

A method for calculation of coefficients of the impact of factors on the need for specialists of the highest qualification was proposed. The method is based on expert evaluation methods, in particular, on determining the importance, degree of realization, and tendency of factors that affect the need for highly qualified specialists. The method implements the unit of data reliability verification based on the Kendall coefficient of concordance and Pearson criterion. The method applies an original approach to determining the competence of experts, in particular, by taking into consideration self-evaluation, mutual evaluation, and objective evaluation. The proposed method makes it possible to take into account the influence of factors on the need for specialists of the highest qualification with the possibility of forecasting.

The totality of factors that influence the need for specialists of the highest qualification and the magnitude of their impact was determined. They were determined by calculating the indicators of each of the criteria regarding importance, realization, and tendency. Determining was carried out using the algorithm for calculating the coefficients of influence of the factors on the need for specialists of the highest qualification.

In general, the following groups of factors were determined: conditions of scientific and scientific-pedagogical activity at a certain institution of higher education, the attractiveness of scientific and scientific-pedagogical activity in a certain country (region), development of industry (speciality). A group of 30 experts was selected to determine the numerical values of the factors, which satisfies the condition for achieving a confidence probability of 0.94.

The results of the evaluation of expert judgments revealed that the most influential factors are: social protection (0.87), budget for higher education (0.99), remuneration (0.9), and prestige of scientific and pedagogical activities (0.91). The least influential are: the number of primary positions in the area (0.48) and self-realization opportunities at a higher education institution (0.58)

Keywords: postgraduate training, staff turnover, higher education institution, specialists of the highest qualification

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IMPROVING A PROCEDURE FOR DETERMINING THE FACTORS THAT INFLUENCE THE NEED OF HIGHER EDUCATION INSTITUTIONS FOR SPECIALISTS OF THE HIGHEST QUALIFICATION

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1. Introduction

The transformation of higher education in recent years has led to the intellectualization and development of scientific, academic, and teaching staff (ATS) in accordance with the best world trends. On the one hand, this leads to

an improvement in the quality of higher education and, as a result, the mobility of students of higher education. On the other hand, this causes an increase in staff turnover, because the ATS with the competencies that meet the demands of the global labor market, as a rule, are not “linked” to a certain higher education institution (HEI). ”

Thus, the need to respond to an increase in staff turnover exists in the vast majority of the HEIs in different countries of the world. Moreover, this applies to the countries with different economic development, culture, attitude to higher education, for example, such problems exist in the UK, Malaysia, Thailand, South Africa, Ukraine, and some other countries.

The main reasons for an increase in staff turnover are different views on the professional activities of students, teachers, and employers [1], a change in the influence of ethical leadership in higher education [2].

Moreover, it is necessary to take into consideration the regional features and specific features of certain HEIs regarding staff turnover [3], as well as the economic component [4].

No less important for staff turnover are personnel policy both in the country and at the certain HEI [5] and socio-psychological factors [6].

It is possible to overcome the problem of the ATS turnover by improving the conditions of scientific and teaching activities, increasing the amount of training at the third level of higher education (Doctors of Philosophy), or combining these approaches. One of the main scientific problems that arises in the implementation of these approaches is the difficulty of predicting the need for the number of specialists with higher qualifications to meet the internal needs of higher education institutions. This problem is caused by the lack of an effective scientific and methodological apparatus to determine the predicted need for highly qualified specialists taking into consideration regional, sectoral characteristics and the specific features of higher education institutions.

The absence of this apparatus is due to the complexity of formalization and determining of the factors that affect the shortage of the ATS at the HEI after a certain time. Given the period of preparation at the third educational and scientific level of higher education, which is 4 years, forecasting gets significantly complicated.

The consequences of unsuccessful forecasting of this need may be the oversized budget for training highly qualified specialists in the event that the training of an excessive number of postgraduate students is planned. Otherwise, it is possible to decrease the quality of higher education due to the lack of a sufficient number of highly qualified specialists to fill vacant positions of the ATS. Moreover, in the second case, it is also possible to exceed the budget funds of the HEI due to the need to find and hire these specialists in the labor market. Indeed, in this case, it is necessary to create conditions of activity more attractive than in other HEI, which requires significant budget expenditures.

To find a solution to this problem in the practical plane is a significant challenge to the organizational and functional structures of the HEI. After all, the processes of the HEI management may change depending on a large number of both internal and external factors. Both the structure and the functions of separate components of the HEI may change. That is why the existence of a scientific and methodological apparatus to determine the predicted need for specialists of the highest qualification is an urgent need.

In general, the essence of the scientific problem lies in the difficulty of determining the totality of the factors that affect the need for specialists of the highest qualification, the formalization of these factors through indicators, and determining the tendencies of these indicators. In other words, factors over time can change and are likely to change.

Moreover, these changes are difficult to formalize into certain functional dependences.

Thus, under today's conditions, which require an increase in the mobility of highly qualified specialists, staff turnover increases significantly. Accordingly, the study of the factors that influence this turnover becomes relevant.

In practice, the research into the factors that affect the turnover of specialists of the highest qualification will make it possible to reasonably predict the need for such specialists.

2. Literature review and problem statement

Paper [7] examines the links between the formation (orientation) and retention of academic staff. Thirty teachers from five higher educational institutions of Great Britain were studied. It was proposed to change the policy and practice of staff formation. However, sectoral and regional factors that affect staff turnover were not considered.

Study [8] analyzed the staff turnover at several higher education institutions. The explored characteristics of the staff included age, gender, staff type, and contractual status. It was found that there are differences in staff turnover depending on age, gender, and contract type. It was found that younger staff are more likely to look for a job elsewhere but may stay if there are opportunities for career growth and development.

