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Information Support Control by Human Resources Construction Cluster Region

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Abstract

In the present paper, effective factors in the imbalance between labor markets and educational services in the construction industry were identified on the basis of expert assessments. A model was developed as a system of equations that made it possible to determine the direction of influence of selected factors with subsequent graphic interpretation. Graphical visualization of models was also presented in the form of graphs. On this basis, scenarios of socio-economic development of region were defined in this area (optimistic, realistic and pessimistic scenarios).

Keywords: Human resources of the construction cluster of region; Balance of labor markets and educational services; Decision support; Expert assessments; Oriented graph; Scenarios of development of construction cluster.

1. Introduction

Recently, there is a significant imbalance between the real needs of regional economy and the training of specialists with professional education. Therefore, actual task is to harmonize the work of the professional education system with the real needs of the regional labor market for professional personnel who are able to work in various fields (Kostenkova and Pishchulin, 2016; Mohammadi *et al.*, 2018).

Most graduates do not find work in their professional spheres due to a large number of unclaimed personnel.

Therefore, the mechanism of interaction between the labor market and the market of educational services is now rather inefficient, namely the demand for personnel of any level qualification and supply of relevant jobs has not been coordinated; there are not considering the changing requirements of employers for the quality of vocation training in the regional network of professional education institutes; there is no regular participation of employers in the activities of the professional education system in order to achieve the correlation between demand and supply to workforce (Villalobos Antúnez, 2008).

Based on the above-mentioned cases, it is necessary to perform an effective management of educational services for the rational provision of the economy with workforce. It should be based on needs of the labor market. The main purpose of this regulation is to reproduce the necessary number of personnel that have required qualification and required level of education (Abel *et al.*, 2013; Ecirlia *et al.*, 2014).

2. Research Body

According to authors, the workforce capacity of a region is a complex of professional knowledge and basic skills of both available personnel in this regional economic realm (including those registered with employment service) and accumulated knowledge, abilities and skills potential personnel who currently study in the region's professional educational institutions (Ivashchuk *et al.*, 2015b; Ivashchuk *et al.*, 2016; Ramírez and Rodríguez 2017).

The construction is now a promising and high developing economic realm in Russia. The development of the construction cluster determines the urgent need for training of highly qualified personnel in scientific, academic, engineering and labor sphere. Such personnel will be able to ensure the effective performance of this branch of economy. At the same time, as stated above, it is necessary to maintain a balance in the performance of market and educational services sphere in the construction sector (Ivashchuk *et al.*, 2015a).

A comprehensive analysis was performed on the current situation in this area to determine factors and changes in the implementation of management influences to achieve a balance between needs of the labor market and the training professional personnel. An expert valuation method was then applied inspiring by an individual questionnaire (Ivashchuk and Udovenko, 2015). Questionnaires were designed for experts from different spheres, in particular labor

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administration and employment of population sphere, residential construction sphere, science and education sphere. It involved 52 experts from the Belgorod region, which ranked the 4th among the Central Federal District members in terms of "Quantity of performed work according to the type of activity "Construction" (80 621.4 million rubles by January 2018) (Ivashchuk *et al.*, 2018).

In the Belgorod region, there is also realization of training program of vocational school or college, bachelor's and master's degrees within the framework of group 08.00.00. Engineering and technology of construction. Experts were asked to range presented factors in questionnaires and suggest introducing new factors, which, in their opinion, are significant in the function of possible control actions.

The following factors have been identified as a result of questionnaires. Factors are systematized according to five groups.

2.1. Factors of Social Environment (S)

The number of graduates, who studied in relevant majors of higher and secondary special professional educational institutions (S_{01}); the number of vacancies that not corresponded to enterprises and organizations (S_{02}); employment level (S_{03}); birth rate (S_{04}); the number of migrants (S_{05}); selection of personnel by employer during the training period (S_{06}); number of personnel engaged in research and development in the region (technical and natural sciences) (S_{07}).

