HOW TO MANAGE RAILWAY STAFF'S TURNOVER

Epishkin, Ilya A., *Moscow State University of Railway Engineering (MIIT), Moscow, Russia.*
Frolovichev, Alexander I., *Moscow State University of Railway Engineering (MIIT), Moscow, Russia.*

ABSTRACT

The authors describe the results of a study of the influence of external and corporate factors on the staff turnover level in the Central Directorate of Infrastructure – a branch of JSC Russian Railways in the context of regional directorates. Based on the econometric tools, mathematical equations of the dependence of staff turnover on the factors identified were made, economic conclusions on the use of the dependencies found in human resources management were drawn, and the prospects for continuing research in this field were considered.

Keywords: railway, human resources, staff turnover, wages, turnover factors, turnover management.

Background. *The task of efficient management of staff turnover is one of the classic tasks of management. A lot of research and publications are devoted to this problem [1–4]. Many companies, research organizations pay much attention to the search for tools and methods by which to influence the organization's most complex and significant group of resources – human resources [5].*

It is well known that a high level of staff turnover leads to an increase in additional personnel costs [6]. Typical factors of cost growth associated with turnover are the following: the need to search for and select a new employee, his adaptation and training, the cost of special clothing and personal protective equipment [7]. At the same time, along with a skilled worker, his experience, the resources of the organization invested in him (in training, advance training skills, social security) go away.

Objective. *The objective of the authors is to consider the problem of staff turnover in the railway sector.*

Methods. *The authors use general scientific methods, comparative analysis, evaluation approach, analytical method, economic and mathematical analysis.*

Results. *Features of formation and use of labor resources of railway transport enhance the importance of economic losses from staff turnover in the industry. These features include a unique system of personnel training for the industry that objectively requires significant funds for the training of skilled workers, high requirements regarding the level of personnel due to traffic safety problems and the implementation of complex technological processes [8, 9].*

It is difficult to manage what cannot be measured. Therefore, in order to find effective levers for influencing staff turnover, it is necessary to know the factors that cause it, and to try to quantify the influence of these factors using a modern economic and mathematical apparatus [10].

In previous studies [11, 12], some factors influencing the turnover of personnel in the Central Directorate of Infrastructure, a branch of JSC Russian Railways (hereinafter referred to as CDI), were identified. This is the most numerous functional division of the company (more than 300000 employees), carrying out functions of current maintenance and service of the railway infrastructure.

As a result of the research, it was found that the level of staff turnover in the context of regional infrastructure directorates (territorial subdivisions of the Central Infrastructure Directorate, hereinafter referred to as RDI) is significantly influenced by both the average monthly salary level for the regional directorate and its ratio to the average monthly salary for the federal entities (regions) of the Russian Federation, gravitating to this regional directorate (according to 2014 [11]).

As the average salary for regions of the Russian Federation, gravitating toward RDI, the average salary was considered as the most characteristic for this RDI subject of the Russian Federation. More complete statistical data for 2012–2014 made it possible to clarify the results obtained earlier.

So, to assess the impact of salary on staff turnover in the Central Directorate of Infrastructure in the context of regional directorates, we take 2012–2014 years. We will operate with the following indicators and factors:

T *– resulting variable, the level of staff turnover by RDI, %;*

S_{DI} *– average salary for regional directorates, rubles;*

S_{RF} *– average salary for the subjects of the Russian Federation, which gravitate toward RDI, rubles;*

$K = S_{DI}/S_{RF}$ *– the ratio of the average salary for regional directorates to the average salary for the subjects of the Russian Federation that gravitate toward the RDI;*

U *– unemployment rate for the subjects of the Russian Federation, which gravitate toward RDI, %.*

Each of four proposed factors, in our opinion, affects to some extent the resulting variable – staff turnover.

To adjust a set of factors, we study their interrelationships with each other and the strength of their connection with the resulting variable. For this we use the possibilities of correlation-regression analysis. A detailed study is given only for the average values of the proposed indicators for three years (2012–2014). This will increase the reliability of the results, smoothing the random fluctuations in certain years, while fixing the stability of the interrelationships over time. On the other hand, let us note separately the dynamics of the interrelations between the indicators over time, which will allow us to determine the changes in the system over time.