Practical processes for the improvement of the consideration of factors that affect staff turnover were proposed. In particular, the need for a detailed analysis of the dynamics of staff turnover was substantiated to determine where the policy and practice of hiring and retaining personnel need to be concentrated. However, the study did not address the issues of the relation of the staff turnover and staff training at the postgraduate department.

Paper [9] analyzed the turnover of full-time employees at one of the UK universities in the period after 1992 with a sample of more than 2,000 employees. It revealed localized high indicators of turnover rate related in particular to researchers. The approach and conclusions on personnel management at higher education institutions were proposed. However, the article did not take into consideration the sectoral context of staff turnover.

Study [10] analyzed the factors influencing the work efficiency and the involvement of the members of both academic and non-academic staff in higher education institutions in Malaysia. The method of expert evaluation was used, in particular, through surveys. 200 respondents of several HEIs took part in the survey. It was found that career development, employees' involvement, and the work-life balance have a significant relationship with the staff retention and outcomes of work. However, this does not make it possible to determine the quantitative impact of factors on staff turnover.

Study [11] revealed the relationship between job satisfaction and employees' involvement. The model of job satisfaction and the involvement of the staff at higher education institutions in Thailand was created. The research was based on the methods of expert evaluation and factor analysis. A positive correlation between job satisfaction and employees' involvement and the quality of higher education was detected. The findings of this study are useful to enhance the level of job satisfaction and employees' engagement. However, the study did not consider the application of the proposed methodology and the model in various areas of higher education.

Paper [12] presented the results of the research into the organizational climate in a South African higher education institution and identified the prospects for the development of personnel management at higher education institutions. It was found that the decision to quit the job at a university is made by employees based on the compliance between the job requirements and compensation. The study offered practical recommendations to reduce the staff turnover, ensure productivity and efficiency of their work. However, the article does not consider the impact of staff turnover on the number of postgraduate students at HEIs.

Paper [13] deals with studying the relationship between the promotion of specialists of the highest qualification and their intentions to change the institution (to increase turnover) in Pakistan educational institutions. The method of expert evaluation was applied. To collect data, 502 respondents completed questionnaires. The results showed a negative link between promotion and intention to change institutions and a weak correlation between promotion and analytical indicators. However, the article took into consideration only the specific features of staff turnover for the Pakistani province of Khyber Pakhtun Khwa. The sectoral factors were not taken into consideration either.

Thus, existing studies on the problem of the turnover of the staff of higher qualification do not take into consideration the relationship with the issues of planning the number of postgraduate students. In addition, the existing studies did not take into account the totality of contexts (regional, sectoral, internal (HEIs)), nor did they substantiate the ways of quantitative influence of factors.

3. The aim and objectives of the study

The purpose of the study is to improve the procedure for determining the factors that affect the need of higher education institutions for specialists of the highest qualification, taking into consideration regional, sectoral characteristics and specific features of higher education institutions. This will allow making well-grounded decisions on determining the need for a number of postgraduate students.

To achieve the aim, the following tasks were set:

- to devise a method for calculating the coefficients of influence of factors on the need for specialists of the highest qualification;
- to determine the totality of factors that affect the need for highly qualified specialists and the magnitude of their impact.

4. The study materials and methods

The object of this study is the factors that affect the need of higher education institutions for specialists of the highest qualification.

The main hypothesis is that the factors that influence the need for highly qualified specialists are of regional, sectoral, and internal (regarding higher education) character and should take into consideration the importance, realization, and the tendency of development.

The accepted assumption is that the totality of experts selected for the study is competent in the formation of the need for specialists of the highest qualification.

The accepted simplification is that the research was carried out within educational area 25 for the conditions of functioning of higher education institutions in Ukraine.

Microsoft Excel 2010 (Microsoft, USA) was used for calculations.

To determine the importance of the factors that influence the predicted need for specialists of the highest qualification, the expert evaluation method was used, in particular, the simultaneous factor ranking method.

The essence of the expert evaluation method is to determine the generalized value of expert judgments by analyzing and processing the judgments of separate experts who belong to the group [14–16].

Ranking of information about experts makes it possible to determine the normalized coefficients of the importance of experts' judgments. The essence of such ranking is the assessment by an expert of the level of his competence, other experts of the group, and objective data about the expert. This approach ensures an impartial determination of the expert's competence and significantly reduces errors of judgment.

In general, the approach to determining the relative competence of experts during the aggregation of pairwise comparisons meets the improved approach proposed in [17, 18]. Thus, the basic components of the coefficient of relative competence of a member of expert group C is self-evaluation C_{self} , mutual evaluation C_{mutual} , and objective component $C_{objective}$. The general expression is: $C = C_{self}(X_1C_{mutual} + X_2C_{objective})$, where X_1 and X_2 are relative weights of objective and mutual evaluation of competence of the members of the expert group [17, 18]. In this case, mutual evaluation is determined as the indirect value of the judgments of all experts C_{mutual} . The parameter of objective component $C_{objective}$ is determined as the normalized value of such indicators as education, professional experience, etc.

It should also be noted that the “snowball” approach was applied when selecting experts. The essence of the approach is that the experts are included in the list of experts on the recommendation of the experts who were already included [18]. This suggests that weight coefficients X_1 and X_2 will have the same value – 0.5.

Subsequently, according to the essence of the method, experts determine the degree of influence of a certain factor on the research subject. Moreover, the least important factor corresponds to numerical designation 10, and the most important one corresponds to numerical designation 1.

To prevent the influence of the order of factors placement on the judgment of experts, they are placed randomly, and experts are warned about it.

