Improvement of Algorithms and Procedures of Decision Support in the Field of Personnel Management

Iryna Davydova, Oleksandr Balan, Olena Danyliuk, Maryna Horbashevska, Nataliia Bakulina, Illia Samarchenko

Abstract: In current conditions, the staff is considered as the leading resource of the organization. The theory that defines personnel as costs, which, above all, should be reduced, has been replaced by the theory of human resource management. Under this theory, the staff is one of the primary resources of the organization that must be properly managed, create optimal conditions for its development, and invest the necessary funds in this. The problem of selecting personnel for a position belongs to the category of loosely structured tasks that traditionally boil down to decision making. That is why the challenge of improving the algorithms and procedures for decision support in the field of personnel management is very relevant in the modern world.

The article substantiates the need to use intelligent technologies to support decision-making in human resource management tasks. The specific features of the personnel selection problem are highlighted, immersing the latter in a fuzzy environment. A multi-scenario approach is described for solving the problem of hiring, which takes into account the importance and ambiguity of indicators characterizing applicants for the position, as well as the nature of the requirements of employers.

Keywords : Decision Support, Human Resource Management, HRM, Personnel Management.

I. INTRODUCTION

In the transition to a knowledge-based economy, ensuring the efficient operation and competitiveness of an organization (enterprise, company, company, etc.) requires increased attention to staff, the human factor. Employees of the organization are considered as the central strategic resource that ensures its activities and the achievement of goals. According to this concept, the staff is one of the leading resources of the organization, which must be appropriately managed, create optimal conditions for its development, and invest the necessary funds in it [1].

The basis of the concept of personnel management is the growing role of the employee's personality, knowledge of his motivational attitudes, the ability to form them and direct them by the tasks facing the organization. The functions of human resource management (HRM) form the basis of personnel policy. The correct solution to these tasks, the adoption of objective and democratic decisions on HRM allow achieving the global goals set for the organization [3].

In general, today, human resource management is becoming the strategy of a company or firm. In this case, the funds invested in the development of human resources are converted into investments, and not costs [4, 5]. Therefore, in recent years, computer technology has been increasingly used in HRM tasks. So, to make more objective decisions regarding staff planning, selection, hiring, adaptation, dismissal, promotion, development, training and staff motivation, the decision-maker (DM), in each case, must evaluate and take into account information characterizing the applicant, his interests, possible impacts and results. At the same time, an essential factor in the quality management of personnel is their assessment using competencies.

Tasks in the field of HRM are complex and diverse. They are united by the fact that a finite number of evaluated objects are used as initial data and these objects are characterized by a combination of heterogeneous features, i.e. these tasks are multicriteria, they have to take into account a large number of factors, evaluate the many influences, preferences, interests and consequences that characterize the alternatives [6–8]. The volume, quantitative and qualitative nature, complexity and inconsistency of the flow of information coming to the decision-maker, as well as the need to take into account the interconnection of many factors, the dynamism of the situation creates difficulties in the decision-making process for resource management. To overcome the above difficulties and, accordingly, a more effective HRM organization, it seems appropriate to use intelligent decision support technologies [7–9].

II. STAFF SELECTION TASK

The problem of selecting personnel for a position belongs to the category of loosely structured tasks that traditionally boil down to decision making.

* Correspondence Author
    Iryna Davydova*, Department of Economy and Marketing, National Aerospace University named after M.E. Zhukovskiy "Kharkiv aviation institute", Kharkiv, Ukraine
    Oleksandr Balan, Administrative Management and Market Problems Department, Odessa National Polytechnic University, Odessa, Ukraine
    Olena Danyliuk, Department of Social Pedagogy and Social Work, Kamianets-Podilskyi National Ivan Ohiienko University, Kamianets-Podilskyi, Ukraine
    Maryna Horbashevska, Department of Management, Mariupol State University, Mariupol, Ukraine
    Nataliia Bakulina, Department of Management, Public Management and Personal, Ternopil National Economic University, Ternopil, Ukraine
    Illia Samarchenko, Administrative Management and Market Problems Department, Odessa National Polytechnic University, Odessa, Ukraine

In the implementation of such tasks, the opinion of the decision-maker and the preferences (experience, knowledge and intuition) of experts play a significant role. A particular leader determines the intellectual support of the selection policy

