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DEVELOPMENT OF THE FORECAST MODEL FOR MANAGEMENT OF THE DISBALANCE BETWEEN THE LABOR MARKETS AND EDUCATIONAL SERVICES IN THE CONSTRUCTION INDUSTRY

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Abstract

Purpose: In this article, the procedure of the development of the forecast model is described. Within the model based on expert assessment factors that affect the imbalance between labour markets and educational services in the construction industry have been identified. Graphical visualization of models in the form of graphs is presented. On this basis, scenarios of social and economic development of the region in this area (optimistic, realistic and pessimistic scenarios) are defined.

Methodology: The developed method for constructing a predictive model includes the following steps. Stage 1 - a comprehensive consideration of the factors, Stage 2 - conducting the procedure for the selection of experts, Stage 3 - a preliminary assessment of the importance of groups of factors, Stage 4 - the construction of a system of interdependent equations describing LM and ESM, Stage 5 - development of a set of graph-analytical models that visualize the nature and direction of the influence of factors and groups of factors on LM and ESM

Result: While finding an imbalance between the labor and educational services markets, the most significant criteria from those considered in the study were identified. Oriented graphs visualizing the direct and indirect influence of significant criteria on the markets in question were constructed. The importance of the impact of potential measures, both on the labor market and on the educational services market, was calculated.

Applications: This research can be used for universities, teachers, and students.

Novelty/Originality: In this research, the model of Development of the Forecast Model for Management of the Disbalance between the Labor Markets and Educational Services in the Construction Industry is presented in a comprehensive and complete manner.

***Keywords**: Balance of Labour Markets and Educational Services, Decision Support, Expert Assessments, Human Resources in The Construction Industry, Oriented Graph.*

INTRODUCTION

Currently, special importance is attached to modeling methods in research on socio-economic processes. The model in research of control systems in this area is used as an image, a simplified likeness of an object that reproduces properties and characteristics of a given object or system of objects under certain conditions as their “deputy" or "representative”.

Modeling performs important heuristic functions: identifies negative trends; identifies positive solutions to problems; offers alternatives, i.e. modeling acts in unity with forecasting, being its integral part.

Modeling in the socio-economic sphere in the construction, improvement, study, and application of models of actually existing or projected socio-economic systems, their elements, processes and phenomena associated with them.

With the help of models, two methodological problems are usually solved - expert and / or constructive. On the basis of the available information, the expert task describes the past; the Predictive model is a model of prediction object, which allows you to obtain information on possible states of the object in the future (or) the ways of their implementation.

The analysis of the development of the situation on the basis of forecast models is largely based on the use of indicators taken as a basis, indicators of the state of the socio-economic system, as well as their interrelations and cumulative influence on the state and development of the system being analyzed.

This article discusses the procedure for developing a forecasting model for managing the balance of the labor market in the construction and educational services markets. The choice of this topic is due to the current situation in the construction industry.

Recently, there has been a significant imbalance between the number of institutions of higher and secondary vocational education, as well as between the real needs of the regional economy and the graduation of personnel with vocational education. In this regard, the fundamental task is to coordinate the work of the vocational education system with the real needs of the regional labour market in professional personnel in the construction industry.

The supply on the construction market is specific in that if the rest of the mass of goods can accumulate and then spread out and be realized as the favorable position develops, the accumulation of construction objects cannot be transferred, they cannot be moved from one market where supply prevails over demand, another. Supply and demand in the market of construction products do not differ much. Hence, we can see the high requirements for the management and marketing of construction organizations.

The supply of building products is also specific: an increase in supply, especially for production facilities, such as automotive plants, cannot be carried out within the framework of a short-term or even medium-term (4-5 years), but requires a longer period of time, while construction and supply in the market of enterprises for the maintenance and repair of road transport may change in shorter periods of time.

The question regarding the interaction of two socially significant markets: the labor market and the educational services market is relevant. Most university graduates do not find work in their field, which is caused by a large number of unclaimed specialties, and there is a decrease in the quality of education received by graduates.