The method of calculating the average value of each of the indicators for three years will be chosen based on their nature. The indicators T, U and K as relative, will be averaged with the help of the geometric mean; the indicators for the average salary, as absolute, will be averaged with the help of the arithmetic mean.

The average values of the described indicators for the period from 2012 to 2014 are shown in Table 1.

As a tool for assessing the relationship between the indicators and the performance of specification

Average indices of staff turnover and assumed influencing factors in the context of regional infrastructure directorates for 2012−2014

Regional directorates of infrastructure	Average level of staff turnover for 2012−2014 (T)),%	Average salary for 2012−2014 for RDI (S_{DI}), rubles	Average salary for the subjects of the Russian Federation gravitating towards RDI for 2012−2014 (S_{RF}), rubles	Average unemployment rate for the subjects of the Russian Federation, which are gravitating toward RDI for 2012−2014 (U),%	Average ratio of average salary for RDI to the average salary for the subjects of the Russian Federation, gravitating towards RDI for 2012−2014 (K)
Kaliningrad	8,52	32 690	24 333	6,13	1,35
October	7,28	37 110	30 814	4,07	1,21
Moscow	7,88	40 995	32 813	3,55	1,25
Northern	7,45	36 765	27 754	5,53	1,33
Gorky	8,87	29 310	22 486	4,93	1,31
South-Eastern	8,31	26 767	21 161	4,53	1,27
North-Caucasian	11,12	26 791	21 863	6,81	1,23
Privolzhsky	9,32	27 766	20 952	6,03	1,33
Kuibyshev	11,60	26 821	22 121	4,49	1,22
Sverdlovsk	12,20	34 819	30 821	5,77	1,13
South-Ural	8,72	30 212	22 297	6,16	1,36
West-Siberian	9,42	32 485	23 856	6,40	1,36
Krasnoyarsk	5,84	40 092	30 274	5,64	1,33
East-Siberian	6,42	44 847	27 977	8,31	1,60
Zabaikalsky	9,90	41 075	28 045	8,62	1,47
Far Eastern	8,12	47 623	30 015	6,66	1,58
Average	8,81	34 761	26 099	5,85	1,33
Variation coefficient	0,194	0,188	0,152	0,23	0,094

The matrix of paired correlation coefficients between the studied indicators (in the context of RDI)

	T	S_{DI}	S_{RF}	U	K
T	1	-0,529	-0,358	0,043	-0,465
S_{DI}	-0,529	1	0,835	0,332	0,632
S_{RF}	-0,358	0,835	1	-0,060	0,104
U	0,043	0,332	-0,060	1	0,696
K	-0,465	0,632	0,104	0,696	1

of the regression model, the matrix of pair correlation coefficients given in Table 2 was used.

Elements of the matrix are paired correlation coefficients, reflecting the tightness and direction of the relationship between the relevant indicators. Here and below, the significance level, on which all statistical hypotheses will be checked, is assumed equal to 5%.

For the selected level of significance with a sample size of 16 (in terms of the number of regional directorates), the critical value of the correlation coefficient is 0,497. That is, all correlation coefficients that exceed the given value by a modulus will be considered statistically significant (substantially different from zero) according to the Student's criterion, which tests the hypothesis of the significance of the correlation coefficient.

Therefore, we can argue that the staff turnover in the presented section is significantly affected only by the level of average salary for regional directorates ($r_{TS_{DI}}$ = −0.529) where the connection is reverse, that is, the higher is the average salary in the directorate, the lower is the staff turnover. The established connection is fairly stable over time (in 2012, $r_{TS_{DI}}$ = −0.440, in 2013 $r_{TS_{DI}}$ = −0.554, in 2014 $r_{TS_{DI}}$ = −0.523), which means that the selected factor can be included in the regression model.

Let's consider the exponent K. Its influence on the turnover is slightly weaker (r_{TK} = −0.465, it becomes significant already at 6%). Over time, it also varies insignificantly, with a marked increase in its impact: in 2012, r_{TK} = −0.383, in 2013 r_{TK} = −0.424, in 2014 r_{TK} = −0.481. The nature of the connection is again reverse, that is, the greater is the ratio of the average salary in the regional directorate to the average salary in the subjects of the Russian Federation, gravitating toward RDI, the lower is the staff turnover in the directorate. We will consider this hypothesis to be justified.

