing a talent management system" (10.4%), "Integrating employees into industry processes" (10%), "Creating adaptive work processes" (7.2%) and "Organizing healthy eating" (5%). The largest amount of investment is allocated to the areas that are part of the priority blocks of the program and provide the greatest impact on employee competence development;

2) in scenario 2, the priority directions of the well-being program receiving around 42% of the investments are "Creating adaptive work processes" (9.4%), "Integrating employees into industry processes" (8.7%), "External development of SOFT competencies" (8.3%), "Implementing a talent management sys-

Table 2.

Confidence levels

Parameter	Scenario 1	Scenario 2	Scenario 3
Integral competence indicator	0.6	0.6	0.6
Limitation on the volume of investments into the "Financial well-being" well-being block	0.6	0.9	0.7
Limitation on the volume of investments into the "Environment" well-being block	0.9	0.6	0.7
Limitation on the volume of investments into the "Career development" well-being block	0.9	0.6	0.7
Limitation on the volume of investments into the "Healthy lifestyle" well-being block	0.6	0.9	0.7
Limitation on the volume of investments into the "Development of skills" well-being block	0.9	0.6	0.7
Limitation on the volume of investments into the "Corporate infrastructure" well-being block	0.6	0.9	0.7

tem" (8.1%) and "Organizing healthy eating" (7.4%). This set of priority directions is similar to scenario 1, yet the investment structure is significantly different. Specifically, more financial resources are invested in program directions that fall within the priority clusters of the strategy;

3) scenario 3 shows a similar trend with respect to priority directions, but the structure of financial resource distribution is again different.

Across all scenarios, two directions ("External development of HARD competencies" and "Meaning management") receive virtually no funding. This can be explained by the low effect of the measures within these program directions on competencies or burnout reduction.

λ has a significant influence on creating the portfolio of well-being program measures and the structure of funding for program directions.

Our research shows that the dynamics of change in the volume of financial resources depending on λ is monotonous (increasing or decreasing) for most program directions. To be specific, the amount of allocated financial resources increases with λ for the directions of "Implementing corporate benefits," "Integrating employees into the company's corporate life," "Implementing a talent management system," "Internal development of HARD competencies," etc. An opposite dynamic is observed for "Integrating employees into industry processes" and "Developing technological and team leadership."

Analyzing the results by staff, we observed that the largest amount of funding is allocated to employees who fit the following portrait: "Employee between the ages of 31–40 with 3–6 years of total experience. Holds a position above the level of a senior specialist. Works in IT. Shows low levels of several personal competencies and high levels of professional competencies. Burnout is below the company average."