The theory of the relationship between the labor market and the educational services market is to create an effective and regulatory mechanism for the interaction of these markets since today this mechanism works inefficiently. This mechanism includes the following:

- Ways to reconcile the demand for specialists of a particular level of qualification and the supply of relevant jobs;
- Ways to take into account the changing requirements of employers (as the main customers of vocational education) to the quality of vocational training in the regional network of vocational education institutions;
- Formats of participation of employers in the activities of the vocational education system in order to achieve compliance with the demand and supply of labor (both in quantitative and qualitative parameters).

Thus, to meet the labor needs of the economy, effective state regulation is needed, which consists of regulating educational services based on the needs of the labor market itself.

In the conditions of innovation-oriented economic development, the formation of the region's human resources (RHR) is characterized by the following principal features:

1. The strong influence of the demographic situation on the structural components of the RHR;
2. The state of the modern regional labor market (LM) and educational service market (ESM) are in continuous change;
3. The processes of interaction between LM and ESM among themselves and with the external environment are distinguished by high dynamics and complexity;
4. The level of state regulation in this area is extremely low (Ivashchuk and Udovenko, 2014).

The efficiency of managing processes of complex socio-economic objects with high dynamics is associated with the need to collect and process large amounts of heterogeneous information, build and implement forecast models, ensure prompt and adequate response of the management system to changes in all components of the control object and in the external environment. To date, there is no single model that describes not only qualitative but also quantitative factors that have control effects on the RHR to achieve a balance in the labor and educational markets.

With a large number of research and practical work carried out in the field of human resource management in the region, a unified theoretical and methodological approach to building information technology has not yet been created to ensure effective adaptive management with regard to the dynamics and complexity of interaction with labour markets and educational services, external environment, features of the territory (Ivashchuk and Udovenko, 2015).

In this regard, today it is extremely important to model and study systemic links and regularities of the processes of managing the personnel potential of a region, to implement probabilistic forecasting based on them, and to work out possible scenarios for the development of a region in the construction industry.

Today in Russia fragmentary quantitative forecasting of the parameters of the labor market is carried out, however, this is not enough to develop the country's human potential and overcome the emerging problems of human resource development as the basis for the competitiveness of regions and the country as a whole. To date, there has been an urgent need to build an effective and adequate RHR management system, which ensures competent scientifically sound management when implementing the most rational perspective management mechanisms, which implies identifying factors and groups of factors, changing the values of which will allow managing labor markets in the construction and educational services, reducing the degree of mismatch of the current human resource potential of the region in terms of the number of specialists required by of specialization, potential employees from among students, as well as the demands of the labor market (Ivashchuk, et al. 2015).

METHODS

The developed method for constructing a predictive model includes the following steps.

Stage 1 - a comprehensive consideration of the factors that have control over the human potential of the region in terms of

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achieving a balance between the labor market and educational services, taking into account the characteristics of the Belgorod region and the existing trends in the region in the field of construction and education.

Stage 2 - conducting the procedure for the selection of experts, including the preparation of questionnaires and conducting expert surveys, which allowed the identified factors to be divided into 5 groups: economic, organizational, educational, social and information environment factors.

Stage 3 - a preliminary assessment of the importance of groups of factors, as well as factors within each group, for which, based on the hierarchy analysis method, experts were asked to complete a matrix of pairwise comparisons of factors and groups of factors. Processing the matrices of pairwise comparisons yielded the following results: the group of economic indicators has the most influence, in the group of social factors the factor "recruitment by the employer during the training period" - "the level of demand for housing in the region", in the group of the information environment - "the level of technologization of construction processes", in the group of training - "the number of training areas implemented in the secondary technical schools and institutions of higher education in the region, related to the project area "(Putivtseva, et al. 2015).

Also, an analysis of the results showed that some factors from different groups and within the group slightly differ in degree of importance and this approach does not provide information about the effect (positive or negative) it has.