The similar conclusions were obtained in the study, made earlier, which results were published in

233
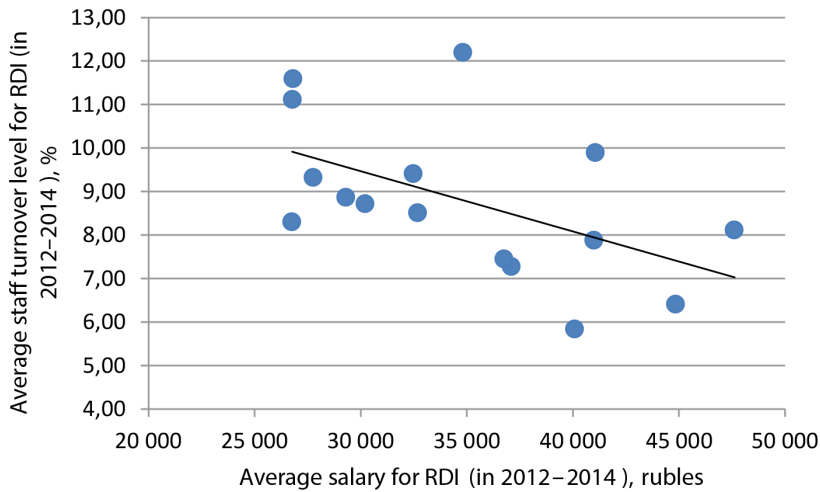
Pic. 1. Dependence of the level of turnover T (in%) on the average salary S_{DI} (in rubles) for RDI (average for 2012–2014).
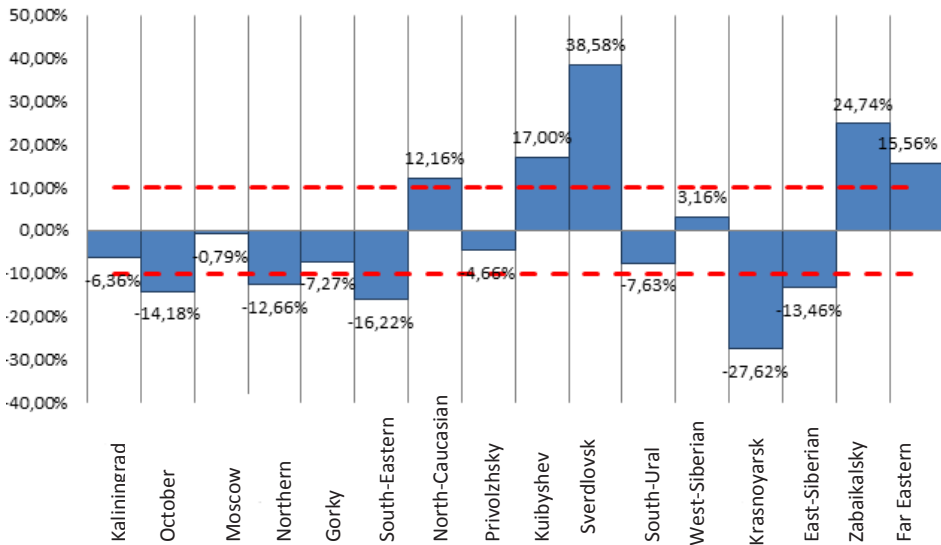
Pic. 2. Relative deviations of the observed values of staff turnover from the calculated ones obtained with the help of equation (1).

the article «Application of economic-mathematical methods in the analysis of indicators on labor and wages in railway transport» [11]. However, the data for 2014 were used there, and a different method for determining the average salary for the regions of the Russian Federation was chosen, which led to the exclusion from the sample of three regional directorates that did not correspond to the general trend in studying the connection of turnover with the exponent K.

It should be noted that two factors K and S_{DI} considered are related to each other much more strongly than with the index of turnover ($r_{KS_{DI}} = 0.632$). This suggests that their joint use in one equation is undesirable. But, using them as factors, it is possible to construct two independent equations of pair regression.

Let's consider two remaining factors: S_{RF} and U. Of course, the indicator of the average salary in the regions of the Russian Federation gravitating toward

RDI had to be included in the initial set, as its value is a guide for adjusting the level of salary for regional directorates in a specific region of the Russian Federation. From the correlation matrix presented above, we see that the connection between salary in the regions of the Russian Federation, gravitating towards RDI with staff turnover is rather weak ($r_{TS_{RF}} = -0.358$). In addition, S_{RF} indicator is very closely related to the indicator of the average salary for RDI ($r_{S_{DI}S_{RF}} = 0.835$) and, in fact, is the «doubler» of the latter, and is substantially inferior to the strength of the effect on turnover. In this regard, we exclude the indicator of the average salary in the regions of the Russian Federation, which are gravitating towards the RDI, from consideration in this section.

