The Third International Conference "Problems of Cybernetics and Informatics"
September 6-8, 2010, Baku, Azerbaijan. Section #1 "Information and Communication Technologies"
www.pci2010.science.az/1/23.pdf

FUZZY MULTICRITERION ESTIMATION OF DEMAND FOR IT-SPECIALITIES

Masuma Mammadova[1], Faig Mammadzada[2]

[1]Institute of Information Technology of ANAS, Baku, Azerbaijan
[2]IDRAK LL Company on a Technologies Transfer, Baku, Azerbaijan
[1]*depart15@iit.ab.az*, [2]*c.nicat94@mail.ru*

Dynamics of expansion of ICT sector, state policy and strategic documents in this area, oriented to integration of the country into global information space, Azerbaijan IT-industry growth rates have caused sharply increased demand for IT-experts. According to the results of monitoring of a supply and demand in the market of the IT-experts, carried out by Institute of information technologies, for today the ratio of demand for IT-experts exceeds corresponding offers approximately in 3 times, i.e. IT-experts in the market are required three times more, than train the high schools [1]. Moreover the diversification of Azerbaijan economy stipulates the further expansion and a deepening of IT applicable spheres and enables to assume, that there is no fear of the fall of demand for IT-experts nearest years.

Penetration IT into the diversified spheres of human activity promotes diversification of the IT-segment, that, on the one hand, causes the transformation of old IT-professions, on the other hand, stimulates occurrence in the market the new ones. Such a course of affairs promotes increase of break between system of IT training and a labour market and leads to situation that there is no any high school in the country training number of the new IT-specialities today demanded on a labour market. One more reason of the imbalance of supply and demand in this perspective of specialities and specializations is the orientation of high schools to wide line profiling while on a labour market the experts in narrower subject domains are demanded.

For today the problem of revealing of demands of a labour market from the angle of trades and specialities is the typical problem and so far insufficiently surveyed in many countries, including Azerbaijan. It is precisely this situation that dictate the necessity of revealing of a supply and demand on various trades and specialities, reorientation of an education system to needs of a labour market on a priority basis had supported the development of a number of political documents [2,3,4].

In the present paper within the framework of revealing IT-specialities and their demand on a labour market the method of an estimation of needs for various IT-specialities is offered. It is necessary to indicate, that the problem of a choice of the specialities that are in most demand in the market belongs to a category of weakly structured scheme that traditionally comes to decision-making [5]. For realization of similar problems an essential role plays the opinion of the person who is a decision-maker (DM), and also preferences (experience, knowledge and intuition) experts. Intellectual support of policy of a choice of experts is determined in this case by the concrete leader - DM, the experts are participating in the process of evaluation of alternatives based on attribute data set, decrypting a demand degree of a specialty in the market, and on preference relations for each of them, and the problem of an evaluation of needs for IT-specialties can be reduced to sorting of alternatives at the uncertain initial information.

For a formal assessment and sorting of IT-specialities the method of multicriterion collective decision making that reduces to a rational choice of alternatives based on attribute data set and preferences of experts is proposed.

The method of decision-making subject to attribute data set and preferences of several experts comes to the following.

Let $X=\{x_1, x_2, \dots, x_n\}=\{x_i, i=\overline{1,n}\}$ is a set of alternatives (IT-specialities) among which it is necessary to choose the one; $K=\{k_1, k_2, \dots, k_m\}=\{k_j, j=\overline{1,m}\}$ is a set of attributes (criteria or properties), specific to alternatives. Set of assumed alternatives is represented by two-dimension

matrix, in which the degree of meeting of alternative x_i to criterion k_j is determined by membership function

