Information support of management decisions in forming study program to meet labor market requirements

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Abstract[1]

The article provides a documentary base that allows us to obtain some knowledge about the labor market requirements so as to take it into account when managing the process of building and educational program for training computer science specialists in a higher education institution. To provide a decision maker with the information support the article gives description of the developed models: functional ones, knowledge representation models which help to develop the DSS.

1. Introduction

In the modern world there appear new approaches to the management of higher education institutions that aim to increase efficiency, agility, the ability to adapt and develop. Universities take great interest in their educational services meeting the labor market requirements to the fullest extent possible. The study programs (SP) have to comply with the profile of preparation which fact creates demand for university graduates in the labor market. The basis of profiling of the SP in its variable part must be determined by the competencies which are reflected in the professional standards.

Many Russian and foreign specialists are involved in developing basic educational programs, among them V.I. Baidenko, E.V. Karavaeva, S.V. Korshunova, V.L.Petrova, N.A. Selezneva, S.A. Semenov, U.G. Tatur as well as K. Alford, C. Carter, D. Ragsdale, E. Ressler, C. Reynolds, B. Lunt.

The requirements for the potential employers need to be generalized, made concrete and clarified depending on the orientation of the program and the state of the regional labor market.

The analysis of the information resources has shown that the knowledge of the labor market requirements may be extracted from text documents.

2. Knowledge extraction by textual methods

Content monitoring of information resources needed to manage the building of the SP has revealed their common features: the heterogeneity and distribution of information resources, large amount of poorly structured information (Fig.1).

Textual methods are suitable for a well-documented subject area. The task of extracting knowledge from the text is set as the task of understanding the meaning of the text. Textual methods contribute to the compilation of the dictionary of the subject area. Preparation for the reading of specific texts is to choose together with the experts a basic list of references, which will gradually introduce the analyst in the subject area. In developing a SP it is recommended to consider the requirements for employers through the analysis of the requirements of professional standards that solve the problem of arranging, organizing and documenting modern description of the requirements of the community of employers to carry out certain professional duties within the framework of certain types of work.

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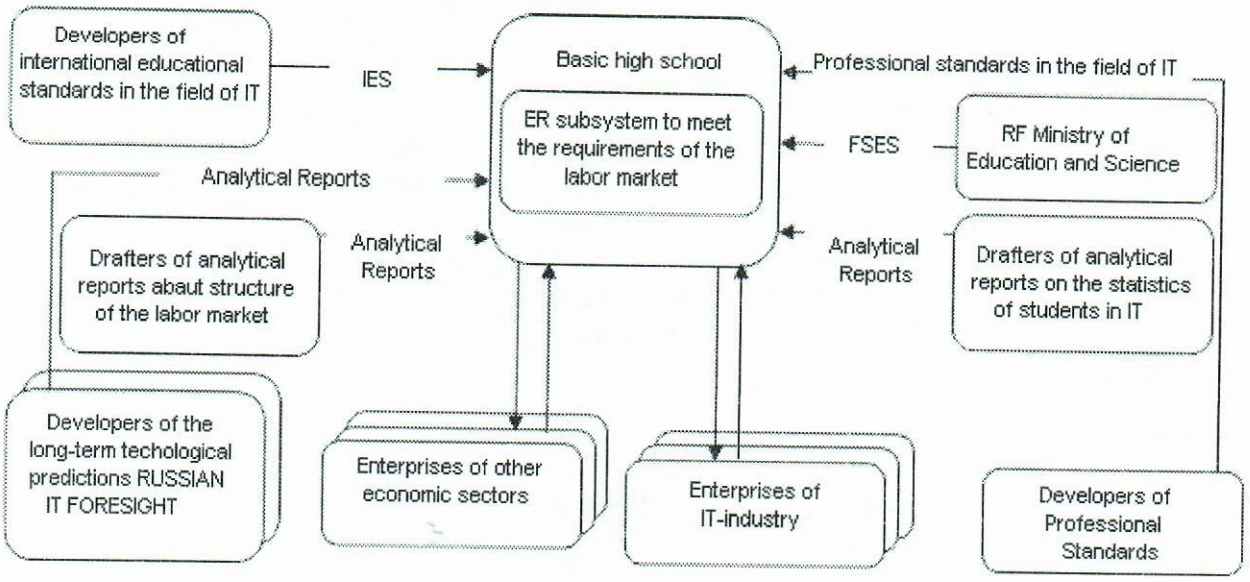

Fig. 1. Information flows when taking account of the requirements of the labor market

In recent years the community of the programmers has worked hard to organize the accumulated knowledge and to find the ways to convert it into the curricula. As a result of these efforts there appeared the projects SWEBOK (Guide to the Software Engineering Body of Knowledge) and IES Computing which includes: Computer Engineering, Computer Science, Information Technology, Software Engineering and Information Systems, etc. [1] [2].

SWEBOK reflects the commonly held view of what software engineer having a bachelor's degree and four years' work experience should know.