Stage 4 - the construction of a system of interdependent equations describing LM and ESM. Based on the construction of a system of simultaneous equations, the strength and direction of influence of selected factors on the balance of labor markets and educational services in construction was determined and its graphical interpretation was performed

Stage 5 - development of a set of graph-analytical models that visualize the nature and direction of the influence of factors and groups of factors on LM and ESM. Based on the analysis of the constructed models, factors affecting the imbalance of the markets were identified, and their grouping was carried out, the degree of their influence on the level of imbalance was identified.

Stage 6 - determining the importance of groups of factors to achieve a balance and the importance of factors within the group.

Stage 7 - building scenarios for the development of the construction sector in the region. Based on the analysis of graphical interrelations, graph-analytical models reflecting the influence and interaction of factors on the balance were built, and for each model based on additional studies and surveys, three different scenarios of the socio-economic development of the region were built. For each scenario, the degree of influence of each factor on the balance of labor markets and educational services and the probability of the possible influence of the corresponding factor, as well as the reduced integral influence of factors, taking into account its direction, were determined.

RESULTS AND ITS DISCUSSION

Below are examples for calculating the generalized integral probabilities of the influence of factors on the balance and significance (weight) of these factors (Mamatov, et al. 2018).

Table 1: Matrix of Factors Probability

Cr	C1	C2	…		…	U1	…		
C1									
C2									
…									
…									
U1									
…									

Table 2: The matrix of factors' significance (importance)

Cr	C1	C2	…		…	U1	…		
C1									
C2									
…									
…									
U1									
…									

Table 3: Matrix of the reduced integral influence of factors

Cr	C1	C2	…	…	U1	…
C1						
C2						
…						
…						
U1						
…						

Figure 1 shows a fragment of the matrix of probabilities of influence of factors.

	C1	C2	C3	C4	C5	C6	C7	E1	E2	E3	E4	E5
C1	0,00	0,20	0,00	0,00	0,00	0,09	0,06	0,15	0,00	0,00	0,00	0,00
C2	0,04	0,30	0,24	0,00	0,18	0,20	0,00	0,00	0,00	0,00	0,00	0,00
C3	0,00	0,15	0,15	0,00	0,18	0,11	0,00	0,00	0,00	0,00	0,10	0,00
C4	0,20	0,00	0,00	0,00	0,05	0,00	0,00	0,00	0,00	0,00	0,00	0,25
C5	0,00	0,19	0,23	0,00	0,25	0,00	0,00	0,00	0,00	0,00	0,00	0,15
C6	0,03	0,05	0,02	0,00	0,00	0,00	0,00	0,03	0,00	0,00	0,00	0,00
C7	0,00	0,02	0,03	0,00	0,00	0,00	0,00	0,00	0,00	0,10	0,00	0,00
E1	0,00	0,00	0,00	0,00	0,00	0,04	0,06	0,00	0,00	0,20	0,00	0,00
E2	0,00	0,23	0,25	0,00	0,17	0,19	0,00	0,19	0,00	0,00	0,28	0,25
E3	0,00	0,00	0,00	0,00	0,11	0,00	0,00	0,20	0,00	0,00	0,00	0,00
E4	0,00	0,10	0,10	0,00	0,09	0,00	0,00	0,00	0,00	0,00	0,00	0,30
E5	0,00	0,00	0,00	0,05	0,03	0,00	0,00	0,00	0,00	0,00	0,00	0,00
E6	0,00	0,00	0,00	0,00	0,06	0,00	0,00	0,00	0,10	0,00	0,05	0,22
E7	0,00	0,21	0,00	0,00	0,00	0,00	0,00	0,00	0,16	0,00	0,10	0,00
E8	0,00	0,07	0,12	0,03	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,00
U1	0,10	0,00	0,00	0,00	0,00	0,20	0,08	0,12	0,00	0,10	0,00	0,00
U2	0,00	0,00	0,00	0,00	0,00	0,08	0,25	0,15	0,00	0,16	0,00	0,00
U3	0,00	0,00	0,00	0,00	0,00	0,10	0,00	0,13	0,00	0,14	0,00	0,00
I1	0,02	0,14	0,00	0,00	0,10	0,00	0,00	0,00	0,00	0,00	0,00	0,00

Figure 1: Fragment of the table of probabilities of the influence of factors

Calculations were carried out, both for each block, and as a whole according to the tables. The maximum (by module) values were calculated by rows and columns, as well as by individual blocks and as a whole by tables. In addition, to identify the degree of importance of groups of factors to achieve a balance between LM and ESM, total indicators were calculated (Putivtseva, et al. 2016, Lomakin and Lifirenko, 2014).