The last indicator is unemployment rate U. Undoubtedly, its influence on the turnover index was initially doubtful, which was confirmed by calculations ($r_{TU} = 0.043$, the correlation coefficient is statistically insignificant). This value of the
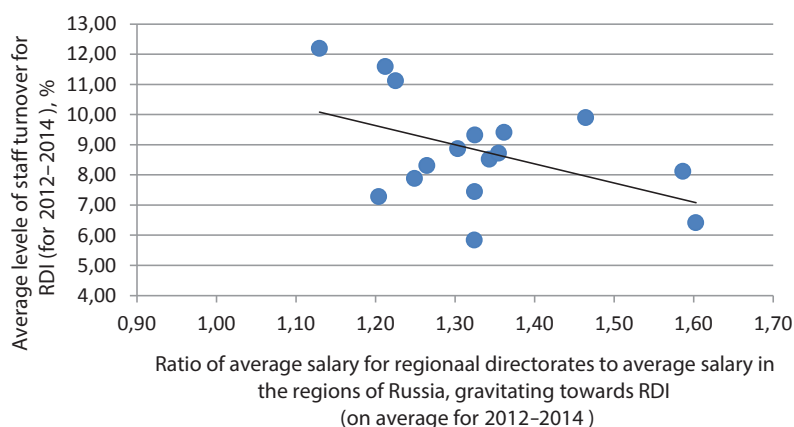
Pic. 3. Dependence of the level of turnover T (in%) on the ratio of the average salary for regional directorates to the average salary in the subjects of the Russian Federation gravitating towards the RDI (on average for 2012–2014).

correlation coefficient indicates a practically complete lack of connection between the selected indicators. Such a value of correlation coefficient means an almost full absence of the connection between selected indicators. But if we consider this relationship in the dynamics for three years, we get the following results: in 2012, $r_{TU} = 0.093$, in 2013 $r_{TU} = 0.008$, in 2014 $r_{TU} = -0.136$. When choosing the hypothesis of the study, it was assumed that two of the indicators have reverse connection, which is shown in data for 2014. In this connection, the information for 2015, which at the time of writing the article was not yet formed, will be of great interest. There are grounds to assert that, on the wave of the crisis, the inverse relationship between the level of unemployment in the regions and the level of turnover in the regional directorates of JSC Russian Railways will increase [13]. Thus, at the moment, use of the unemployment rate as a factor affecting the turnover of personnel in JSC Russian Railways, is inappropriate. However, the level of unemployment should not be ruled out from further research.

Note that the study of staff turnover was not limited to this set of factors. In particular, the growth rates of salaries, indices of change in turnover and other factors were considered. But, firstly, such indicators make it difficult to interpret the results and, accordingly, the application of future models. Secondly, many of the analyzed factors do not have a significant impact on the staff turnover level.

The assumption that salary indicators affect the turnover with a time lag was not confirmed. When revealing the relationship between the level of turnover in 2014 and the salary indicators 2013, there was no significant improvement in the quality of connection.

Summarizing the results of the correlation analysis, we can conclude that, in the context of regional directorates, only two salary indicators deserve further attention so far: the average salary for RDI S_{DI} and the ratio K of the average salary for regional directorates to the average salary in the regions of the Russian Federation that gravitate toward RDI.

The regression analysis that follows is as follows. Two independent equations of pair regression were constructed, where two selected salary indicators act as the factors, and as a result variable is staff turnover level T was chosen. In connection with a small number

of regional directorates, it was not possible to construct one model containing two factors.

For a visual assessment of the relationship between the average salary indicator for regional directorates and the turnover of personnel, we pay attention to the correlation field (Pic. 1).