2.2. Factors of Economic Environment (E)

The degree of innovation in the construction sphere (E_{01}); the number of acting construction company (E_{02}); features of business communities' structure in this area (E_{03}); quantity of work performed for the type of activity "Construction" (E_{04}); commissioning of the residential building (E_{05}); level of demand for housing in the region (E_{06}); the level of necessity in the construction of socially significant building projects (E_{07}); the region's gross regional product in "Construction" (E_{08}).

2.3. Factors of Information Environment (I)

The number of alternative occupational standard as regional industry regulatory documents (I_{01}); the level of education employed in construction (I_{02}); the level of education of workforce capacity of the region, including the number of students of universities, post-graduate students and doctoral students of the region (I_{03}); the level of requirement for new blue-collar job specialists (I_{04}); the level of requirement for new engineering specialists (I_{05}); the level of correlation between construction process and legal framework (I_{06}); the level of regional education expenditures (I_{07}); the level of technological development of construction process (I_{08}).

2.4. Factors of Academic Environment (A)

The number of implemented training courses vocational school and higher education institute of the region related to the construction sector (A_{01}); the number of implemented training program of highly qualified personnel (postgraduate studies, doctoral studies) (A_{02}); the number of continuing education program in the training program in construction sector (A_{03}).

2.5. Factors of Organization Environment (O)

The number of state-financed openings in higher education institutions in these training programs (O_{01}); the number of employer-sponsored education spaces (O_{02}); the number science, innovation and education centers as links between science and industry (technology park) (O_{03}); the number of training and consultation centers in the relevant directions (O_{04}); the number of specialized classes to prepare applicants for admission to vocational education institutions in the relevant directions (O_{05}); the number of students using distance learning (O_{06}); the number of retraining centers as part of additional vocational training (O_{07}); vocational counseling work (O_{08}).

The authors used hierarchy analysis method for the preliminary estimation of both the importance of groups in general and the importance of individual factors within each group. They also used the Saaty scale to fill the pairwise comparison matrixes (Saati, 1993).

Table 1 presents results of averaging the pairwise comparison matrixes, where experts compared groups of factors in terms of their impact on the balance between the labor market and educational services.

Table-1. Results of Averaging Pairwise Comparison Matrixes

Balanced State	S	E	I	A	O	Local Priority Vector	Normalized Vector
S	1	1/7	4	6	2	1.4697	0.175625
E	7	1	8	9	7	5.12278	0.612159
I	1/4	1/8	1	3	1/3	0.5	0.059749
A	1/6	1/9	1/3	1	1/5	0.262001	0.031308
O	1/2	0.142857	3	5	1	1.013894	0.121158
						8.368375	1

Conformity evaluation CE =0.086696

Similar tables were filled and processed for all groups of factors.

The resulting conformity evaluations indicate that (CE<0.1): Judgments are consistent; there is no need to refill the questionnaires; there is no transitivity violation (Putivzeva *et al.*, 2015).

The meanings of group factor loading are presented in Table 2. There are received the meanings of separate factor loading with their use. The meanings are presented in Table 3.

Table- 2. Meanings of Group Factor Loading

S	E	I	A	O
0.175625	0.612159	0.059749	0.031308	0.121158

Table-3. Meanings of Separate Factor Loading

Factors of Social Environment						
S_{01}	S_{02}	S_{03}	S_{04}	S_{05}	S_{06}	S_{07}
0.010429	0.042034	0.02756	0.010429	0.005868	0.061641	0.017665
Factors of economic environment						
E_{01}	E_{02}	E_{03}	E_{04}	E_{05}	E_{06}	E_{07}	E_{08}
0.024275	0.024275	0.054804	0.086862	0.086862	0.1293	0.014397	0.191385
Factors of information environment						
I_{01}	I_{02}	I_{03}	I_{04}	I_{05}	I_{06}	I_{07}	I_{08}
0.001656	0.001656	0.003637	0.008511	0.012414	0.003637	0.005654	0.022584
Factors of academic environment						
A_{01}		A_{02}		A_{03}		
0.018226		0.002176		0.010907		
Factors of organization environment						
O_{01}	O_{02}	O_{03}	O_{04}	O_{05}	O_{06}	O_{07}	O_{08}
0.010339	0.044291	0.004954	0.010339	0.002414	0.004931	0.018228	0.025662