Based on the analysis of the probability table (Fig. 1, Table 1) of the influence of factors, the following conclusions were obtained:

1. According to the degree of influence of groups of factors on each other, the following pairs have the greatest: informational - social, social - educational and educational - informational, forming a triangle of maximum influence;
2. The greatest influence among the individual factors on the imbalance have C5 (the number of migrants) and I2 (the level of education employed in construction), which confirms the previously made hypotheses (Lomakin, et al. 2017);
3. The smallest influence among individual factors on the imbalance is exerted: O6 (number of students using distance learning) and C6 (recruitment by the employer during the training period (target training));
4. The factors that are most affected are C2 (the number of vacancies at the respective enterprises and organizations), O7 (the number of centers for retraining specialists based on additional vocational training), C5 (the number of migrants), C3 (the level of employment);
5. The factors that are least affected are O1 (the number of budget places in universities in these areas) and C4 (birth rate).

Based on the analysis of the table of weights of factors, the following conclusions were made:

1. According to the degree of influence of groups of factors on each other, the following pairs have the greatest: informational - social, social - educational and educational - informational, a group of factors of social environment;

2. The greatest influence among the individual factors on the imbalance is exerted: I8 (the level of technologization of the construction processes) and I5 (the level of need for new engineering specialties);
3. O6 (number of students using distance learning) and E6 (the level of demand for housing in the region) have the least impact among individual factors on the imbalance;
4. Factors most affected: C2 (number of vacancies at relevant enterprises and organizations), O7 (number of specialist retraining centers based on additional vocational training), C5 (number of migrants), C3 (employment level);
5. The factors that are least affected are O1 (the number of budget places in universities in these areas) and E2 (the number of active construction companies) (Zhilyakov, et al. 2015).

Based on the analysis of the pivot table, the following conclusions were made:

1. According to the degree of influence of factor groups on each other, the following pairs have the greatest: informational - educational, informational - organizational, organizational - social, social - informational and educational - informational;
2. The greatest influence among the individual factors on the imbalance is exerted: E2 (the number of active construction enterprises, C5 (the number of migrants) and I5 (the level of need for new engineering specialties));
3. The smallest influence among individual factors on the imbalance is exerted by O6 (the number of students using distance learning) and C7 (the number of personnel engaged in research and development in the region);
4. The factors that are most affected are: C6 (recruitment by the employer during the training period (target training)), C2 (the number of vacancies at the respective enterprises and organizations (taking into account the seasonal coefficient)), O7 (the number of centers for retraining specialists based on vocational training), C3 (level of employment);
5. The factors that have the least impact are O1 (the number of budget places in universities in these areas), E2 (the number of active construction companies), O6 (the number of students using distance learning).

Following the analysis of all the tables, models for managing the balance of LM and ESM were built. An example of a graphical representation of the model for the educational services market is represented as a focused graph in Fig. 2, and for the labour market - in Fig. 3. The focused graph has identified factors and connections this direction of communication indicates the influence of one factor on another; (the positive influence of the factor is indicated by a solid line, the negative one by a dotted line).

