Modeling the Results of Personnel Training for the Transport Industry

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Abstract: The competencies acquired during the training are the basis for employers' assessment of the young specialists' degree of readiness for specific activities. The purpose of the article is to develop a model of an internal system for assessing the initial state of university applicants and the effectiveness of quantitative and qualitative advancement of students in courses; and on their basis to determine the probability of their successful graduation from the university. The data obtained is proposed to be used in the justification of preventive measures to improve the quality of university graduates training. The results of the study are presented, including the substantiation of methods for assessing the quality of training, the collection of analytical data on quantitative and qualitative characteristics of discrete states of students for a specific educational program. The modeling was carried out on the basis of stochastic Markov processes discrete in time, describing the sequence of possible states of the objects of study with a certain probability. The results obtained are of practical importance for the modernization of quantitative and qualitative results of students' training based on their systematic assessment in the learning process.

1 INTRODUCTION

The task of increasing the level of human resource development is determined by the economic and social interests of society. It is implemented in the form of competitiveness of educational institutions graduates and personnel of organizations. Our research on the formalization of the learning management process at the university caused the need to specify the target setting of the quality of training specialists in accordance with the requirements of the transport industry (Corporate Requirements for Qualification of Russian Railways' Employees with Higher and Secondary Professional Education). The formulation of this task led to the development of a model on the basis of which it is possible to carry out operational and strategic management of qualitative and quantitative components of the competitive personnel training.

Currently, the complexity of assessing the level of training of specialists for the industry is due to the discrepancy between the requirements of the parties to the components of the quality of training, which makes it difficult to model and interpret the assessment. The results of the analysis are presented in more detail in (Parshina, 2013). The basis for the formation of the competence model of an employee of the transport industry is the condition of compliance with state and industry educational standards (Fig. 1).
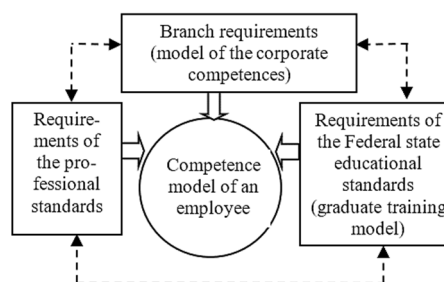
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Figure 1: Competency model of an industry worker.

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Currently, work is underway to form the general requirements of the parties to the quality of graduates. After ensuring this compliance, it is possible to adjust the evaluation criteria.

2 MATERIALS AND METHODS

Emerging publications (with reference to employers) about the incomplete compliance of the quality of graduate training with the increased requirements of the production and services sphere, put forward the task of studying the causes of this phenomenon. At the same time, there is a dropout of students during training, which is reflected in the inefficient spending of funds on training. Therefore, a comprehensive study of the managerial impacts of the university on the results of personnel training is relevant at the present time. The analysis of theoretical sources (Cripe, 2012; Mathis, 2012; Modern approaches to knowledge management development. Collective monograph, 2020; Bornmann, 2006; Black, 2009), the review of modern practice in the field of education (Sànchez, 2018; Alyahyan, 2020), the assessment of the ratings of higher educational institutions and the level of training in them by the eyes of employers allowed us to identify problems of educational activity that are insufficiently represented in the literature and have specific character in this country.

Attention to the field of personnel training in the world is initiated by the proclaimed general idea of stable economic development. The formulated national goals of educational processes are complemented by intra-university systems for monitoring and improving learning processes. The review of modern literature demonstrates the manifestation of the initiative of universities in improving the quality of education. The experience of the world's leading universities shows that the success of an educational institution is determined by the chosen strategy in the field of specialist's training quality (Care, 2018). One of the tasks is to develop preventive measures to identify and work with students at risk groups, which can significantly increase the comprehensive effectiveness of training. Such actions are conditioned by the desire to meet the requirements of employers, students and their parents. The effective and efficient application of various methods of factual data analysis provides solutions for determining the success factors of university graduate. The study of the factors of ensuring the quality of training, for example, in China and Germany (Zhang, 2011), indicate the importance of process management at various levels, including the actions of the university.

The proposed research is aimed at developing a methodology for analyzing the factual data of educational processes to predict the effectiveness of learning, keeping in mind the peculiarities of industry education (Parshina, 2021; Parshina, 2019). With this purpose, literature and modern information were analyzed as part of the systematization of learning processes. The analysis of the statistical methods used to identify patterns, trends and probabilities using the initial data is carried out. For data processing, the Markov process method was chosen, which allows predicting qualitative and quantitative indicators of training specialists. The results obtained can be converted into a compressed format and brought to the involved university and corporation heads.

