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DEVELOPMENT OF A MATHEMATICAL MODEL AND SOFTWARE COMPLEX FOR OPTIMIZING EFFECTIVE EMPLOYMENT MANAGEMENT OF UNIVERSITY GRADUATES

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Abstract: The paper proposes a model for managing the distribution of university graduates from the point of view of meeting the demand of the population for educational services and providing the regional economy with specialists with higher education, formalizing the task of employing a university graduate in a specialty, defining the nature of the functional dependence of the university's throughput on the student's professional self-determination, using real data to obtain a system of production rules, which makes it possible to formulate recommendations for adjusting the professional self-determination of prospective employment of future graduates.

Key words: model, optimization, employment of graduates, data mining.

Introduction: Today, one of the serious social problems is the threat of unemployment for young specialists who graduated from universities. Employment of university graduates is not only a problem for graduates, employers, but also a problem for higher educational institutions. Each university is a subject of two markets: the market for educational services and the labor market for specialists, whose work is closely interrelated. Therefore, increasing the guarantee of employment after receiving education is an important competitive advantage of the university in the educational services market [2].

Monitoring of the effectiveness of the activities of universities is determined by the indicator of employment of

graduates [3]. Consider the issues of employment of graduates in a particular university taken. The Tashkent Institute of Architecture and Civil Engineering (TASI) is the largest university in Uzbekistan, an educational, research and cultural center, consistently implementing a multi-level education system.

The results of monitoring according to TASI indicate that according to five criteria the university meets the specified threshold values [4].

In this regard, the search for factors influencing the employment of university graduates and methods for solving the problem are an urgent task for a university.

The main innovation of the monitoring was the calculation of threshold values -

these are the median values of the indicator for a group of universities [6].

In this regard, TASI needs to strengthen its work on the employment of graduates in order to fulfill one of the criteria of the university's activity.

The issues of competitiveness of graduates were investigated by J. Beilerot, I.V. Virina, N.V. Volkova, T.G. Gesuke. S.R. Demidov, M.V. Seibert, O.M. Kirilyuk, N.V. Korneichenko, T.G. Ozernikova, O.V. Saginova, etc.

The analysis of factors affecting the competitiveness of graduates was reflected in the works of N.A. Kontareva, N.Sh. Nikitina, Ya.M. Roshchina, L.G. Milyaeva, Borisova O.V.

S.V. Shishkina and others.

The external model of TASI (Fig. 1) forms the supply of educational services and the offer of graduates for a set of educational programs, therefore, a generalized criterion for the effectiveness of the university's functioning can be formulated: coordination, satisfaction and advanced formation of spatially localized demand for educational services and graduates within the specified institutional constraints and resource provision. [6]

Figure 1. External model of TASI functioning

The internal model of TASI as a controllable system includes the number of students enrolled in each

educational program, the provision of study areas, personnel, documentation, and finance at each moment of time. Controlling influences consist of the choice of educational programs, according to which the training of specialists is carried out, and restrictions - the resources that the institute possesses.

Combining the external and internal models of the university, we get a general model of the university in terms of meeting the demand of the population for educational services and providing the regional economy with specialists in the field of architecture and construction with higher education.

As a result, the defining parameters predicting the functioning of the university are:

- forecast of demand for educational services;
- reception forecast;
- actual reception;
- forecast of demand for graduates;
- release forecast; - actual release.

The general model of the functioning of the university can be simplified as a stream model, where applicants are "given" as input, and graduates are at the output after "transformation".

Let us consider in more detail the input of the institute stream model.

Applicants can be:

- persons wishing to obtain higher education under the bachelor's or specialist's degree programs. They have documents confirming the development of a general education program, as a rule, graduates of schools and colleges;
- persons wishing to obtain higher education in Master's programs. They have diplomas confirming the development of a bachelor's or specialty program, university graduates;
- persons wishing to receive higher education in postgraduate programs. They have diplomas confirming the development of a specialty or master's program, university graduates;
- persons wishing to get a second higher education. They have diplomas confirming the development of a higher education program, university graduates;
- persons wishing to receive additional education (course participants). As a rule, there are no restrictions on the requirement of previous education.

After graduating from the university, possible places of employment for graduates are organizations, enterprises, institutions, continuing education at the next stage of education, serving in the ranks of the army of Uzbekistan.

Let us denote by S the throughput of the university - the number of students studying at TASI at time t for each educational program S_1, S_2, \dots, S_n . According to the external model of the university, there is a demand of the

population for educational services DE for each educational program dE_1, dE_2, \dots, dE_n , a demand for university graduates from the economics of the DL region for each educational program dL_1, dL_2, \dots, dL_n .

The activity of a university is considered successful when the demand for educational services is balanced by the demand for university graduates, i.e. the balance equation is fulfilled [5]:

$$DE = S = DL \quad (1)$$

If the balance equation (1) is not satisfied, then the following cases are possible. With $S > DE$, the capacity of the university is greater than the demand for educational services, which can be predicted based on the data on the students in the schools of the region. Consequently, the university will need to develop activities that are not related to the provision of educational services for school graduates, for example, scientific, or optimize the structure in such a way as to reduce the cost of maintaining the available capacity.

With $S < DE$, the university's throughput is less than the demand for educational services on the part of school graduates. In this case, on the one hand, more gifted applicants will come to the university, but there will be no

satisfied demand from the population, or the university will need to expand its capacity, which is associated with increased costs. In this regard, it will be necessary to assess which of the options

will be most favorable for the development of the institution.

If the balance equation (1) is not fulfilled in terms of meeting the demand for graduates, then for $S > DL$, the throughput of the university is greater than the demand for graduates. Consequently, university graduates join the ranks of the unemployed, are forced to leave the region or take up their own retraining.