The processing of pairwise comparison matrixes made it possible to obtain the following results. The greatest influence is utilized by the group of economic parameters (т 2; 0.612159). In this group, the most significant factor is the factor E_{08} (т3; 0.191385). In the group of social factors, S_{06} (т 3; 0.061641) is the most significant. In the group of organization environment, it is O_{02} (т 3; 0.044291). The factor I_{08} is the most significant in the group of information environment (т 3; 0.022584). In the academic environment group, it is A_{01} (т 3; 0.018226). Moreover, experts proposed the factor S_{06}.

The analysis of results indicated that some factors from different groups and within groups insignificantly differ in their importance. Therefore, this approach does not allow obtaining information about positive or negative influence factors on the balance between labor markets and educational services. It also does not allow considering the mutual influence factors within the group. Authors collected statistical information on selected factors over the past 5-10 years allowing to evaluate short-term development trends. However, there were not considered the cyclic components of these processes.

Let's represent the balance between the labor market and the market of educational services as a simultaneous system:

$$\begin{cases} LM = F(S_{01}, S_{02}, S_{03}, S_{05}, S_{06}, E_{01}, E_{02}, E_{03}, E_{04}, E_{05}, E_{06}, E_{07}, E_{08}, \\ \quad I_{01}, I_{02}, I_{03}, I_{04}, I_{05}, I_{08}, \\ \quad A_{01}, A_{03}, O_{01}, O_{02}, O_{03}, O_{04}, O_{07}) \\ ES = G(S_{01}, S_{02}, S_{03}, S_{04}, S_{05}, S_{07}, E_{01}, E_{02}, E_{03}, E_{07}, \\ \quad I_{01}, I_{02}, I_{03}, I_{04}, I_{05}, I_{06}, I_{07}, I_{08}, \\ \quad A_{01}, A_{02}, A_{03}, O_{01}, O_{02}, O_{03}, O_{04}, O_{05}, O_{06}, O_{07}, O_{08}) \\ LM = ES \end{cases} \quad (1)$$

Where, *LM* is the labor market, *ES* refers to educational services, *F* and *G* are functions of corresponding dependencies.

According to analysis results, it was found that it was necessary to increase the collection of statistical data time to 100 years. Therefore, models were built in general forms without calculating any specific numeric parameters. Corresponding dependencies were obtained on the basis of a qualitative analysis of interrelations between *LM* and *ES*. Corresponding dependencies were obtained from included factors in *LM* and *ES*.

An example of such dependence of *LM* and *ES* from the factor S_{01} is presented below:

$$LM \sim \gamma \log_a(S_{01})$$

$$ES \sim \theta^{\triangle S_{01}} \quad (2)$$

Similar dependencies were found for other factors.

As the result of the system solution (1), the following directions were obtained for the influence of studied factors. The labor market 'improves' with an increase in factor score, so factors that have a 'positive' impact on the labor market are $\{S_{01}, S_{03}, S_{05}, E_{01}, E_{02}, E_{03}, E_{06}, E_{07}, E_{08}, I_{02}, I_{03}, I_{08}, A_{03}, O_{02}, O_{04}, O_{07}\}$. The factors that have a 'negative' impact on the labor market: $\{S_{02}, I_{04}, I_{05}\}$. The factors that have a slight or indirect impact on the labor market: $\{S_{06}, E_{04}, E_{05}, I_{01}, A_{01}, O_{01}, O_{03}\}$. The factors that have a 'positive' impact on the educational services market: $\{S_{02}, E_{01}, E_{02}, E_{03}, I_{08}, A_{01}, A_{03}, O_{01}, O_{02}, O_{03}, O_{04}, O_{07}, O_{08}\}$. The factors that have a 'negative' impact on the educational services market: $\{S_{01}, S_{03}, S_{05}, I_{02}, I_{03}, I_{04}, I_{05}, I_{07}, O_{06}\}$. The factors that have a slight or indirect impact on educational services: $\{S_{04}, S_{07}, E_{07}, I_{06}, A_{02}, O_{05}\}$.