The results of expert judgments are entered in the table (Table 1). In this case, the results of the expert's judgments are normalized [19–21] to save the sum of all values (1).

$$N_i = \frac{(I(I+1))/2 - \sum m_{j,i}}{k}, \tag{1}$$

where N_i is the magnitude of the rank value;

I is the number of factors;

$m_{j,p}$ is the magnitude of the rank value that is different from the similar ones;

k is the number of matches of rank values.

To determine the consistency of experts' opinions, the method for determining the Kendall concordance coefficient [22, 23] (2) was used in the research.

$$W = \frac{12S}{n^2(I^3 - I)}, \tag{2}$$

where S is the sum of squares of deviation of the sum of rank values of each factor from the mean sum of rank values [22, 23].

$$S = \sum_{j=1}^I \left(\sum_{i=1}^n m_{i,j} - a \right)^2, \tag{3}$$

where n is the number of experts;

a is the coefficient that is determined from the formula: $a = (n(I+1))/2$.

It is proposed to evaluate the statistical significance of coefficient W by checking statistical hypotheses: $H_0: W=0$; $H_1: W \neq 0$ [24–26].

Table 1

Results of expert judgments on factors' ranking

Factor	Expert				Magnitude of rank value	$\sum_{i=1}^n m_{i,j} - a$	$\left(\sum_{i=1}^n m_{i,j} - a \right)^2$
	1	2	...	n			
1	$m_{1,1}$	$m_{1,2}$	...	$m_{1,j}$	N_1	d_1	$(d_1)^2$
2	$m_{2,1}$	$m_{2,2}$	...	$m_{2,j}$	N_2	d_2	$(d_2)^2$
...
I	$m_{i,1}$	$m_{i,2}$	...	$m_{i,j}$	N_i	d_i	$(d_i)^2$

When proving basic hypothesis H_0 , it will be recognized that the opinions of experts are not consistent. When rejecting this hypothesis, we will accept alternative hypothesis H_1 , indicating the consistency of opinions.

It is proposed to select Pearson's chi-squared test (χ^2) as the criterion for verification of hypothesis H_0 [26–28].

$$\chi^2 = n(I - 1)W. \tag{4}$$

It is necessary to compare the calculated χ^2 with the tabular value at the selected level of significance α and the number of degrees of freedom $\beta = I - 1$. Hypothesis H_0 is rejected, and therefore the consistency in the opinions of experts is recognized when the condition that $\chi^2 \geq \chi_{tabl}^2$ is met [26–28].

5. Results of improving the procedure for determining the factors that affect the need of higher education institutions for specialists of the highest qualification

5.1. Devising a method for calculating the coefficients of influence of factors on the need for specialists of the highest qualification

The essence of the method is to determine the magnitude of the influence of certain factors on the need for specialists of the highest qualification by determining the indicators of importance, realization, and tendency of each factor by a group of experts. Moreover, the competence of each expert is determined taking into consideration the indicators of self-, mutual, and objective evaluation.

It is proposed to represent the method by developing an algorithm for calculating the coefficients of influence of factors on the need for specialists of the highest qualification.

To develop an algorithm, it is necessary to determine the main stages of the study. In general, the following list of stages is proposed. At the first stage, it is necessary to determine the main groups of factors that affect the turnover

of highly qualified specialists in higher education institutions. At the second stage, it is necessary to decompose these groups into the lower-level factors of the hierarchy. Next, it is necessary to select a group of experts and determine the level of their competence. At the next stage, it is proposed to determine the importance of these factors in these groups. Next, it is necessary to determine the degree of implementation of these factors at the moment. At another stage, it is proposed to determine the tendencies in the development of the influence of these factors on staff turnover. Subsequently, it is necessary to check the adequacy of the proposed approach and the reliability of the results.

In general, the algorithm of formalization of the factors that affect the formation of the need for specialists of the highest qualification is shown in the flowchart (Fig. 1).

For further application of calculations, it is proposed to clarify the general algorithm (Fig. 1), in particular, taking into consideration the calculation dependences (Fig. 2).

The first step of this algorithm is to determine the factors that influence the need for specialists of the highest qualification in higher education institutions. They are determined by analyzing existing studies in this area, reports of activities, and the HEI staff. Moreover, the main groups of factors are selected, and then they are decomposed into the factors of the lower level of the hierarchy.

The next group of steps is related to the selection of experts and determining their competence. According to the method proposed in the paper, it is advisable to select experts by the “snowball” method [29], which will ensure the appropriate level of competence of experts at the initial stage. This makes it possible to reduce the group of experts without losing the adequacy of results.

In general, this group includes steps to determine the coefficients of mutual evaluation, self-evaluation, and objective evaluation of experts, as well as the resulting determining of the expert's competence.

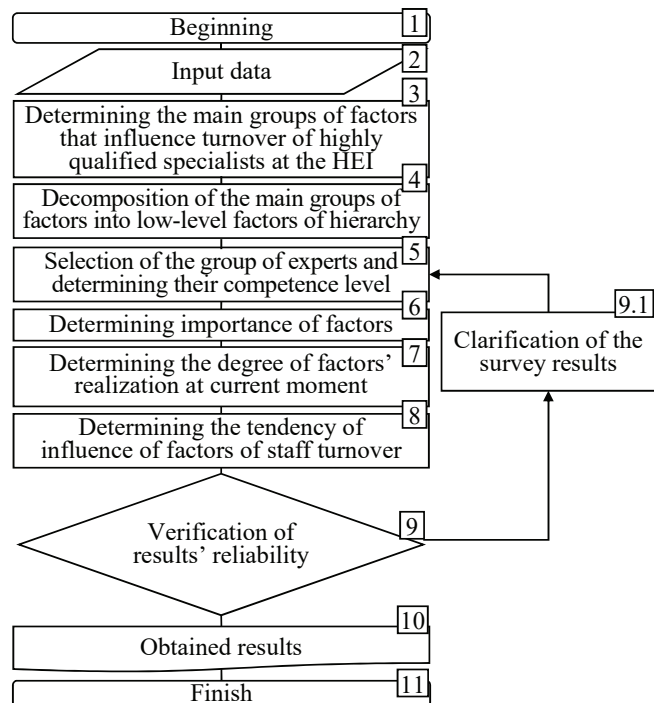


Fig. 1. Generalized flow-chart of the algorithm for the formalization of factors that affect the formation of the need for specialists of the highest qualification