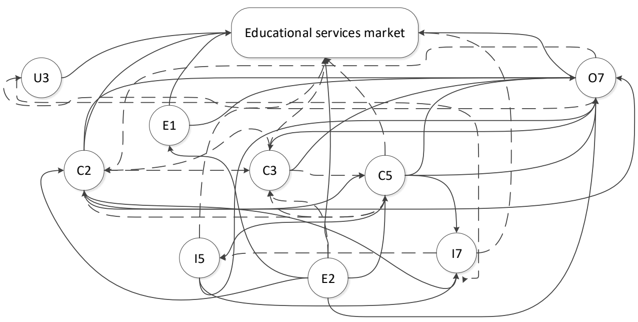

Figure 2: Oriented graph for educational services market

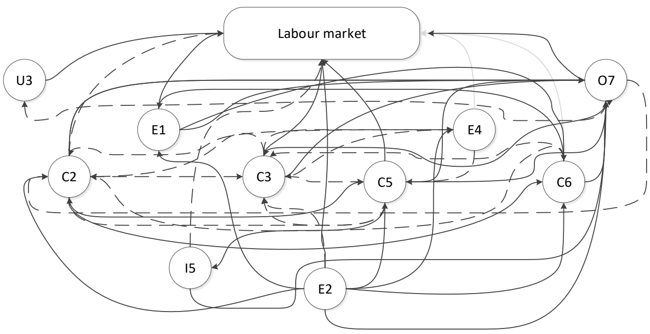

Figure 3: Oriented graph for the labour market

Based on the analysis of all the tables, a cognitive map of the effect on correcting the imbalance and maintaining the balance between Labour market and Educational services can be built. For a realistic scenario, two chains were distinguished:

- To reduce the degree of influence of E2 - E4 - E7 - C2 - C3 - I7 - E8 - C3
- To increase the degree of influence of C7 - U3 - E1 - E2 - E7 - E4 - E2

Also, the most characteristic criteria for this model are E7, E4, E2.

The results obtained are the basis for decision-making support in managing the balance between the labour market and the educational services market in the construction industry, which in turn will make it possible to predict the degree and direction of influence of factors, as well as develop recommendations and a list of possible measures aimed at reducing (eliminating) imbalance between the relevant markets.

To make management decisions to reduce the imbalance between the labour and educational markets, depending on the current situation, an algorithm has been developed that allows you to manage a single factor, an aggregate or a group of factors (Fig. 4).

Figure 4: Algorithm of managing a single factor, an aggregate or a group of factors

This algorithm was realized as a computer program. The screens of the developed software support are presented in Figures 5-8. In fig. 5 the main window of the program is presented, it allows you to select a task, views the results of previous calculations, and open the instructions for working with the program for review. In fig. 6 a window for selecting a forecast mode is presented. After selecting the forecasting option, the calculation of the initial imbalance takes place. The results of the calculation are presented in Fig.7. In the case when the user considers that imbalance value is valid, then the calculation ends at the moment. In that case, when the value of the imbalance gets out of the permissible values, then the further work with the program takes place in one of two modes: automatic or semi-automatic. In the automatic mode, the program calculates the most significant measures and recalculates the imbalance, taking into account each measure alternately, starting with the most significant one (Fig. 7). In semi-automatic mode, the user puts down the importance of each event, and the calculations are carried out taking into account these importance (Fig. 8).