The form of the correlation field allows us to conclude that the relationship between the selected indicators is linear, which is confirmed by the coefficient of pair correlation. We construct an equation describing the chosen dependence. It has the form:

$$T = 13,63 - 0,00014 \cdot S_{DI}. \qquad (1)$$

It should be noted that at a significance level of 5% this equation (according to Fisher's F-criterion) and each of its parameters (according to the t-criterion of Student) are recognized as statistically significant, the average relative error of approximation is 14%. This suggests the possibility of using the equation to predict the level of staff turnover when the average salary changes. In particular, the coefficient of determination is 0.28. This suggests that 28% of the variation in turnover is due to average salary.

From the resulting equation it follows that an increase in the average salary for RDI by 1000 rubles will lead to a decrease in the level of turnover on the directorate by an average of 0.14 points. Since the average level of turnover for RDI for 2012–2014 was 8.81%, the use of equation (1) allows us to conclude that to achieve a turnover level of 8%, it is necessary to increase the average salary by 5856 rubles.

The average coefficient of elasticity of the level of turnover relative to the average salary for RDI is (−0.55). This suggests that, with an average salary increase by 1% (348 rubles) on average on the aggregate the turnover level will decrease by 0.55% of its average value or by 0.048 points. For regional directorates, this indicator ranges from (−0.93) in the Far Eastern DI to (−0.37) in the Southeastern and North-Caucasian DI.

Of particular interest are the relative deviations of the observed values of the turnover level from the calculated ones (Pic. 2). In accordance with this criterion, regional directorates can be divided into three categories:

1. Regional directorates, the level of staff turnover in which is significantly higher than the estimated (Sverdlovsk, Zabaikalsky, Kuibyshev, Far Eastern, North Caucasian).
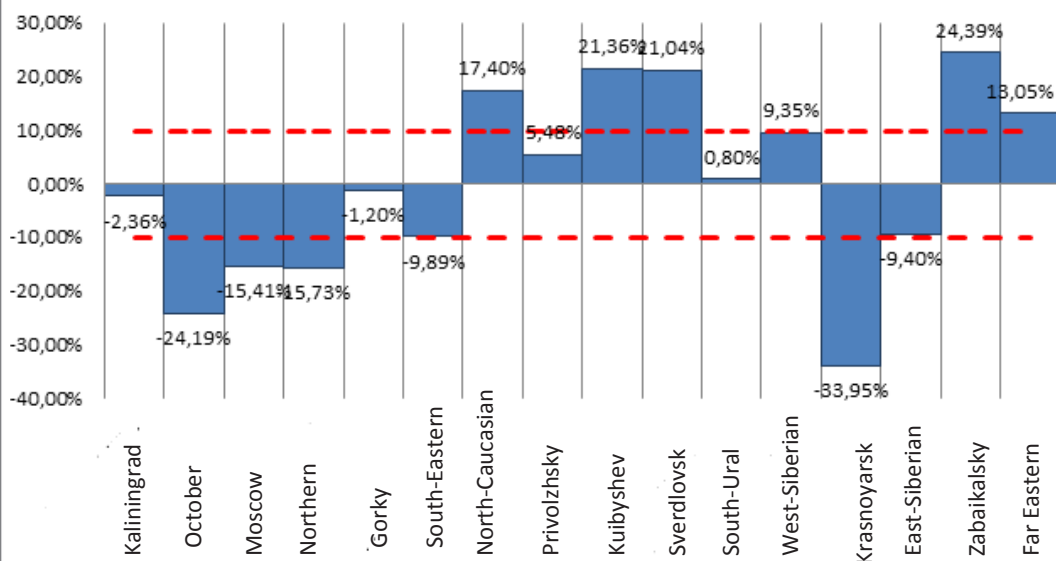
Pic. 4. Relative deviations of the observed values of turnover from the calculated values obtained with the aid of equation (2).

2. Regional directorates, the level of staff turnover in which is comparable to the calculated value (Moscow, West Siberian, Privolzhsky, Kaliningrad, Gorky, South Ural).

3. Regional directorates, the level of staff turnover in which is significantly lower than the estimated (Krasnoyarsk, South-Eastern, October, East-Siberian, Northern).

In accordance with the above classification, it is possible to develop some recommendations for the next year. To optimize the level of turnover in the regional directorates of the first group, it is necessary to achieve a greater increase in salary, possibly due to its smaller increase in the regional directorates of the third group. In addition, the revealed deviations signal an increased role in these regions of other factors, which in one case significantly increase turnover, while in another, on the contrary, contribute to a significant decrease in it.