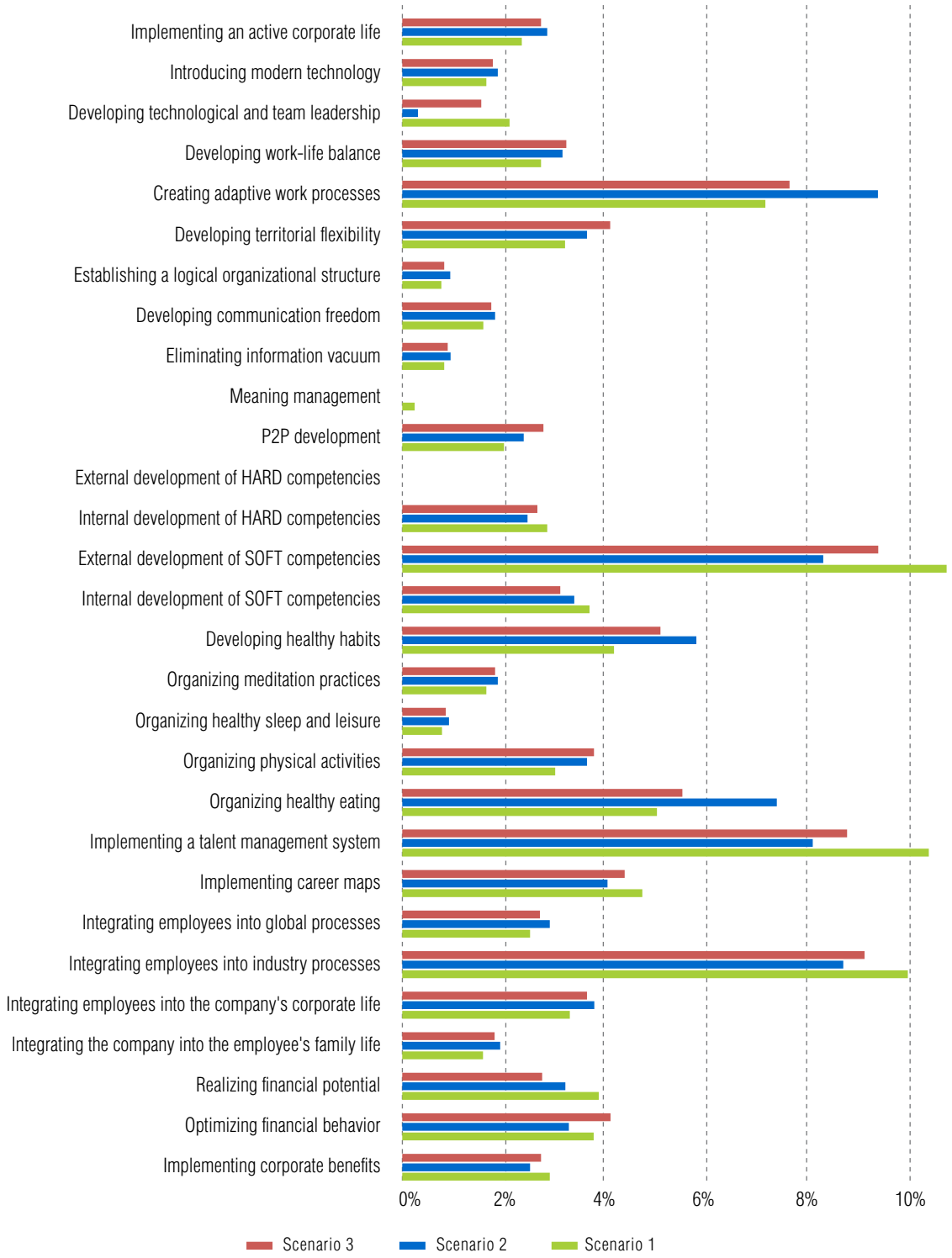

Fig. 4. The structure of financial resources allocation to the directions of the well-being program under three scenarios.

The final increase in the integral indicator of KPIs over 1 year amounted to: under scenario 1 – 11.85 units; under scenario 2 – 11.8 units; under scenario 3 – 12 units. As you can see, provided that the total investment volumes in the well-being program areas are identical, the key criterion for making a decision is the final value of the integral KPI. As part of this example, it is recommended to choose scenario number 3, i.e. a scenario in which the company's management artificially does not prioritize specific areas of the program. Thus, the tool proposed by the authors independently allows you to determine the optimal portfolio of program activities, taking into account the initial input parameters.

The final portfolio of measures is implemented in the corporate well-being program. We recommend conducting a flexible quarterly portfolio adjustment because the results of specific activities more accurately indicate their impact on the competence of a group of employees and their burnout reduction. Thus, this will introduce another indicator for the measures in terms of their contribution to the integral KPI. Future studies are planned to collect retrospective data on the implemented measures to modify the proposed model and improve its accuracy.

5. Discussion

Most studies investigating the effects of corporate well-being programs on an organization's functioning confirm the influence of such programs on human capital and employee productivity. However, these studies focus not on the overall process of human capital development using the program (from investment into personnel well-being to the productivity of their work) but rather its fragments. Gonsiorowska and Zieba [3], Salman et al. [4], Mathibe and Chinyamurindi [7], and Nursel [8] describe the influence of the program on various aspects of employee competence and burnout. Naczenski et al. [14], Kurniawan et al. [18], and Kim and Jung [22] explore the influence of different elements of employee competence and burnout on their productivity and efficiency. Several studies propose economic and mathematical models describing the interrelationships between elements of human capital development through the well-being program [26, 27].

Existing works do not consider the differentiated impact of well-being program directions on aspects of employees' work, on the one hand, and the synergetic effects arising from the implementation of several directions at once, on the other. The analyzed studies do not address the effects of multiperiodicity in implementing these programs and the optimization aspects of their development.

In the presented model, we accounted for these shortcomings and the demands of real commercial organizations.

A distinctive feature of our model is the consideration of two uncertainty levels in forming the optimal portfolio of well-being program measures. The first level has to do with the reliability of estimates of the numerical coefficients of influence channels' functional dependencies found by defuzzifying fuzzy piecewise constant regressions based on the matrices of correspondence between the fuzzy categories of the integral indicators of expectations, competencies, burnout level and KPIs. The second level relates to the need to set several limit parameters determined by experts (e.g., the finances invested in a specific direction of the program) in fuzzy numbers.

The model is marked by multiperiodicity and the opportunity to adjust the portfolio of well-being program measures for the entire planning horizon during quarterly monitoring of the achieved results, assessing deviations from the plan and reshaping the portfolio of activities based on new data. Thus, the model steadily improves the accuracy of executive decisions and employee efficiency.