Figure 1 shows these results: The positive influence of the factor is marked by solid heavy line; the negative influence is marked by heavy dash; the influence of the factor is closed to zero is marked by continuous thin line; and the factor that does not exert an impact is marked by thin dash.

Figure-1. Graphical Representation of the Influence of the Factors on LM and ES
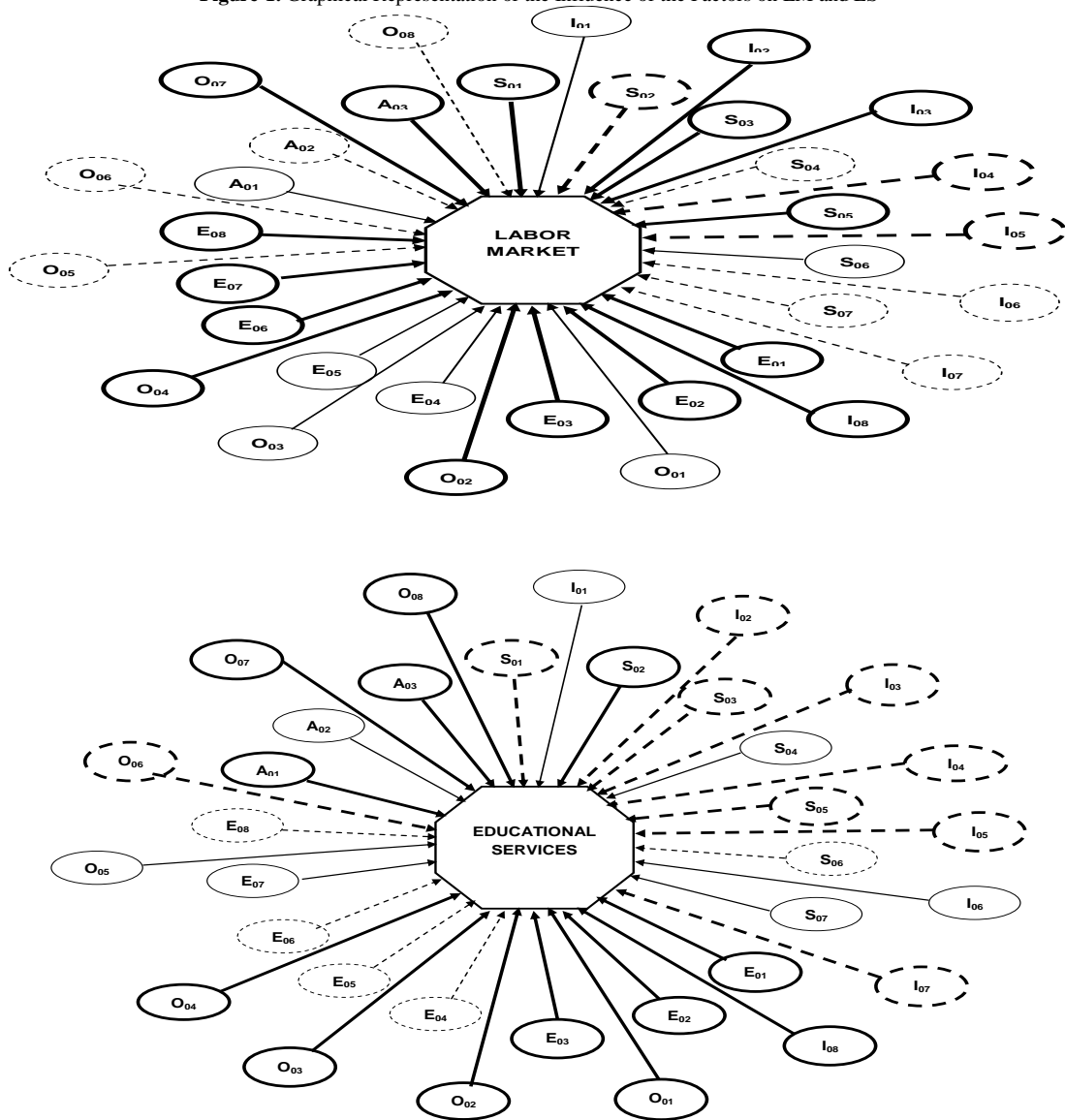
Based on the analysis, there were constructed graphic-analytical models reflecting the interaction of factors inside groups and between groups' factors as a whole. Figure 2 shows an example of a graphical representation of social environment factors in the form of an oriented graph. The oriented graph has eight vertices (corresponding to the number of factors in the group) and the connections between them. In addition, the communication direction indicates the influence of one factor on another.