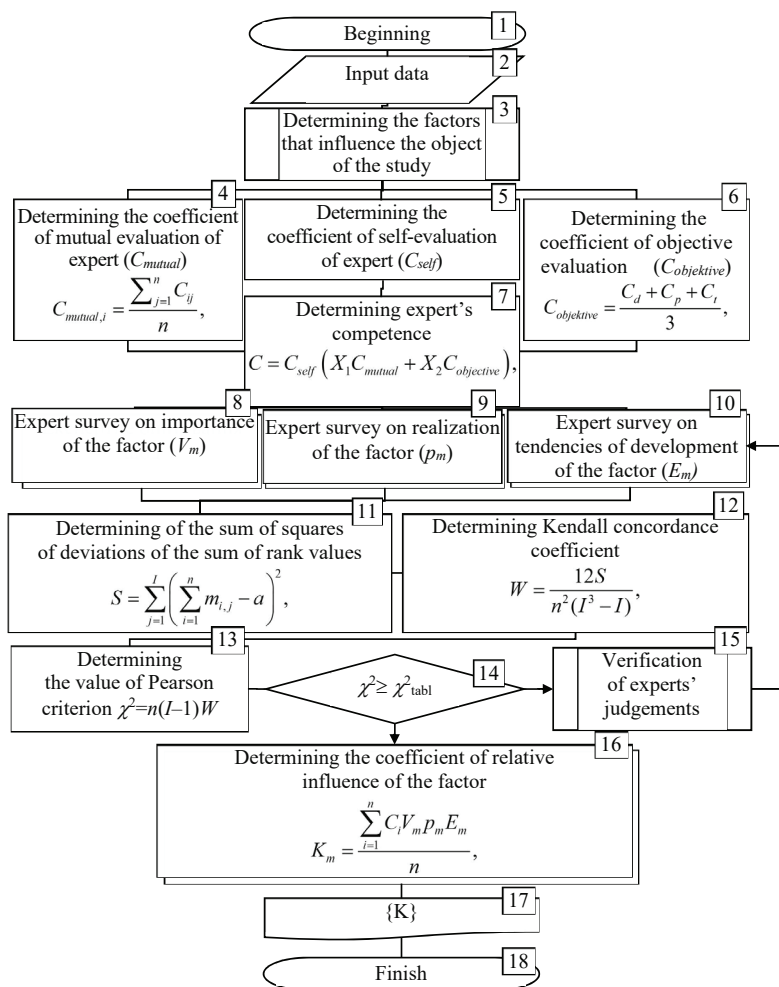


Fig. 2. Algorithm for calculating coefficients of influence of factors on the need for specialists of the highest qualification

It is proposed to determine the coefficient of mutual evaluation of an expert by the generalization of subjective values of judgments of other experts regarding the competence of a certain expert. In this case, the judgments of experts can be in the range from 0.1 to 1.0, where 0.1 is the expert who is not competent at all, and 1.0 is the expert who is the most competent [29]. Such generalization is proposed to be carried out according to the formula:

$$C_{mutual,i} = \frac{\sum_{j=1}^n C_{ij}}{n}, \tag{5}$$

where C_{ij} is the expert's judgments on the level of competence of a certain expert; n is the number of experts.

Self-evaluation is carried out in accordance with the subjective judgment of each expert regarding his competence in the issues under consideration. In this case, the level of competence of an expert can be in the range from 0.1 to 1.0, where 0.1 is the expert who is not competent at all, and 1.0 is the expert who is most competent [29].

Objective evaluation is carried out by summarizing objective facts confirming the competence of an expert. Such facts, within the framework of the study, include the level of education, the experience of professional activity in the area, the experience of scientific and scientific-pedagogical

(SaSP) activities. Generalization is carried out using the formula:

$$C_{objective} = \frac{C_d + C_p + C_t}{3}, \tag{6}$$

where C_d is the coefficient that reflects the education level (determined in accordance with Table 2);

C_p coefficient reflects the experience of professional activity in the area (determined in accordance with 2);

C_t coefficient reflects the experience of the SaSP activity (determined in accordance with Table 2).

The general competence of an expert is determined taking into consideration the relative weight of objective and mutual evaluation of the competence of the expert group members (X_1 and X_2) [18]. Taking into account the chosen method of experts' selection, these coefficients acquire the value of 0.5 [18]. Thus, the general calculation dependence will be as follows:

$$C = C_{self} (X_1 C_{mutual} + X_2 C_{objective}). \tag{7}$$

The general competence of an expert is calculated from the calculation dependence (1).

To summarize the data and determine the competence of an expert, it is proposed to use software, in particular the capabilities of the Excel 2010 office program. In the specified software, the created table for summarizing the data and calculating the competence is shown in Table 3.