(selection of experts) in this case - decision-maker, experts participate in the process of evaluating alternatives for a set of attributes that form the degree to which alternatives meet the criteria and preference relationships for each of them, and the task of evaluating applicants for the position can be reduced to streamline alternatives with fuzzy source information. When hiring, it is necessary to determine the presence or absence of a candidate's competence necessary for effective work, i.e. the totality of knowledge, skills, abilities, social and personal characteristics and norms of employee behaviour, determined by the goals of the organization and the task of a specific situation. During the selection of candidates, their competencies are evaluated and compared with the "portrait of the ideal employee", expressed as a set of corporate competencies for a given workplace.

It should be noted that many factors and indicators characterize human competencies, and depending on the areas of professional activity, profession and organization profile, these indicators have the different relative weight of importance. In recent years, during the selection of personnel, a new trend has been observed, expressed in the individual requirements of employers to applicants for a particular position, which involves assessing the latter from the standpoint of the mandatory, desirable and unclaimed characterizing indicators concerning the proposed position. So, an indicator, mandatory according to the preferences of one employer, for the purposes and needs of another employer, may be desirable or even unnecessary.

The concept of effective personnel management should be based on the study and development of professional competencies of employees as a factor in increasing competitiveness (Fig. 1).
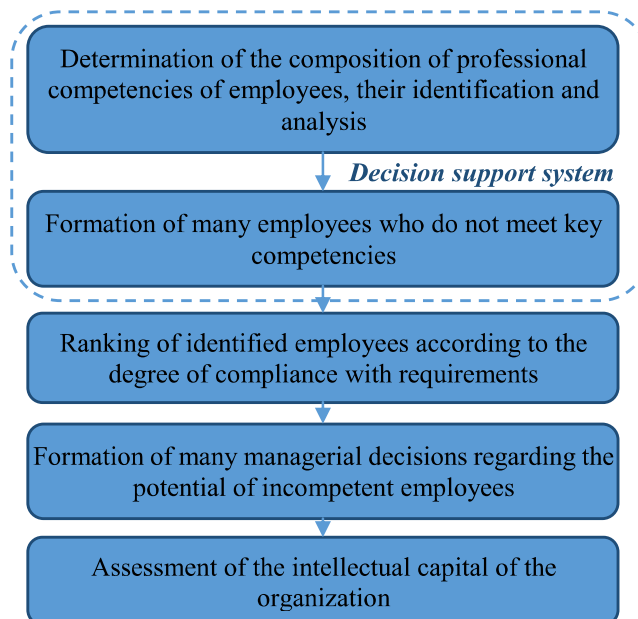

Fig. 1.HR concept

The proposed conceptual model will allow us to identify not only incompetent employees but also to develop an effective solution that allows us to evaluate and increase the intellectual capital of this organization.

A large number of researchers understand the decision-making system as "interactive computer systems that help the decision-maker use the information and models obtained to solve structureless or difficult formalized problems."

With the aim of an obvious definition of decision support systems, it is worth revealing the place of DSS among information systems in general. Exploring DSS through the multifaceted nature of decision-making processes, it is possible to distinguish three types of decision support:
1) Information;
2) Model;
3) Expert.