Figure 5: The main window of the program support

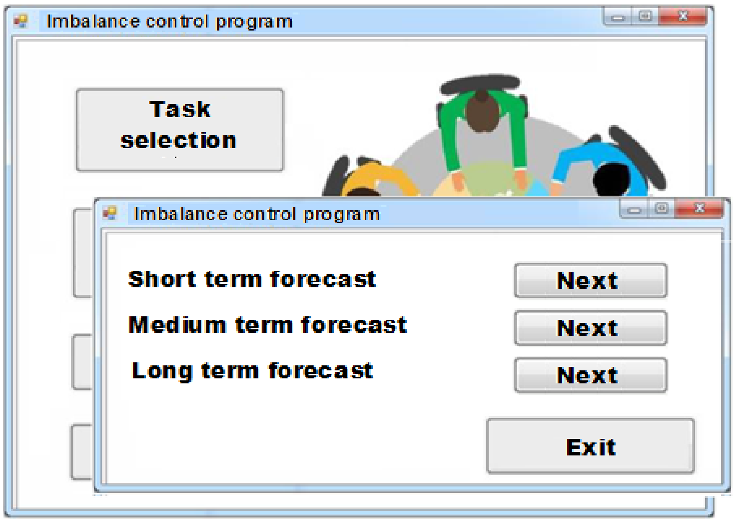

Figure 6: The choice of the forecast modes

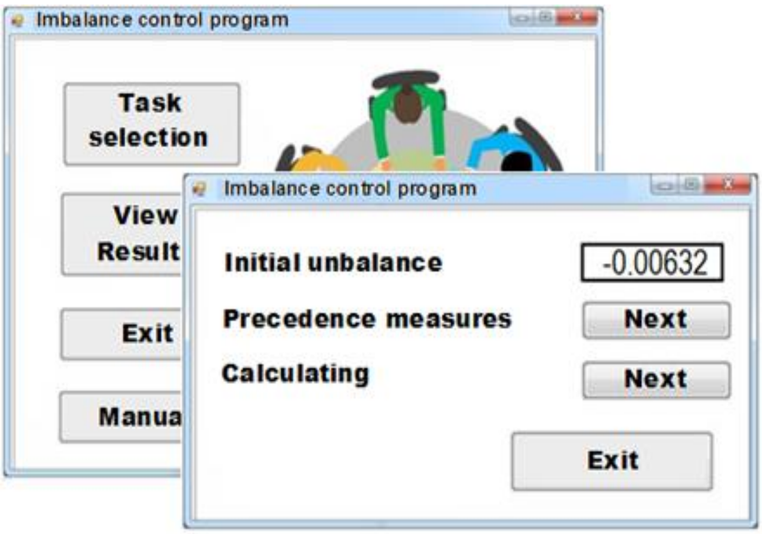

Figure 7: The interim results of the calculated forecast

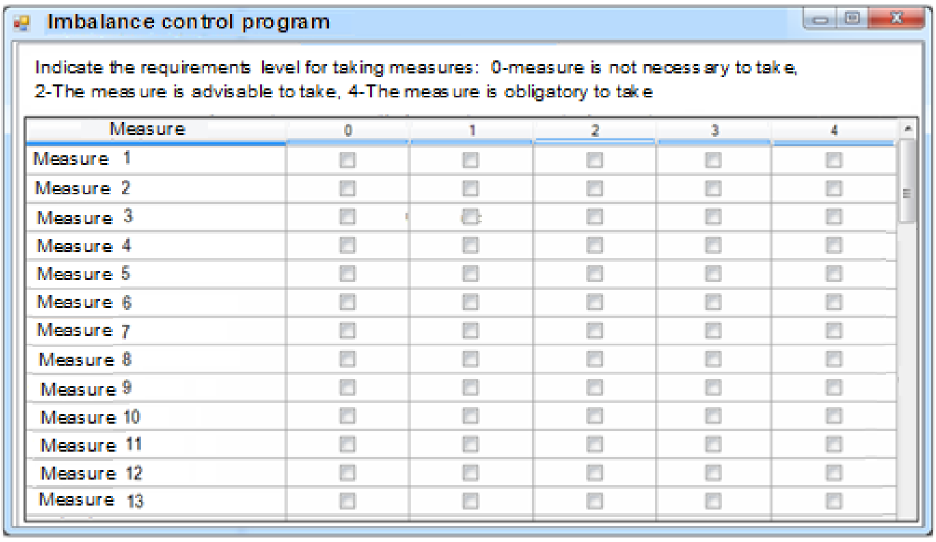

Figure 8: Filling in the cells with the degree of significance for measures

CONCLUSION

As a result, the following conclusions can be made:

1. While finding an imbalance between the labor and educational services markets, the most significant criteria from those considered in the study were identified.
2. Oriented graphs visualizing the direct and indirect influence of significant criteria on the markets in question were constructed.
3. Tables for taking into account the influence of criteria and groups of criteria were formed
4. The importance of the impact of potential measures, both on the labor market and on the educational services market, was calculated.
5. An algorithm to correct the imbalance between the markets under consideration, which is based on planned measures, was developed.

A prototype of the information system called the “Imbalance control program” was developed

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