$$\varphi_{k_j}(x_i): X \times K \rightarrow [0,1] \quad (1)$$

Let's give a method for collective decision making on the basis of fuzzy model.
Let G is the set of experts, and for each $g \in G$ a fuzzy relation of preference on set of alternatives X is defined, in other words, a membership function $\psi: X \times X \times G \rightarrow [0,1]$. Value $\psi(x_i, x_j, g)$ denotes relation of preferences on the set of alternatives, proposed by g- expert. This is understood as a degree of preference of alternative x_j to alternative $x_{j,,}$ proposed by the expert g, $\psi(x_i, x_j, g)$ is reflexive, i.e. $\psi(x_i, x_j, g)=1$ for every $\forall x_i \in X$. Statement $\psi(x_i, x_j, g)=0$, which reflects uncomparaitiveness of alternatives x_i, x_j, between each other, is absent as we presume all alternatives to be compared with each other.

$\psi(x_i, x_j, g)$ is defined as follows:

$$\psi(x_i, x_j, g) = \begin{cases} 1 - \left[\varphi(x_j, g) - \varphi(x_i, g) \right], & \text{if } \varphi(x_j, g) \geq \varphi(x_i, g) \\ 1, & \text{if } \varphi(x_j, g) \leq \varphi(x_i, g) \end{cases} \quad (2)$$

where $\varphi(x_i,g)=\min\{\varphi_{k_j}(x_i,g), j=\overline{1, m}\}$ and meets conditions mentioned above. With this formula for each expert the matrix of fuzzy relation of preferences of alternatives is defined.

On the other hand, experts are not equally competent in given subject domain therefore decision maker are not equally estimates competences of experts invited by him for an assessment of alternatives. This factor is reflected in coefficient of experts competence: $\gamma(g) \rightarrow [0,1]$, with account of which from statement

$$\nu(g_1, g_2) = \begin{cases} 1 - \left[\gamma(g_2) - \gamma(g_1) \right], & \text{if } \gamma(g_2) \geq \gamma(g_1) \\ 1, & \text{if } \gamma(g_2) \leq \gamma(g_1) \end{cases} \quad (3)$$

A fuzzy relation of expert's competence $\nu: G \times G \rightarrow [0,1]$ is defined. Value $\nu(g_1, g_2)$ is understood as a degree from which the expert g_1 is more competent than expert g_2 .

After that, a problem is reduced to a rational choice of alternatives from set X with account of information described above. According to [6], a fuzzy subset of not-dominant alternatives $\psi^{n.d.}(x_i,g)$ is found, witch corresponds to fuzzy relation of preferences $\psi(x_i, x_j, g)$ under fixed $g \in G$:

$$\psi^{n.d..}(x_i, g) = 1 - \sup_{x_j \in X} \left[\psi(x_j, x_i, g) - \psi(x_i, x_j, g) \right]$$

Alternatives that bring possibly greater value to membership function $\psi^{n.d.}(x,g)$ on set X, coincide with the individual decision g- expert.

Further fuzzy relation $\nu(g_1, g_2)$ is generalized in a class of fuzzy subsets of set G. Induced fuzzy relation on set *X* is defined as follows:

$$\eta(x_i, x_j) = \sup_{g1, g2 \in G} \min \{ \psi^{n.d.}(x_i, g_1), \psi^{n.d.}(x_j, g_2), \nu(g_1, g_2) \}.$$

This fuzzy relation of preference is the result of "roll-up" of family of fuzzy relations $\psi(x_i,x_j,g)$ into one resulting fuzzy relation of preferences with account of competence of experts in given subject domain.

Thus, the problem of a choice of alternatives with several relations of preference is reduced to the problem of choice of alternatives with only one relation of preference. For its solution, on

the basis of induced relations of preference on set of alternatives $\eta(x_i,x_j)$ a respective set of not dominant alternatives is defined:

$$\tilde{\eta}^{n.d.}(x_i) = 1 - \sup_{x_j \in X}\left[\eta(x_j, x_i) - \eta(x_i, x_j)\right] \quad (4)$$

Eventually, from statement:

$$\eta^{n.d.}(x_i) = \min\left\{\tilde{\eta}^{n.d.}(x_i), \eta(x_i, x_j)\right\} \quad (5)$$

a corrected fuzzy set of not dominant alternatives is defined, and alternative which gives a maximum value of the function $\eta^{n.d.}(x)$

$$\eta^{n.d.}(x) = \sup_{x_j \in X} \eta(x_i) \quad (6)$$ e

efficient alternative is chosen. The selected alternative is the resulting groups decision for choice and coincides with one of individual decisions.