All three types of decision support implemented in DSS are information systems that assist in solving poorly structured tasks, as well as task formation (Fig. 2).
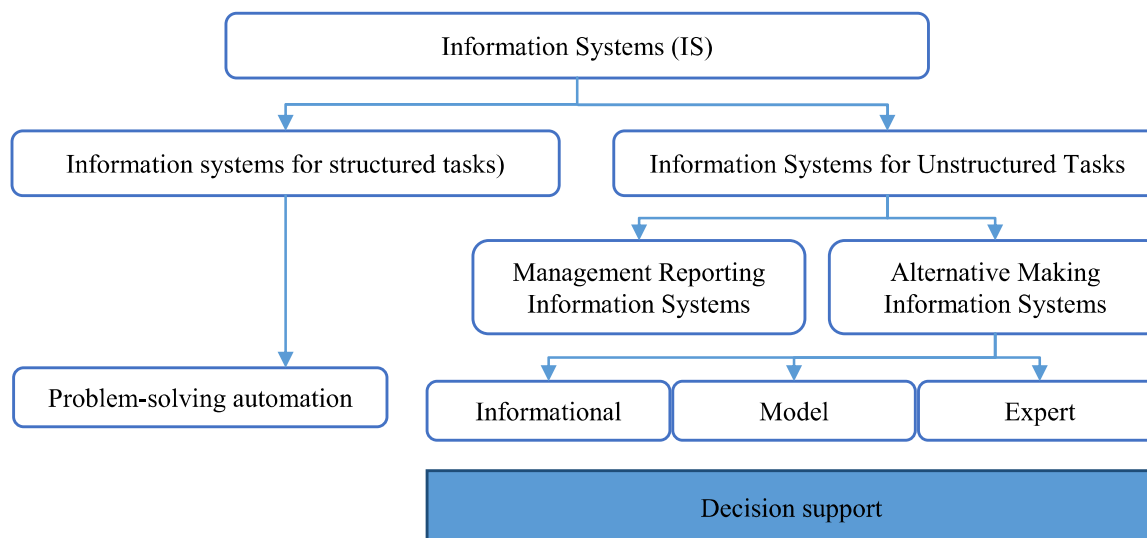

Fig. 2.The place of decision-making systems among information systems

As a poorly structured, the task of personnel selection is characterized by the following features: multifactorial and multicriteria; qualitative and quantitative nature of the criteria and indicators; the need to consider opinions in the assessment process; hierarchical assessment of the criteria characterizing the evaluated object, expressed in the fact that each top-level criterion is based on the aggregation of particular criteria; Dependence on the requirements of employers who determine the "portrait of a specialist" for a specific position.

A. Formulation of the problem

Let $X = \{x_i, i = \overline{1,n}\}$ – be the set of alternatives, which is a list of candidates applying for a position, among which it is necessary to choose the best, i.e. most suitable to the requirements of the employer, candidacy;

$K = \{k_j, j = \overline{1,m}\}$ – a set of criteria (features, properties) that characterize the alternatives. The criteria characterizing those applying for a particular position are determined by a multitude of unequal indicators, i.e. $k_j = \{k_{jt}, t = \overline{1,s}\}$ where s is the number of indicators defining j k. The set of feasible alternatives is represented by a two-dimensional matrix in which the degree of satisfaction of the alternative i x to the index jt k is determined by the membership function (x): $\varphi k_{jt}(x_i): X \times K \to [0,1]$. On the other hand, these indicators, depending on the requirements of the employer (in this case, the employer acts as a decision-maker) for a candidate for a particular position, may have a different character, i.e. be obligatory, desirable or insignificant (unnecessary).

Suppose that: 1) $\{\varphi k_{jt}(x_i), t = \overline{1,s}, j = \overline{1,m}\}$, are membership functions of the alternative i x to the indices $\{k_{jt}, t = \overline{1,s}, j = \overline{1,m}\}$; 2) the requirements of the decision-maker regarding the occupation of a particular position, expressed in assessments of the importance of the indicators $\{k_{jt}, t = \overline{1,s}, j = \overline{1,m}\}$ by classifying them into mandatory, desirable and unnecessary groups, i.e. a base representing search images of employers' requests (requirements of employers on a set of criteria and their level of ownership).

The goal of the task is to select the best alternative that matches the search image of a particular query, and further rank the list of alternatives from best to worst: $K : X \to X^*$, where X is the original set of alternatives, K is the set of required, desirable and unnecessary indicators, X^* – ranked list of alternatives. In a meaningful setting, the goal of the task can be described as the selection of candidates for the proposed vacancy, which is most acceptable for the preferences of the employer both in terms of the set of characteristics (criteria) and the degree of possession.

B. The solution to the problem

To occupy a specific position, a decision-maker (employer) evaluates all indicators characterizing a particular worker from the standpoint of their importance as mandatory (O), desirable (G) and unnecessary (N), and thus expressing his requirements, defines a search image of the request for search for the right specialist. As a result of evaluating all applicants and ranking their performance indicators for satisfaction over three groups of qualitative components, the corresponding sets $\{O\}, \{G\}, \{N\}$ are formed that satisfy the following conditions: $\{O\} \cap \{G\} \cap \{N\} = \emptyset$ and $\{O\} \cup \{G\} \cup \{N\} = \{k_{jt}, t = \overline{1,s}, j = \overline{1,m}\}$, i.e. these sets do not have a common element, and any $k_{jt} \in k_j \in K$ belongs to only one of these sets. Different requirements of employers for each set of indicators $\{k_{jt}, t = \overline{1,s}, j = \overline{1,m}\}$ determine the nature of the relationship between the sets $\{O\} \cup \{G\} \cup \{N\}$ and possible scenarios, which can be represented by the following situational options:

Scenario 1. All indicators characterizing the criterion k_j, where $k_{jt} = \{k_{j1}, \dots, k_{js}\}$, are mandatory: $k_j \in \{O\}, t = \overline{1,s}$

Scenario 2. Some of the indicators characterizing the criterion k_j are mandatory, and the other is unnecessary: $k_{jt} \in \{O\} \cup \{N\}, t = \overline{1,s}$.

Scenario 3. All indicators characterizing the criterion k_j are desirable: $k_{jt} \in \{G\}, t = \overline{1,s}$.

Scenario 4. Some of the indicators characterizing the criterion k_j are desirable, and the other is unnecessary: $k_{jt} \in \{G\} \cup \{N\}, t = \overline{1,s}$.

Scenario 5. One part of the indicators characterizing the criterion k_j belongs to the category of mandatory, and the other is desirable: $k_{jt} \in \{O\} \cup \{G\}, t = \overline{1,s}$.

Scenario 6. Some of the indicators characterizing the criterion k_j are mandatory, and the other is desirable and unnecessary: $k_{jt} \in \{O\} \cup \{G\} \cup \{N\}, t = \overline{1,s}$.

Scenario 7. All indicators characterizing the criterion k_j are unnecessary: $k_{jt} \in \{N\}, t = \overline{1,s}$.

Further, following the generated scenarios, the membership functions of the alternatives are determined by the criteria, multifactor approaches are proposed to assess the compliance of the alternatives with the requirements (requests) of employers based on the additive and multiplicative models of J. von Neumann and O. Morgenstern [10].

A lot of alternatives when choosing under risk conditions presuppose the presence of probabilistic distributions of possible incomes. According to the expected utility of NM, if the probability of generating a profit of I_1 is p, then the likelihood of generating a profit of I_2 is $(1-p)$, where $0 < p < 1$. Accordingly, not only the negative value of income I, but also the amount of lost profit $I_1 - I_2 < 0$ can be considered a loss.

To simplify the presentation of the FS model, we set $I_2 > I_1$. We denote the risky alternatives by α1, the other options allowing to obtain a guaranteed income, and we denote by α2.

The presence in the FS model of non-risky alternatives α2 that bring reliable income I_0 is fair since, in the selection process, they represent both real and opportunity costs. The costs are actual when I_0 is the current income buyer of the employer, which is a resource for the implementation of a risky alternative.
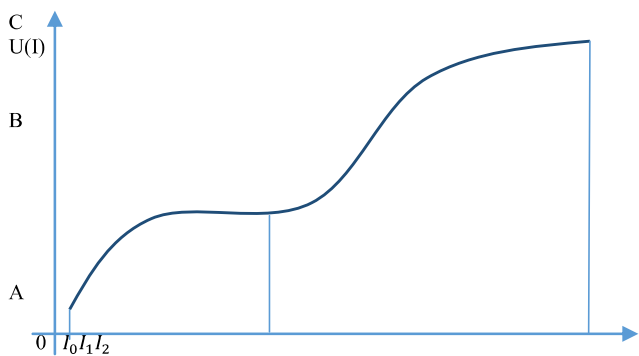
Fig. 3.Utility feature compatible with specific worker characteristics

Based on the above assumptions, we put the utility of the alternative $\alpha2 - U(I_0)$, and the expected utility $\alpha1$:

$$\overline{U}_{(\alpha1)} = p \cdot u(I_1) + (1-p) \cdot u(I_2) \qquad \Box\Box\Box$$

where $\overline{U}_{(\alpha1)}$ is the expected utility of the risky alternative $(\alpha1)$.

Following the NM model, the employer will choose $\alpha1$ if $\overline{U} >\cdot u(I_0)$; chooses $\alpha2$ if $\overline{U} <\cdot u(I_0)$; and he will not care which alternative to choose if $\overline{U} =\cdot u(I_0)$.