3 RESULTS AND DISCUSSION

To predict the quantity and quality of graduates of the transport university an analytical review of the students' achievements depending on the admission score was made. Bearing in mind that the formation of competencies occurs in the process of mastering specific disciplines, the analysis of students' progress in them was carried out. The general basis for assessing the quality of education serves the progress in educational programs for the entire period of study. The level of students' competence is considered on the specific educational program "Management" (period of study in the university in 5 years). The training standard assumes mastering 22 general cultural and 50 professional competences.

To get the necessary basis for assessing the level of competence formation it is proposed to use: the results of examinations and tests on academic disciplines, coursework design, the results of all types of practices and defense of the graduate qualification work. In order to formalize the quality of the achieved competences the criteria presented in table 1 were developed.

Table 1: Criteria of competences formation.

An interval of a students, estimation	The level of competence, %
4,5-5,0	> 90
4,0-4,5	80 – 90
3,5-4,9	70 – 80
3,0-3,4	60 – 70
3,0	< 60

Then the average score of the students of the academic group for each discipline and the average score of the group for each cycle were calculated. The results of calculations and an overall assessment of the level of competence formation within a particular cycle are presented in fragments in Table 2.

Table 2: Estimation of the level of students, competences formation.

Training cycles	The average students scores	Codes of formed competences	The level of competence formation, %
Humanitarian, social and economic	4,15	14 general cultural competencies	80 - 90
Mathematical and natural science	3,80	4 general cultural competencies	70 - 80
Professional	4,22	3 general cultural and 50 professional competencies	80 - 90
Physical Training	4,14	1 general cultural competence	80 - 90
Training and industrial practices	4,68	3 general cultural and 3 professional competencies	90 and above
Final State Attestation	4,24	2 general cultural and 50 professional competencies	80 - 90

As follows from the table, the actual level of competence formation among students not less than 70%. All general cultural competencies were mastered in the learning process. Among them, the highest level of mastering the following competencies (more than 90%): the desire for personal and professional self-development; the ability to critically assess personal strengths and weaknesses; the ability to carry out business communication: public speaking, negotiations, meetings, business correspondence, electronic communications; as well as the ability to take into account the consequences of managerial decisions and actions from a position of social responsibility. To a lesser extent, they have mastered: possession of a culture of thinking, the ability to perceive,

generalize and analyze information, setting goals and choosing ways to achieve.

To manage the process of training competitive graduates, their modeling based on Markov processes was used. A homogeneous Markov chain is constructed on the basis of the results of the Unified State Exam obtained during the differentiated analysis of applicants for admission, students' academic progress during the entire period of study, and the number of students who were expelled for failure (Fig. 2). As a result of the calculation of the chain, a conclusion was made regarding the probability of obtaining the necessary training of specialists, the total risk of student expulsions and expulsions risks for groups of students with different school preparation and academic performance at all stages of training were calculated.
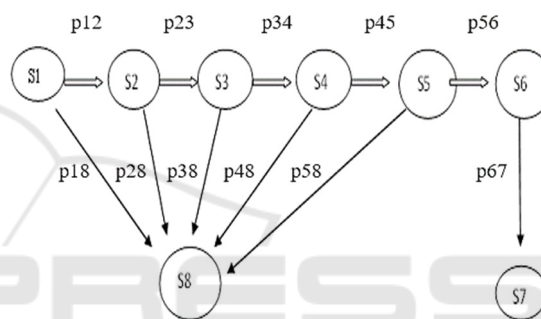

Figure 2: General view of the Markov chain to describe the training of students of a particular direction of training.

Here: S1 – first year students;
 S2 – second year students;
 S3 – third year students;
 S4 – forth year students;
 S5 – fifth year students;
 S6 – students who achieved the final state certification;
 S7 – professionals who graduated from the university;
 S8 – university students.