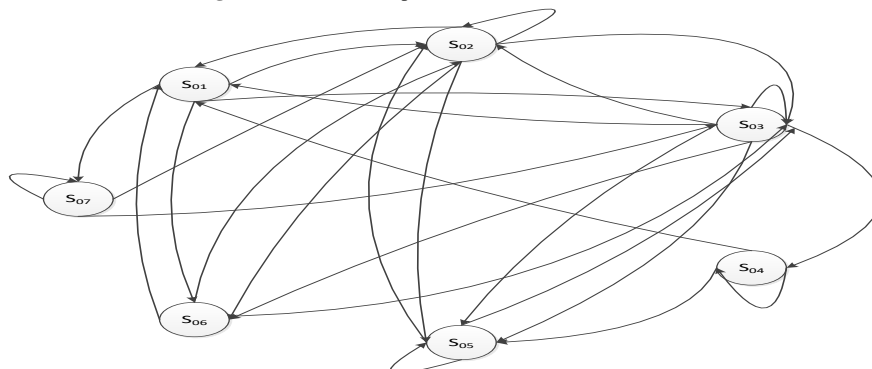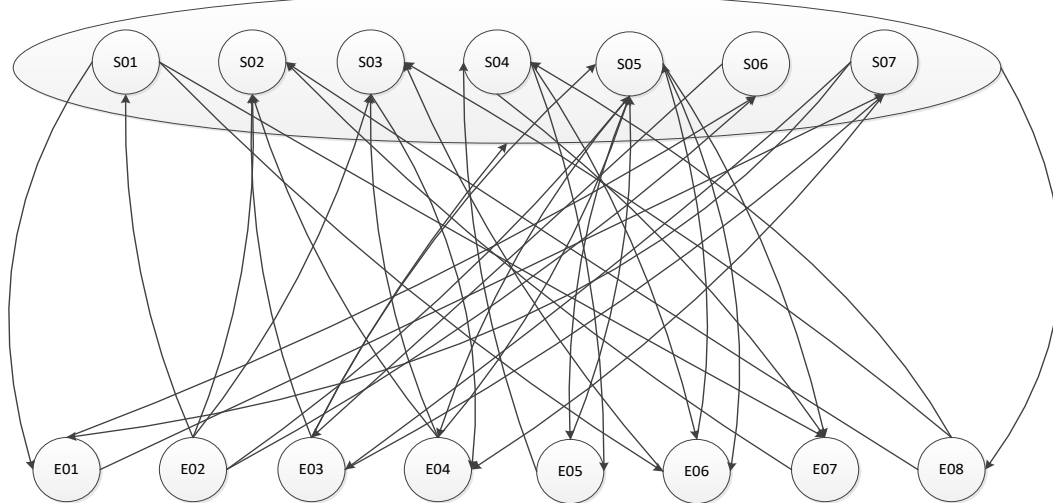**Figure- 2.** Oriented Graph for Social Environment Factors

Figure 3 shows an oriented graph consisting of social and economic environment factors. The gray oval allocation shows that absolutely all factors of the social group have impact on the E_{08} index.