Similarly, the assessment of dependence of the level of turnover on the ratio of the average salary for regional directorates to the average salary in the regions of the Russian Federation gravitating toward the RDI was made. Again, we start with the correlation field (Pic. 3).

The picture shows quite contradictory trends within the sample, its heterogeneity, which will certainly worsen the quality of the obtained equation. But we cannot refuse to use the chosen factor, since there is reason to assume that within the regional directorates the situation is also very heterogeneous and a more detailed analysis is needed in the context of the regions of the Russian Federation.

The equation describing the relation under consideration has the form:

$$T = 17,234 - 6,33 \cdot K. \qquad (2)$$

The resulting equation is inferior in quality to equation (1). But at a significance level of 10%, the parameters of the equation and the equation (2) as a whole can be considered significant, as evidenced by Fisher's F-criterion and Student's

criterion. The coefficient of determination here is 0.22. Thus, 22% of the variation in the level of turnover is due to the ratio of the average salary for RDI to the average salary in the regions of the Russian Federation gravitating towards the RDI.

Below there are some practical conclusions that follow from the equation (2).

The increase in the ratio of the average salary for RDI to the average salary in the regions of the Russian Federation, gravitating towards RDI by 0,1% leads to a decrease in the level of turnover by an average of 0.63 points. Thus, to achieve a level of turnover of 8%, it is necessary to increase the ratio of the average salary for RDI to the average salary for the regions of the Russian Federation that are gravitating towards to RDI by 0.13.

The average coefficient of elasticity of the level of turnover relative to the ratio of the average salary for regional directorates to the average salary for the regions of the Russian Federation gravitating towards RDI is (−0.96). This suggests that with a similar increase by 1% on average, the turnover level will decrease by 0.96% of its average value. For the regional directorates, this indicator ranges from (−1.43) in the East Siberian DI to (−0.71) in the Sverdlovsk DI.

The relative deviations of the observed values of the turnover level from the calculated ones are shown in Pic. 4. Regional directorates are also divided into three categories:

1. Regional directorates, the level of staff turnover in which is much higher than the estimated (Zabaikalsky, Kuibyshev, Sverdlovsk, North-Caucasian, Far Eastern).

2. Regional directorates, the level of turnover of personnel in which is comparable to the calculated value (South Ural, Gorky, Kaliningrad, Privolzhsky, West Siberian, East Siberian, South-Eastern).

3. Regional directorates, the level of staff turnover in which is much lower than the estimated (Krasnoyarsk, October, Northern, Moscow).

If we compare two proposed classifications of regional directorates (Pic. 2, 4) by the relative magnitude of the deviations, then we can observe the

following. The composition of the directorates included in the first group with a high level of deviation exceeding the calculated ones did not change at all. Only their ranking changes (they are arranged in error decreasing order). The second and third groups underwent big changes. But in fact, analyzing the figures for the directorates included in the second and third groups, we can conclude that the deviations differ only in the Moscow direction, which moved from the second group to the third one. The East-Siberian and South-Eastern Directorates, having formally switched to the second group of directorates from the third, changed their deviation not so significantly. In addition, their indicators in the second case are very close to the boundary between the second and third groups. All this can say that the results obtained with the help of equation (2) confirm the results of equation (1), that is, the reliability of the results has increased.

Analyzing the deviations obtained, it can be assumed that in the directorates included in the first group, it is necessary to maintain salary growth rates that exceed the growth rates of salaries for regions of the Russian Federation that gravitate toward these directorates (possibly due to the redistribution of salary mass from the directorates of the third group, where the slow salary growth will not lead to a critical increase in turnover). In the directorates of the second group it is desirable to maintain the existing growth rates.

Conclusions. The study of the dependence of the staff turnover level in the Central Directorate of Infrastructure in the context of regional directorates allowed to obtain the following results.

First, it was possible to find two factors that exert a significant influence (confirmed by econometric methods) on staff turnover. Given that the relationship of turnover with selected factors of average strength, it can be assumed that there are other factors that significantly affect the turnover of staff. This can be both macroeconomic parameters and factors of the internal environment of JSC Russian Railways.

Secondly, the territorial structure of the regional directorates is very heterogeneous, incl. on indicators of salary. Some directorates include several significantly different from each other in the state of the labor market regions of the Russian Federation. Therefore, there is an assumption that a similar study is conducted in the context of the regions of the Russian Federation with the possible clusterization of regions and, perhaps, consideration of sections for individual infrastructure farms and mass working professions.