For practical realization of a problem of an estimation of demand for IT-specialities the list of the specialties developed by workers of Institute of information technologies NASA on the basis of the results monitoring of the IT-segment of a labour market, data about IT-professions and specialities on which training in an education system of Azerbaijan is under way ; the tariff-qualification directory of professions, positions; statistical data of Central administrative board on employment; advertising of vacancies in republican periodicals, application forms of employers provided for filling for vacancies in a web-sites recruiting firms. As a result the list of IT-specialities is combined into 14 integrated groups of IT-specialities

For comparison of IT-specialities (alternatives) it is important to have the reliable criteria of an assessment of them. These criteria, on the one hand, should characterize IT-specialities from the supply and demand relation standpoint in the market, on the other hand, allow their ranging, i.e. sorting in ascending or descending order.

For selection of criteria and rating scales of priorities of IT-specialities the discussions with leading experts of Institute of information technologies National AS Azerbaijan, the Ministry of Education, IT-industry had been carried out, and the list of them was completed. As a criteria, applied for an estimation of IT-specialities, the followings are sorted out:

1. A priority basis of a speciality both in the IT- branch, and in other branches of economy.
2. Opportunities for making a career (promotion perspective) both in IT-branch, and in other branches of economy.
3. Evaluated IT-speciality remuneration.
4. Demand on evaluated IT-specialities from the job placement standpoint.
5. Supply of evaluated IT-specialities from the job placement standpoint.

The criteria estimation scales have various convenient and understandably for experts qualitative gradation and their fuzzy correspondence sorted from best to worst. The expert estimation and logic calculations with application of the offered method to all 14 estimated IT-specialities have enabled to receive following ordering:

1. The Programmer
2. The Programmer-developer (Web, SQL, Java, NET, etc.)
3. The Expert on information security
4. The Expert on information systems
5. The Expert on system administration (system administrator)
6. The Manager of database
7. The communications expert
8. The Manager of information technologies
9. The Manager on sales and marketing of solutions and complex technical systems
10. The IT-researcher
11. The adviser on implementation of IT-solutions
12. The electronic engineer

13. The System analyst
14. The expert on hardware architecture

Approbation of the proposed method was carried out by the comparative analysis of the obtained sorting with trends of professions vacancies on the IT-speciality in mass-media, a web-sites of recruiting firms, employment agencies, and also results of monitoring of the IT-segment of a labour market [1]. The analysis of dynamics of the vacancies demanded in these entities concerning a demand on listed IT-specialties, confirms the obtained sorting with 80-85% coincidence.

References

1. Məmmədova M.H., Cəbrayılova Z.Q., Manaflı M.İ. İnformasiya texnologiyaları mütəxəssislərinə tələbatın monitorinqi. Bakı, 2009, 199 səh.
2. Государственная программа по развитию связи и информационных технологий в Азербайджанской Республике («Электронный Азербайджан») (2003–2008 гг.). – Баку, 21 октября 2005 г.
3. Государственная программа по имплементации стратегии занятости (2007–2010 гг.). – Баку, 15 мая 2007 г.
4. Государственная программа по обучению азербайджанской молодежи за границей (2007–2015 гг.). – Баку, 16 апреля 2007 г.
5. Мамедова М.Г. Принятие решений на основе баз знаний с нечеткой реляционной структурой. – Баку. Элм, 1997. – 296 с.
6. Орловский С.А. Проблемы принятия решений при нечеткой исходной информации. М.: Наука, 1981. – 208 с.