Table 2

Table of determining the components of objective assessment of experts' competence

Coefficient value	Education level		Experience of activity, year	
	Basic	Qualification upgrading	professional activity	Scientific and scientific and pedagogical activity
0.1	secondary	absent	up to 2	up to 1
0.2		1 year	up to 4	up to 2
0.3		≥2 year	up to 6	up to 3
0.4	professional	absent	up to 8	up to 4
0.5		1 year	up to 10	up to 5
0.6		≥2 year	up to 12	up to 6
0.7	higher	absent	up to 14	up to 7
0.8		1 year	up to 16	up to 8
0.9		≥2 years	up to 18	up to 9
1	scientific degree	≥20	≥10	

The next step is to conduct a survey and determine coefficients of influences of certain factors. To do this, it is proposed to indicate in the questionnaires in relation to each factor its importance, degree of realization, and tendencies. Regarding these indicators, it should be clarified that the importance is an indicator that characterizes the advantage of a certain factor over others in relation to the impact on the research

Table 3

Generalized table for determining the competence of experts

Expert	Self-evaluation	Mutual evaluation					Objective evaluation				Expert's competence
		1	2	...	<i>n</i>	Σ	education	experience	S and SP	Σ	
1	C_{self1}	C_{11}	C_{12}	...	C_{1n}	$C_{mutual1}$	C_{d1}	C_{p1}	C_{r1}	$C_{objective1}$	C_1
2	C_{self2}	C_{21}	C_{22}	...	C_{2n}	$C_{mutual2}$	C_{d2}	C_{p2}	C_{r2}	$C_{objective2}$	C_2
...
<i>n</i>	$C_{self,n}$	C_{n1}	C_{n2}	...	C_{nn}	$C_{mutual,n}$	C_{dn}	C_{pn}	C_{rn}	$C_{objective,n}$	C_n

subject. As for the degree of factor realization, it is necessary to indicate how much this factor is implemented because the degree of realization of a certain factor significantly affects the research subject. Regarding the tendency of the factor development, given that these data are needed for forecasting, it is necessary to indicate if this factor will develop or lose influence on the research subject. Such surveys are proposed to be conducted in relation to each group of factors. In addition, to determine the need for specialists in certain specialities, it is advisable to conduct a survey on those specialties that are at the HEI.

It is proposed to calculate the resulting value of the factor rank from calculation dependence (1) and verify results according to (2) to (4). To determine the factor importance:

$$V_m = \frac{\sum_{i=1}^n V_i}{100n}, \tag{8}$$

where V_m is the expert's judgment on the level of importance of the first factor, m is the ordinal index of the factor.

To determine the resulting value of the degree of realization of a certain factor, it is proposed:

$$p_m = \frac{\sum_{i=1}^n p_i}{100n}, \tag{9}$$

where p_m is the judgment of an expert on the degree of implementation of a certain factor.

To determine the resulting value of the tendency of influence of a certain factor, it is proposed:

$$E_m = \frac{\sum_{i=1}^n E_i}{100n}, \tag{10}$$

where E_m is the expert's judgment on the level of realization of a certain factor.

In this case, it is necessary to take into account that E_m can acquire the value of 1.2 in case of a significant increase in the factor influence; 1.1 – increase; 1 – without changes; 0.9 – decrease in influence; 0.8 – a significant decrease in influence.

It is proposed to determine the resulting coefficient of the influence of a certain factor as follows:

$$K_m = \frac{\sum_{i=1}^n C_i V_m p_m E_m}{n}. \tag{11}$$

The next totality of steps includes checking the consistency of experts' opinions. According to the chosen method, the method for determining the Kendall concordance coefficient (2) and determining the compliance with Pearson criterion (4) [22, 28] were used in the research. In the case when the coefficient does not match the value of the Pearson criterion, the judgments of experts are reviewed, and peak values are excluded. If this did not affect the compliance of the concordance coefficient with the criterion, it is necessary to choose the new members of the expert group.

Thus, the proposed algorithm allows calculating the coefficients of influence of factors on the need for specialists of the highest qualification, taking into consideration the importance, realization, and tendencies of each factor that was chosen. In addition, this algorithm allows determining the consistency of experts' opinions, which increases the reliability and accuracy of the obtained data.

In general, this method makes it possible to determine reasonably the magnitude of the influence of certain factors on the need for specialists of the highest qualification for further forecasting of the number of students of higher education at the third educational and scientific level.

5. 2. Determining the totality of factors that influence the need for specialists of the highest qualification and the magnitude of their influence

It is proposed to determine the main group of factors that affect the turnover of highly qualified specialists in higher education institutions by analyzing the research into this problem. Moreover, it is necessary to take into consideration both the regional and the sectoral context.

Thus, it was found that the conditions of the SaSP activities in a certain higher education institution, attractiveness of the SaSP activities in a particular country, the development of the area (speciality) have the greatest influence on the turnover of specialists of the highest qualification at higher education institutions [30, 31].

In general, there are much more groups of factors, but it should be noted that all of them have an indirect effect on staff turnover, or depend significantly on unpredictable (poorly predicted) processes (phenomena). Moreover, it is the identified groups of factors that directly affect the turnover of highly qualified specialists in higher education institutions and may include factors that will reflect the full range of main influences on this process. Therefore, it is proposed to consider just this totality of groups of factors.

It is proposed to decompose these groups of factors into the factors of the lower level of the hierarchy based on the essence composition of these groups. Thus, the conditions of the SaSP activities at a certain HEI can be divided into social security, remuneration, the prestige of the SaSP activities, opportunities for self-realization.

The attractiveness of the SaSP activities in a particular country can be divided into the prestige of the SaSP activities, social security, development of higher education in a particular country (region).

The group of factors related to the development of the area (speciality) includes the number of specialists in a particular area, the budget for higher education, the number of primary positions in a certain speciality.

Graphical reflection of the influence of the factors that affect the need for specialists of the highest qualification is shown in Fig. 3.

This way of determining gives a general idea of those factors that affect the need for specialists of the highest qualification. However, it should be noted that they all affect the research subject with different magnitudes. Moreover, some of these factors may only seem important, but in fact, only indirectly influence the studied need.