Thus, our study rests on the theoretical foundation of prior research while also solving a different problem using mathematical apparatus. The need for new methods owes to the existing trend of improving financial resource management, on the one hand, and ensuring that the organization continuously develops and creates competitive advantages to secure a market share sufficient for success in the face of growing competition, on the other.

The approbation of the model on real business units of a commercial company enabled us to form a portfolio of well-being program measures depending on the priority assigned to the directions by company management. The analysis of prioritization scenarios highlighted the most significant directions that have the greatest influence on improving employees' competencies and reducing their burnout and the organization's overall efficiency. The reliability of the results is confirmed by the experts in personnel performance management who participated in our survey and research. We can conclude that the proposed method is a functional tool that allows one to create the optimal portfolio of measures under the corporate well-being program based on an organization's starting parameters. Therefore, the hypothesis posed in this study was confirmed.

Conclusion

In this study, we proposed a fuzzy method for creating the optimal portfolio of measures in a corporate well-being program to achieve maximum progress toward employees' target KPIs by developing their competencies and reducing burnout.

This method accounts for the drawbacks shown in the literature analysis and puts forward possible solutions: the effects stemming from the multiperiodicity of the implementation of a well-being program are considered; the optimization aspects of developing the portfolio of measures under the well-being program are examined; the uncertainties and risks associated with the subjectivity of input parameters are accounted for; the comprehensive influence of employee competence and burnout on productivity and efficiency is explored.

We built a fuzzy dynamic model to create the optimal portfolio of well-being program measures. The loss function used in the model is an integral indicator characterizing the attainment of target employee KPIs while accounting for the importance of each KPI for the organization.

The optimization variables in the model are binary variables that determine the inclusion of a measure into the organization's well-being program at a specific time within the given planning period.

The model proceeds from three types of limits:

1) the total amount of investment allocated to the well-being program is limited by the organization's available budget;

2) the permissible amount of financial resources to be invested in a direction of the well-being program has a top limit represented by a specified fuzzy number;

3) an increase in each employee's integral competence indicator due to investment in the well-being program does not exceed a given fuzzy value.

The features of the program are as follows.

First, the model relies on the functional dependencies of influence channels (between the categories of integral indicators of expectations, competencies, burnout level and KPIs) found by defuzzifying fuzzy piecewise constant regressions based on the matrices of correspondence between the fuzzy categories of integral indicators;

Second, the set of input parameters of model limits is specified in fuzzy numbers, which allows for either tightening or loosening the limits by setting their confidence level.

The fuzzy approach allows us to account for the uncertainties and risks associated with subjective raw data, an important component of the model.

The proposed method demonstrates theoretical significance because it is a tool for creating the optimal portfolio of measures within the corporate well-being program in terms of specific employees and points in time. This allows for structuring the allocation of financial resources to different program directions to improve the performance and efficiency of staff and the organization.

Our findings confirm the study hypothesis.

The study's practical value lies in the fact that it presents persons tasked with managing the efficiency and overall state of organization employees with an instrumental apparatus for determining and forming a well-grounded portfolio of measures for the corporate well-being program to influence employee productivity.

In the future, we plan to conduct an in-depth study to quantitatively assess the risks of deviation of actual progress toward the achievement of employees' target KPIs over the planning horizon from the ones forecasted based on the creation of the optimal well-being program. ■

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About the authors

Lev S. Mazelis

Doctor of Sciences (Economics);

Professor, Department of Mathematics and Modeling, Vladivostok State University, 41, Gogol St., Vladivostok 690014, Russia;

E-mail: lev.mazelis@vvsu.ru

ORCID: 0000-0001-7346-3960

Gleb V. Grenkin

Candidate of Sciences (Physics and Mathematics);

Associate Professor, Department of Mathematics and Modeling, Vladivostok State University, 41, Gogol St., Vladivostok 690014, Russia;

E-mail: gleb.grenkin@vvsu.ru

ORCID: 0000-0002-1307-3757

Kirill I. Lavrenyuk

Project Manager, Yandex, 16, Lva Tolstogo St., Moscow 119021, Russia;

E-mail: kirlavrenyuk@yandex-team.ru

ORCID: 0000-0002-9092-3196

Andrey A. Krasko

Candidate of Sciences (Economics);

Associate Professor, Department of Mathematics and Modeling, Vladivostok State University, 41, Gogol St., Vladivostok 690014, Russia;

E-mail: andrey.krasko@vvsu.ru

ORCID: 0000-0002-6136-6893