With $S > DL$, the throughput of the university is less than the demand for graduates, the regional economy in this case experiences a shortage of personnel, and all university graduates are employed.

With $DE > DL$, the region experiences a shortage of jobs and no educational institution will solve this problem, this is the prerogative of the regional authorities. If $DE < DL$, the university can help the region by increasing information accessibility and inviting applicants from other regions.

The institute cannot influence either the demand from the population or the demand from the economy; the university can only manage its bandwidth. To provide educational services, the university must have the resources and comply with legal requirements. Consequently, resource

constraints $R = (r_1, r_2, \dots, r_m)$, where r_1, r_2, \dots, r_m are specific resources corresponding to the internal model. Also, the throughput depends on the set

of educational programs $O = (O_1, O_2, \dots, O_n)$, where O_1, O_2, \dots, O_n are the corresponding educational programs of the internal model. To fulfill the balance equation (1), it is necessary that the professional self-determination of the graduate coincides with the need of the regional economy for professional personnel.

Professional self-determination is understood as the process of forming a person's attitude to professional activity and the way of its implementation through the coordination of personal and socio-professional needs. Therefore, professional self-determination is a kind of creative process of personality development.

Thus, we can assume that the capacity of the university is dependent on educational programs O , available resources R and professional self-determination P , i.e.

$$S = S(O, R, P). \quad (2)$$

From the point of view of the management of any university, it is important to know the minimum amount of resources required for conducting educational activities, therefore, we introduce an inverse relationship $R(S)$, which characterizes the minimum amount of required resources for a given bandwidth.

The quality of the models was assessed on the basis of contingency matrices, according to which positive outcomes are better classified in all models.

In the course of the research, results were obtained that made it possible to find out what influences the success of graduates' employment and what problems do they face when entering the labor market? The main factors for the successful employment of graduates in 2020. were as follows. In the first place are personal qualities such as communication skills, activity, initiative, learning ability, etc., which were noted by 48.8% of respondents, which is almost 4 times higher than in 2019 (12.3%). In second place is work experience (24.8% of respondents), which is 7.5% higher than the corresponding indicator for 2019 (43.3%). The prestige of the university - the third most important factor in the success of employment was noted by 20.2% of respondents, which is 4.1% higher than in 2019.

(25.5%). Every seventh respondent indicated the influence of personal connections, however, compared to 2019, the significance of this factor decreased by 40.6%. At the same time, successful internship over time guarantees less and less employment opportunities (this was noted by 8.2% of respondents), and since 2010 the significance of this factor has decreased by 40.1%.

The study made it possible to identify the main problems faced by graduates in the process of their employment. The main problem is the lack of work experience, this was indicated in 2020 by more than half of the respondents.

Significant problems are also the low level of the offered salary and the excessive demands of employers to job seekers, as indicated by 20 and 15% of the respondents, respectively. Half of the employed graduates noted that they had no problems with employment and the result of employment depended on their activity.

Currently, universities pay considerable attention to assistance in the employment of graduates. The monitoring showed that throughout the entire study period, the majority of graduates (about 80%) are convinced of the need for such assistance from the university. Even working graduates (80.9%), who do not face the problem of finding a job, actively advocate various forms of assistance in employment from the university. In their opinion, assistance should be provided through providing graduates with internship bases (noted by a fourth of the respondents), organizing internships (one fifth of the respondents), as well as through meetings with employers (noted by a fourth of the respondents). Less significant are areas of employment promotion such as organizing job fairs, compiling vacancy databases and distributing graduates.

Based on the studies carried out, the following conclusions can be drawn. In general, the university is developing a rather favorable situation with the employment of graduates. However, this conclusion does not apply to all

specialties and areas. In some specialties (accounting, analysis and audit, finance and credit), graduates do not experience problems with employment in their specialty, while in others, the opposite is true (regional studies, economics and management at environmental enterprises). The Internet remains the most important job search channel, but graduates are increasingly using informal employment channels (personal connections). Formal channels of employment (contacting the employment service, recruitment agencies, etc.) are less in demand by university graduates, which corresponds to the general trends in finding work by young people in the labor market. The main factors for the successful employment of graduates in the labor market are personal qualities and work experience. For the first time in the entire monitoring period, we state the importance of the prestige of an educational institution as a factor in successful employment in the labor market. An assessment of the directions of the university's assistance in the employment of graduates showed that they give preference to those where they can actively position themselves: to show their knowledge, skills and abilities during practice, internships, and meetings with employers. At the same time, areas such as providing them with a database of vacancies, organizing vacancy fairs, and distributing graduates, which require passive participation, are less important for graduates.

It should be noted that monitoring the employment of graduates is an effective way of organizing feedback with university graduates. The implementation of such studies allows the university to assess the employment of graduates, diagnose emerging problems in time and make decisions to eliminate them. In general, monitoring contributes to more successful employment of graduates and an increase in the efficiency of educational activities of the university.

The research carried out made it possible to form a system of production rules that form the basis of the developed information system, which forms recommendations for adjusting the professional self-determination of prospective employment of future graduates.

The proposed model of the university, from the point of view of meeting the population's demand for educational services and providing the regional economy with specialists with higher education, makes it possible to determine the nature of the functional dependence of the university's throughput on the professional self-determination of the student and contributes to the management of employment of the future graduate of the institute.

Based on the developed mathematical model and algorithms, a software package was compiled in the Visual

Studio programming environment in the language

C ++ programming. The work of the software complex has shown the effectiveness of the used mathematical models of optimization algorithms.

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