That is why to determine the magnitude of the influence of each of the factors, it is proposed to use the algorithm for calculating the coefficients of influence of factors on the need for specialists of the highest qualification.

To determine the number of experts for the survey, it is proposed to apply the well-known inequality in determining the confidence probability [32].

$$P_{confidence} \leq \frac{n-1}{n+1}, \tag{12}$$

Based on this inequality, the involvement of 30 experts will satisfy the condition $P_{confidence} \leq 0.94$.

According to the proposed algorithm, the next step is to determine the competence of experts. The results of the survey are shown in Table 4.

The next step is to generalize the evaluations of experts regarding each group of factors. It should be noted that the

factors were evaluated by a 10-point scale, where 10 is the most important (realization), and 1 is the least. For the tendency, the scale proposed in the previous section (from 0.8 to 1.2 with an increment of 0.1) was applied.

The first group of factors is the conditions of the SaSP activities at a certain HEI: social security, remuneration, the prestige of the SaSP activities, the possibility of self-realization at a certain HEI. The generalization results are given in Table 5.

The next group is the group of factors related to the development of the area (speciality), in particular: the number of specialists in a particular area, the budget for higher education, the number of primary positions in a certain specialty. It should be noted that the survey was conducted with regard to level 3 of higher education in knowledge area 25 (military sciences, national security, security of the state border). The results of the assessment are given in Table 6.

Subsequently, the group of factors related to the attractiveness of the SaSP activities in a certain country was evaluated. In particular, they include the prestige of the SaSP activities, social security, development of higher education in a particular country (region). It should be noted that the survey was conducted with regard to higher education in Ukraine. However, the approach can be used in any region. The results of the assessment are given in Table 7.

Table 4

Generalized table of results of determining the competence of experts

Expert	Self-evaluation	Mutual evaluation	Objective evaluation				Averaged value	Competence of expert
			Education	experience	SaSP	Σ		
1	0.9	0.70	0.6	1	1	0.87	0.70	1.75
2	0.8	0.65	0.8	0.9	0.5	0.73	0.55	1.49
3	0.5	0.63	0.3	0.8	0.4	0.50	0.28	1.03
4	0.7	0.62	0.9	0.7	0.6	0.73	0.47	1.36
5	1	0.69	1	1	1	1.00	0.85	2.00
6	0.9	0.69	0.6	0.7	0.5	0.60	0.58	1.54
7	0.9	0.69	0.7	0.9	0.6	0.73	0.64	1.64
8	0.6	0.79	0.8	0.5	0.5	0.60	0.42	1.26
9	0.4	0.78	0.7	0.7	0.6	0.67	0.29	1.04
10	0.8	0.75	0.5	0.8	0.7	0.67	0.57	1.52
11	0.7	0.69	0.8	0.7	0.7	0.73	0.50	1.40
12	0.5	0.59	0.9	1	1	0.97	0.39	1.21
13	0.9	0.59	0.4	1	0.9	0.77	0.61	1.59
14	0.8	0.62	0.5	0.9	0.6	0.67	0.51	1.43
15	0.8	0.69	0.8	0.8	0.5	0.70	0.56	1.50
16	0.5	0.72	0.6	1	0.7	0.77	0.37	1.18
17	0.8	0.64	0.7	0.7	0.5	0.63	0.51	1.41
18	1	0.64	0.9	0.9	0.8	0.87	0.75	1.84
19	1	0.62	1	0.9	0.9	0.93	0.78	1.88
20	0.9	0.61	0.9	1	1	0.97	0.71	1.76
21	0.5	0.57	0.5	1	0.8	0.77	0.34	1.12
22	0.6	0.61	0.8	1	0.9	0.90	0.45	1.32
23	0.7	0.60	0.8	0.8	0.7	0.77	0.48	1.36
24	0.9	0.69	0.6	0.9	0.6	0.70	0.62	1.62
25	0.8	0.59	0.8	0.8	0.4	0.67	0.50	1.41
26	0.8	0.62	0.4	0.5	0.3	0.40	0.41	1.24
27	0.7	0.62	0.9	0.7	0.6	0.73	0.47	1.35
28	0.4	0.61	0.6	0.9	0.7	0.73	0.27	1.00
29	0.5	0.61	0.7	1	0.9	0.87	0.37	1.18
30	0.8	0.62	0.8	0.6	0.4	0.60	0.49	1.38

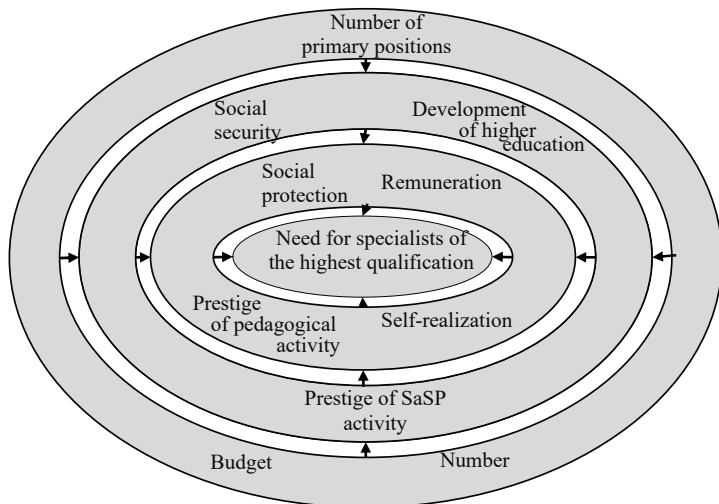


Fig. 3. Diagram of the totality of factors that affect the need for specialists of the highest qualification

Analysis of the results of the evaluation of the development of the area (speciality) (Table 8) shows that the factors affect the staff turnover almost in the same way. Social security is somewhat ahead, which is due to the fact that in this totality it is the factor that affects the basic needs of teachers.