The combination of the generalized efficiency function of the optimum nominal and the Friedman-Savage model allows us to form a system of decision-making models. Such a joint use of the optimum face value method and the Friedman-Savage model will make it possible to combine two levels in decision-making - local, at the choice of a particular employer, and global, at the market level. A visual analogue of such an integrated use of these two models can be presented in Fig. 4.
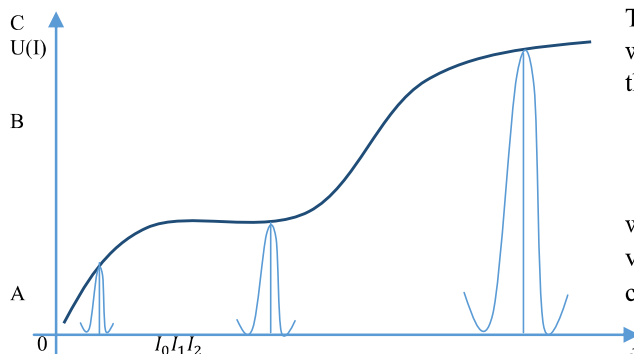

Fig. 4.
Combining the utility curve according to the FS model and the probability density function.

In fig. 4, the placement of the probability density function of the optimum nominal value is presented in relation to several levels of profitability of the 1st employee and the corresponding level of risk and particular usefulness of the decision.

The actual practice of decision making shows an almost infinitely large set of points corresponding to a certain level of utility and the corresponding level of risk. In this regard, it is necessary to take into account either the whole set of these points or their subset, which will be of interest both from the point of view of the investor and from the point of view of the

state of the economy as a whole (it is macro- and micro-component). Isolation of the necessary subset of state points, i.e. the formation of a specific signal is the task of filtering it from the original set according to some efficiency criterion.

This procedure allows you to select those components of the signal that have a specific price component in some valid field of their spread. Such an addition of a comb filter does not yet fully solve the problem facing the enterprise, namely, to warn the directorate about the inefficiency of individual employees. To solve this problem, it is possible to modulate the amplitude of the comb filter by the Friedman - Savage function (Fig. 5).
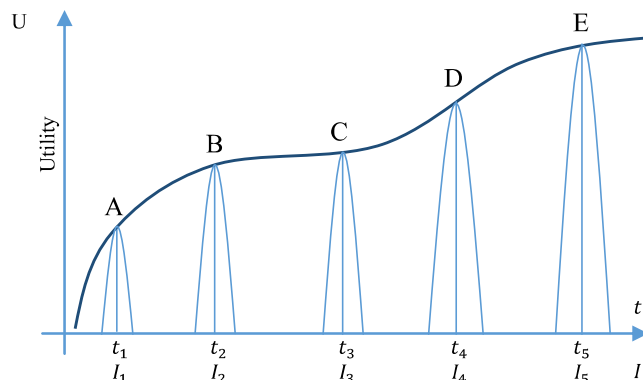

Fig. 5.Combining the utility curve according to the FS model and the probability density function.

Such modulation of the comb filter in amplitude allows you to expand the ability of this filter by changing the restrictions on the amplitude of its characteristics based on the changing utility of the decision (points A, B, C, D, E). The mathematical form of the comb filter is presented in the way of relations (2) and (3) at the corresponding intervals of the Friedman - Savage utility function:

$$\varphi(I)/(l_0 - l_1) = \sum C_i \int_{l_0}^{l_1} f(I) e^{'} dI \qquad \Box\Box\Box$$

where $f(I)$ is the distribution density function of the random variable I; $f(y)_{|a}$ is the distribution density of the results corresponding to a certain strategy α.

On the interval $(I_1 - I_2)$, the synthesis of the decision-making efficiency function is associated with a combination of the optimum value function with a logistic function approximating the utility function of the FS. The synthesized function has the form:

$$\varphi(I) = \sum C_i \int_{l_0}^{l_1} f(I) \frac{\gamma}{1+e^{\alpha+\beta l_i + \varepsilon_i}} dI \qquad \Box\Box\Box$$

Such a filter provides a decision-making process according to two criteria: maximum income with restrictions on risk (local level), maximum utility at a certain level of risk and insurance of hiring a particular type of employee. Of course, such a decision-making process using the above-described system of models is possible at the market level.