We use the basic concept in the theory of Markov processes - the state to describe the object under study, going through the stages from the applicant to the graduate of the university. A graph of the states of the Markov chain relative to the learning process at the university is compiled in a general form and its transition probabilities are marked up. The notation p is used to describe the transition probability. So, to change the state of S1 for a year, it is possible to switch to the state of S2 with a probability of P12, etc. The academic performance of each student over the entire period of study was analyzed. Further, based on

the calculations carried out, the probability with which the student will move to the n-state next year is determined; at the same time, he has improved or worsened his condition. Low academic progress in the initial period is determined by insufficient school preparation of students. Basically, students who had difficulties mastering the educational material in the process of learning are expelled. Timely measures taken (additional classes, assignment of a more qualified teacher, involvement in the creative process, etc.) will allow keeping the contingent of students. Based on the data obtained, calculations were made of the probability of first- and next-year students moving up to the next level within the allocated point ranges (Fig. 3).
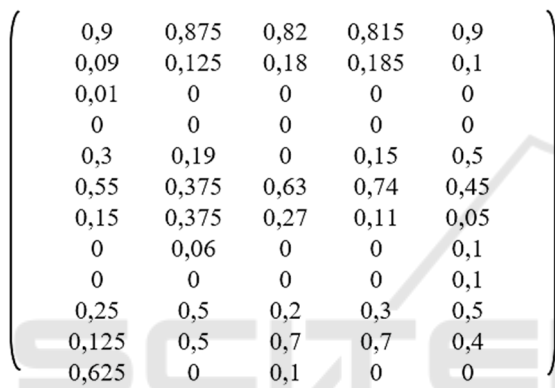
$$\begin{pmatrix} 0,9 & 0,875 & 0,82 & 0,815 & 0,9 \\ 0,09 & 0,125 & 0,18 & 0,185 & 0,1 \\ 0,01 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0,3 & 0,19 & 0 & 0,15 & 0,5 \\ 0,55 & 0,375 & 0,63 & 0,74 & 0,45 \\ 0,15 & 0,375 & 0,27 & 0,11 & 0,05 \\ 0 & 0,06 & 0 & 0 & 0,1 \\ 0 & 0 & 0 & 0 & 0,1 \\ 0,25 & 0,5 & 0,2 & 0,3 & 0,5 \\ 0,125 & 0,5 & 0,7 & 0,7 & 0,4 \\ 0,625 & 0 & 0,1 & 0 & 0 \end{pmatrix}$$

Figure 3: Matrix of probabilities of students', transition to the next course on groups in the distinguished intervals of progress.

Next, the generalized values of the probability matrix of students' advancement in a certain educational program are calculated (Fig. 4).
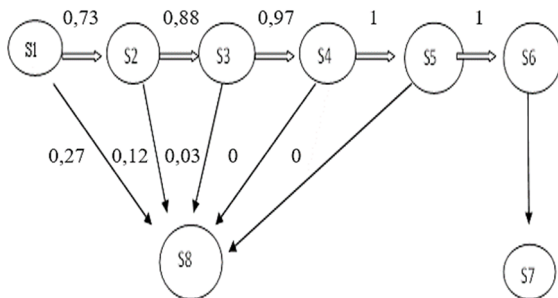

Figure 4: Generalized values of the transition probability matrix of students to the next course.

According to Figure 4, the probability of transition of all students from the first year to the second one is 0.73, from the second year to the third one – 0.88, etc. There are practically no deductions in the last year and all students defend their final

qualifying work. The analysis showed that first-year students find themselves in a situation of the greatest risk of expulsion. The probability of expulsion of a fifth-year student is almost zero. Based on the logical addition of risks, we calculate the overall degree of risk of a student's expulsion in the learning process (P):

$$P = 0,27*0,88*0,97*1*1 + 0,12*0,73*0,97*1*1 + 0,03*0,73*0,88*1*1 + 0 + 0 = 0,32$$

The total risk of expulsion of a student for 5 years of study is 0.32. Assistance to students in mastering the educational program at any stage of preparation will improve the quantitative and qualitative effectiveness of the education process and increase the efficiency of funds invested in training.

4 CONCLUSION

The process of preparing students at the university is described in terms of the theory of Markov processes. Modeling of learning processes and training results with indication of stationary states and identification of transition probabilities between them is carried out. The data obtained is proposed to be used to manage the quantitative and qualitative components of the effectiveness of educational activities of the university. The conclusions can be used by heads of the University to implement timely and strategic actions to optimize the level of development of students' competence mastering, reducing the percentage of students' expulsions, by students to plan their own personal learning process and the likelihood of graduation, and by heads of the transport industry for the planning and selection of candidates for training. The presented materials illustrate only a part of the research carried out for the industry on the improvement of the interaction of branch universities and structural divisions of the corporation.

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