In general, the results of determining the impact of the proposed factors on the turnover of the SaSP staff and, accordingly, on the need for specialists of the highest qualification are shown in Fig. 4.

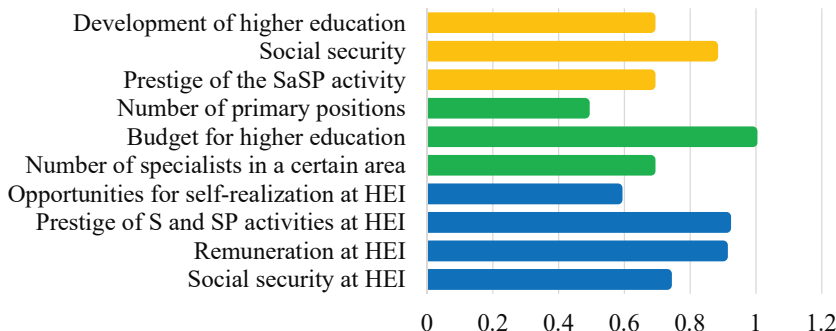


Fig. 4. The magnitude of influence of factors on the need for specialists of the highest qualification for level 3 of area 25 of higher education in Ukraine

In general, to further determine the need for specialists of the highest qualification, it will be possible to apply numerical values of factors influences, which will significantly increase the accuracy of forecasting.

Table 7

Results of evaluation of factors related to the attractiveness of SaSP activities in a particular country

Factor related to the attractiveness of SaSP activities	Importance	Realization	Tendency	Averaged value	Normalized value
Prestige of SaSP activity	7.50	6.03	1.02	0.68	0.30
Social security	8.97	6.23	1.08	0.87	0.39
Development of higher education in a certain country (region)	7.13	6.20	1.07	0.68	0.30

Table 5
Results of evaluation of the factors of the group of conditions of the SaSP activities at a certain HEI

Factors of the group of conditions of the SaSP activities at a certain HEI	Importance	Realization	Tendency	Averaged value	Normalized value
Social security	7.70	6.40	1.01	0.73	0.19
Remuneration	9.00	7.03	1.00	0.90	0.24
Prestige of S and SP activity	8.17	7.73	1.00	0.91	0.24
Opportunities for self-realization	6.53	6.77	0.92	0.58	0.15

Table 6
Results of evaluation of the factors related to the development of the area (speciality)

Factor related to area development	Importance	Realization	Tendency	Averaged value	Normalized value
Number of specialists in a certain area	6.33	6.83	1.15	0.68	0.32
Budget of higher education	8.27	7.07	1.17	0.99	0.46
Number of primary positions	6.00	4.73	1.17	0.48	0.22

6. Discussion of the results of improving the procedure for determining the needs of higher education institutions for specialists of the highest qualification

The method for calculation of coefficients of the influence of factors on the need for specialists of the highest qualification was proposed. This method is presented in the form of an algorithm for calculating the coefficients of influence of factors on the need for specialists of the highest qualification (Fig. 2). This algorithm is based on the application of the expert evaluation method, in particular, the method for determining the competence of experts by taking into consideration the values of self-evaluation, mutual evaluation, and objective evaluation of experts (Table 3, (7)). In addition, this algorithm is based on the method for data reliability verification by Kendall concordance coefficient and Pearson criterion (Table 1, (2) to (4)). Unlike the existing expert evaluation methods, in this study, it is proposed to determine not only the importance (8) of factors but also the degree of their realization (9) and the tendency (10).

The use of these methods in the algorithm makes it possible to objectively take into consideration the competence of experts, check the consistency of their judgments, predict the development of the influence of a certain factor on the research subject. It should be noted that this algorithm allows taking into consideration the influence of factors not only according to their possible influence but also considering

the degree of current influence and the forecast of changes in such an impact in the future.

The specific feature of this method is the complex use of advanced methods for selection of experts and determining their competence (Table 3), verification of reliability and accuracy of obtained data ((2) to (4)), determining the parameters of factors ((8) to (10)). This makes it possible to significantly simplify determining the magnitude of the factors' influence on the need for specialists of the highest qualification.

The advantages of this method include its accuracy and reliability of obtained data. In addition, its merit is the possibility of numerical expression of the magnitude of influence of a certain factor. Another advantage of this method is the ability to use the obtained data to predict staff turnover in higher education (11) and, accordingly, determine the need for specialists of the highest qualifications. In practice, this method will significantly improve the management processes in the HEI on planning further development of human potential.

Restrictions on the use of this method include the need for the selection of such a group of experts, which would make it possible to carry out a high-quality mutual evaluation. Another limitation is the need for a thorough explanatory note to the questionnaire because, in relation to the essence of indicators of realization and the tendency of factor influence, a different interpretation of the meaning of these terms is possible.

The drawback of this method is the need to change the group of experts in case of mismatch of calculated value χ^2 (4) for any indicator of the factor with the tabular value of Pearson criterion.

The next task performed in the study is to determine the totality of factors that affect the need for specialists of the highest qualification and the magnitude of their impact. The essence of this determination is to calculate the indicators of each of the criteria regarding the importance, realization, and tendency. They are determined based on the algorithm of the calculation of the coefficients of factors that influence the need for specialists of the highest qualification (Fig. 2).

In general, it was determined that the following groups of factors significantly influence the subject of the study: conditions of the S and SP activities at a certain HEI, the attractiveness of the S and SP activities in a particular country, the development of the area (speciality). The decomposition of these groups revealed the interrelation of these groups (Fig. 3). A group of 30 experts was selected to determine the numerical values of the factors, which corresponds to inequality (12) and satisfies the condition for achieving a confidence probability of 0.94. The conducted determining of the competence of experts (Table 4) revealed a sufficiently high competence, which is explained by the chosen method of selection.