The expansion of the research framework aims to further bring the results of the analysis closer to the needs of practice. In particular, using the equations obtained, it is possible to perform a quantitative assessment of the costs of reducing the level of turnover for the directives. It is also of interest to assess the influence of the level of turnover on such important indicators as labor productivity and safety of train traffic.

REFERENCES

1. Medina, Elizabeth. Job Satisfaction and Employee Turnover Intention: What does Organizational Culture Have To Do With It? Columbia University, 2012, 44 p.

2. Ali Khan, Sajjad. The factors affecting employee turnover in an organization: The case of Overseas Pakistanis foundation. *African Journal of Business Management*, January 2014, Vol. 8(1), pp. 25–34.

3. Egan, T. M., Yang, B., & Bartlett, K. R. (2004). The effects of organizational learning culture and job satisfaction on motivation to transfer learning and turnover intention. *Human Resource Development Quarterly*, 15(3), pp. 279–301.

4. Abelson, M. A. (1993). Turnover cultures. Research in Personnel and Human Resource/ Management, 11, pp. 339–376.

5. Turnover and Retention Research: A Glance at the Past, a Closer Review of the Present, and a Venture into the Future. Brooks c. Holtom, Terence R. Mitchell, Thomas W. Lee, Marion B. Eberly. The Academy of Management Annals. Vol. 2, No. 1, 2008, pp. 231–274.

6. Epishkin, I. A. Human Resources management: educational guide [*Upravlenie chelovecheskimi resursami: Ucheb. posobie*]. Moscow, MIIT publ., 2013, 242 p.

7. Essays on employee turnover. Peterson, Jonathan R. Cornell University, ProQuest Dissertations Publishing, 2011, 147 pages; 3484826.

8. Tolkacheva, M. M., Epishkin, I. A. The Economics of Railway Transport: educational guide [*Ekonomika zheleznodorozhnogo transporta: Ucheb. posobie*]. Moscow, MIIT publ., 2009, 268 p.

9. Tereshina, N. P., Sorokina, A. V. Increase of efficiency of corporation development management on the basis of formalization of strategic initiatives [*Povyshenie effektivnosti upravlenija razvitiem korporacii na osnove formalizacii strategicheskih iniciativ*]. *Transportnoe delo Rossii*, 2014, Iss. 1, pp. 78–80.

10. Frolovichev, A. I. Valuation of the company's shares during IPO [*Ocenka stoimosti akcij kompanii pri provedenii IPO*]. *Transportnoe delo Rossii*, 2011, Iss. 12, pp. 142–147.

11. Epishkin, I. A., Tikhomirov, A. N., Frolovichev, A. I. Application of economic-mathematical methods in the analysis of indicators on labor and wages in railway transport [*Primenenie ekonomiko-matematicheskih metodov pri analize pokazatelej po trudu i zarabotnoj plate na zheleznodorozhnom transporte*]. *Modern problems of managing the economy of the transport complex in Russia: competitiveness, innovation and economic sovereignty: collection of scientific works*. Moscow, MIIT publ., 2015, pp. 40–44.

12. Epishkin, I. A. Modern scientific approaches to labor remuneration as the most important element of human resources management [*Sovremennye nauchnye podhody k oplate truda kak vazhnejshemu jelementu upravlenija chelovecheskimi resursami*]. Modern problems of managing the economy of the Russian transport sector: competitiveness, innovation and economic sovereignty: collection of scientific works. Moscow, MIIT publ., 2015, pp. 99–102.

13. Smagin, I. I., Smagina, V. I. Social adaptation of the population: life from crisis to crisis [*Social'naja adaptacija naselenija: zhizn' ot krizisa k krizisu*]. Sayapin's readings: collection of materials of the «round table». Tambov, 2016, pp. 222–231. ●

Information about the authors:

Epishkin, Ilya A. – Ph.D. (Economics), associate professor, Head of the Department of Labor Economics and Human Resources Management of Moscow State University of Railway Engineering (MIIT), Moscow, Russia, i.epishkin@myief.ru.

Frolovichev, Alexander I. – senior teacher of the Mathematics department of Moscow State University of Railway Engineering (MIIT), Moscow, Russia, a.frolovichev@myief.ru.

237