III. RESULT AND DISCUSSION

On the basis of the analysis of situations arising in the process of business process management and the range of decisions defined above, the main features of decision-making in this subject area were identified:

- large amount of textual (descriptive and graphic) information;
- large number of criteria considered;
- use of quantitative and qualitative parameters;
- inaccuracy, inaccuracy, uncertainty of input information, which requires special approaches to its description and application;
- the group nature of the decision-making process, most decisions are made by the group;
- the diversity of interests of participants in the decision-making process, resulting in the need for consistency of decisions.

As part of the development of an intelligent decision support system for human resource management, two tasks were considered:

1) an assessment of the employees' labour activity for bonuses;
2) selection of personnel for vacant positions.

The proposed methodology, which is one of the possible solutions to the personnel selection problem, allows you to take into account the preferences of employers, gives them the opportunity to make more informed decisions on the selection of personnel and is successfully used in various companies to support management decisions on hiring personnel. In the process of using the system, it may be necessary to improve the methodology in the direction of taking into account the preferences and interests of the employees themselves.

IV. CONCLUSION

The decision-making process is complex and multi-faceted. Careful study of decision-making problems will help managers to form a clear picture of the problem and correctly identify the solution, which, in turn, will help reduce errors in the development of measures to implement and monitor the implementation of the decision, will allow objectively identify the necessary resources for its implementation. The research conducted can also be useful in building an effective decision support system that takes into account the needs and requirements of managers at different levels of management.

Prospects for further research include problem analysis to identify appropriate decision-making methods and requirements for a computer-based business decision support system based on the issues discussed above. Currently, work is underway to develop a method for making compromise decisions that take into account both the preferences of employers and employees.

REFERENCES

1. Prokopenko O., Kudrina O., Omelyanenko V. Analysis of ICT Application in Technology Transfer Man-agement within Industry 4.0 Conditions (Education Based Approach), ICT in Education, Research and In-dustrial Applications. Integration, Harmonization and Knowledge Transfer (ICTERI 2018): Proceedings of the 14th International Conference on ICT in Education, Research and Industrial Applications. Integration, Harmonization and Knowledge Transfer. Volume I: Main Conference (Kyiv, Ukraine, May 14-17, 2018), Edited by V. Ermolayev, M.C. Suárez-Figueroa, A. Ławrynowicz, R. Palma, V. Yakovyna, H.C. Mayr, M. Nikitchenko, A. Spivakovsky, Kyiv, 2018, Vol-2105, p. 258-273.
2. Bondarenko S.A., Savenko I.I., Sedikova I.O., Kucherenko K.V., The grading of the level of remuneration as a motivational mechanism, *International Journal of Civil Engineering and Technology*, 2018, 9(11), p. 1384-1394
3. Andrea Enrico Del Grosso, Reliability of SHM procedures and decision support in infrastructure management, July 2010, DOI: 10.1201/b10430-235
4. Galina Setlak, The Fuzzy-Neuro Classifier for Decision Support, *International Journal "Information Theories & Applications"*, Vol.15, 2008, p. 21-26
5. P. V. (Sundar), Balakrishnan P. V., Triangulation in decision support systems: Algorithms for product design, *Decision Support Systems*, 1995, 14(4), p. 313-327 DOI: 10.1016/0167-9236(94)00026-O
6. Ronald De Boer, Marco Schutten, W.H.M. Zijm, A Decision Support System for Ship Maintenance Capacity Planning, *CIRP Annals - Manufacturing Technology*, 1997, 46(1), p. 391-396 DOI: 10.1016/S0007-8506(07)60850-6
7. Viktor Sineglazov, Intelligent system of personnel management, May 2019, DOI: 10.18372/1990-5548.59.13634
8. A. Zimenkova, I. Rzhanova, Modern IT-Technologies in Personnel Management, October 2018, DOI: 10.12737/article_5bd1ca9dbf3546.88382941
9. Arif Subhan, Personnel Management/Supervision, *Journal of clinical engineering*, 2018, 43(4), p.138-139 DOI: 10.1097/JCE.0000000000000307
10. Paul J.H. Schoemaker. The Expected Utility Model: Its Variants, Purposes, Evidence and Limitations, *Journal of Economic Literature*, June 1982, v.XX, no.2, p. 529–563.