The results of the assessment of expert judgments on the factors revealed that such factors as social protection, budget for higher education, remuneration, and prestige of the S and SP activities have the most significant influence. The number of primary positions in the area and the opportunities for self-realization in the HEI have the least influence (Fig. 4, Tables 5–7).

Analysis of generalized results of determining the competence of experts (Table 4) shows that the competence of experts is relatively high, which is explained by the method

of experts' selection. Actually, according to the essence of the "snowball" method, some experts suggest others who, in their opinion, are competent enough in the studied issues. This makes it possible to increase indirectly the accuracy of the obtained estimates and data reliability.

Analysis of the results of estimation of the conditions of SaSP activity at a certain HEI (Table 5) shows that the factors that most affect staff turnover are remuneration and prestige of the SaSP activities. This is due to the fact that these two factors determine the basic needs of teachers and provide the minimum necessary conditions for their existence.

Analysis of the results of the evaluation of area (speciality) development (Table 6) shows that the factor that most affects staff turnover is the budget for higher education. This is explained by the fact that training in regulated specialties is characteristic of area 25, that is, the order size depends primarily on the budget for higher education.

Analysis of the magnitudes of factors influencing the need for specialists of the highest qualifications shows that social security, budget for higher education, remuneration, and prestige of the S and SP activities have the most influence. This is explained by the specifics of training at level 3 in area 25 of higher education in Ukraine because training takes place in regulated specialties and in accordance with the specifics of the area. The specifics include the existence of an armed conflict in eastern Ukraine, the transformation of the security sector in accordance with the NATO requirements and standards.

The factors that have the least influence include the number of primary positions in the area and the opportunity for self-realization at the HEI. Although it should be noted that these factors have a relatively high average value of 0.48 and 0.58, respectively.

The fact that the totality of factors was determined makes it possible to reasonably identify the need for specialists of the highest qualification directly when planning the number of adjuncts (postgraduate students) for the following years.

The specific feature of this totality of factors is that the quantitative magnitude of the influence on the research subject was determined taking into consideration such indicators as importance, realization, and tendency.

Restrictions on the application of the obtained results include the fact that the study was conducted relative to level 3 of training in area 25 of higher education in Ukraine. However, it should be noted that the established totality of factors does not depend on the level, area, or region, that is why clarification is necessary in order to use these results in other areas.

The merit of using this totality of factors that affect the need for specialists of the highest qualification is that the quantitative value of influence was determined.

Another advantage is the relatively high accuracy and reliability of the results, which is due to the verification of experts' consistency.

It can be considered that the disadvantage of this totality is that the proposed factors to some extent depend on each other. That is, the quantitative parameter of the influence of a certain factor should be taken into consideration with coefficients of correlation with other factors, which significantly complicates the calculation process. However, it should be noted that the indicated totality of factors and

the magnitude of their impact on the research subject gives an important idea of the dynamics of changes in the turnover of personnel of higher qualification.

The totality of the obtained results indicates the improvement of the procedure for determining the factors that affect the need of higher education institutions for highly qualified specialists. In general, the proposed approach to determining the values of influence of each of the factors ensures comprehensive coverage of the factors, a sufficient level of validity and reliability of the obtained results.

In addition, the improved procedure will contribute to maintaining the quality of higher education in the context of increasing staff turnover, rational distribution of budget funds, and ensuring the sustainable development of higher education.

The advantages of the improved procedure include the simplicity of use, the ability to verify the consistency of expert judgments, and multi-levelness in the study of the factors that affect the need for specialists of the highest qualification.

The drawback of this approach is the need to attract a certain number of experts, which complicates the organizational side of the study.

7. Conclusions

1. A method for calculation of coefficients of factors' influence on the need for specialists of the highest qualification was proposed. The essence of the method is the use of the methods of expert evaluation, selection of experts, verification of data reliability to determine the importance, degree of realization, and the tendency of the factors that affect the need for specialists of the highest qualification.

The specific feature of this method is the comprehensive use of improved methods for the selection of experts and determining their competence, verification of reliability and accuracy of obtained data, determining the factors' param-

eters. A distinctive feature of this method is its versatility of application for any region, area, and HEI. In general, the method makes it possible to significantly simplify the process of determining the magnitude of influence of factors on the need for specialists of the highest qualification. The scope of this method includes the stage of planning of the educational process at the HEI with regard to the problem of determining the number of postgraduate students.

2. The totality and magnitude of the influence of factors that affect the need for specialists of the highest qualification were determined. The idea behind it is to calculate the indicators of each of the criteria regarding the importance, realization, and tendency. The peculiarity of this result is the division of factors into three groups: conditions of the S and SP activities at a certain university, attractiveness of the S and SP activities in a particular country, and development of the area (specialty). A distinctive feature of this result is that 30 experts were involved in the study, which satisfies the condition for achieving a confidence probability of 0.94. The use of the "snowball" method for experts' selection ensures the achievement of this value of confidence probability. Another feature is that the study was conducted with regard to training at the third level in knowledge area 25 of higher education in Ukraine.

In the course of the study, it was found that the most influential factors are: social protection (0.87), budget for higher education (0.99), remuneration (0.9), and prestige of S and SP activities (0.91). The least influential are: the number of primary positions in the area (0.48) and opportunities for self-realization at the HEI (0.58). The obtained results make it possible to reasonably determine the need for specialists of the highest qualification directly when planning the number of adjuncts (postgraduate students) for the following years.

The scope of application of the found totality and the magnitude of influence of factors is the stage of determining the number of postgraduate students (adjuncts) for level 3 of knowledge area 25 of higher education in Ukraine.

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