Figure -3. Oriented Graph with Vertices of Social and Economic Environment Factors

The obtained result is the basis for constructing mathematical models reflecting the mutual influence between the factors inside the group and the interaction between the factors of groups. It makes possible to develop optional scenarios for the development of the construction cluster, depending on the control actions. There were identified optimistic, realistic and pessimistic scenarios of development of the construction industry. It was made on the basis of a retrospective analysis, consideration of experts' opinions, peculiarities of foreign and domestic economic policy. Each scenario describes changes in he region from the standpoint of the selected groups of factors. There were filled the tables that consider the influence of factors both within groups and between groups of factors, the importance of this influence on the balance between the labor market and the market of educational services and chances of such impact.

Table 4 presents an example for realistic scenario (most probable) for a group of the social environment factors considering the indicated interference in Figure 2.

Table-4. Results of Averaging of Pairwise Comparison Matrix of Factor Groups

Effective Factors	Influenced Factors	Probability of Influence	Factor Loading/ Significance of Influence	Influence
S_{01}	S_{02}	P=0.2	W=6	Negative
	S_{03}	P=	W=	Necessary additional research
	S_{06}	P=0.09	W=5	Negative
	S_{07}	P=0.06	W=7	Positive
S_{02}	S_{01}	P=0.04	W=3	Positive
	S_{02}	P=0.3	W=2	Cyclically, autoregression of n-th order
	S_{03}	P=0.24	W=8	Negative
	S_{05}	P=0.18	W=7	Positive
	S_{06}	P=0.2	W=9	Positive
S_{03}	S_{01}	P=	W=	slightly affect
	S_{02}	P=0.15	W=7	Negative
	S_{03}	P=0.15	W=4	Cyclically, autoregression of n-th order
	S_{04}	P=	W=	Necessary additional research
	S_{05}	P=0.18	W=6	Negative
	S_{06}	P=0.11	W=4	Necessary additional research
S_{04}	S_{01}	P=0.2	W=1	Positive
	S_{04}	P=	W=	Cyclically, autoregression of n-th order
	S_{05}	P=0.05	W=4	Negative
S_{05}	S_{02}	P=0.19	W=6	Negative
	S_{03}	P=0.23	W=7	Negative
	S_{05}	P=0.25	W=6	Positive
S_{06}	S_{01}	P=0.03	W=1	Positive
	S_{02}	P=0.05	W=3	Negative
	S_{03}	P=0.02	W=4	Negative

S_{07}	S_{02}	P=0.02	W=2	Positive
	S_{03}	P=0.03	W=1	Positive
	S_{07}	P=	W=	Cyclically, autoregression of n-th order

3. Conclusion

The following results were obtained in the present study:

– Factors influencing the imbalance between the labor market and educational services market were identified and systematized by the use of expert assessments; and the importance of groups of factors was determined to achieve balance and factors within the groups.

– On the basis of the construction of system of simultaneous equations, the influence of selected factors was determined by the subsequent graphic interpretation.

– Graphic-analytical models were constructed by the use of graphical relationships analysis. The models reflect the impact and mutual influence of factors on the balance. Three scenarios of the region's social and economic development were constructed in the construction sector. Scenarios were made for each model on basis of the additional research.

The obtained results were bases for supporting planning on the management of balance between the labor market and the market of educational services in the construction sector. In turn, it helped to predict the extent and direction of the influence of factors and develop recommendations and a list of possible measure aimed at reducing or eliminating the imbalance between relevant markets.

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