SE2004 contains guidelines for making up curricula in software engineering for undergraduate students. SE2004 can be viewed as an educational equivalent of the SWEBOK. SWEBOK describes 10 areas of knowledge[1]: Software requirements; Software design (Architecture); Software construction; Software testing; Software maintenance (support); Software configuration management; Software engineering management; Software engineering process; Software engineering tools and methods; Software quality.

The information gathered through the analysis of the FSES, PS, and IES is presented in the form of text and can be processed with the help of models and methods for intelligent processing.

3. Modeling of the control of the process of forming an educational program to meet the requirements of the labor market

Based on the analysis of the developed at the present time standards (FSES, PS, IES) with the use of the method of extraction and structuring of knowledge there has been built a conceptual model (Fig. 2), including the basic concepts of the subject area and the relationships between the concepts. The model is presented taking into account the hierarchy of the concepts of the given subject area. By complementing the developed model with concepts of the fields of management and decision support you can get a model that will be used as a basis of the control system of the formation of SP. CASE-tools which are used allow to automatize the processes of designing, developing and supporting software applications. The term "structured system analysis" refers to the "method of study that begins with an overview of the system and then details, acquiring a hierarchical structure with many levels." Under the methodology for functional modeling IDEF0 is meant the description technique of the whole system as a set of interdependent actions or functions. The first step in constructing IDEF0 model is to determine the destination of the model - a set of questions that the model must answer. The main issue is to develop an educational program. The next step is to specify the intended target audience for which the model (chair) is built.

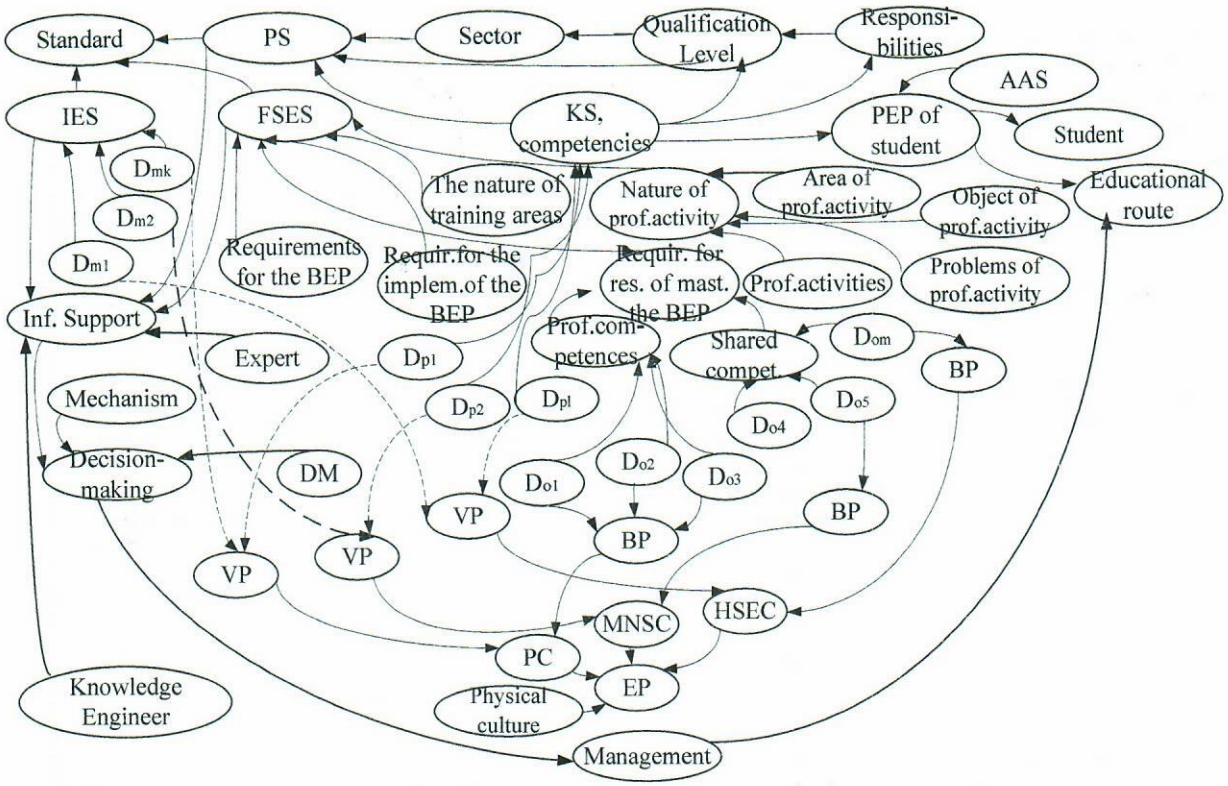

Fig. 2. Conceptual model for managing the formation of an educational program to meet the requirements of the labor market

IDEFO models (Fig. 3) represent the system as a set of hierarchical (nested) functions. Therefore, the function describing the system as a whole is first determined - the contextual function. The contextual function in this case is a decision support function in "Building SP". At the input there is a list of disciplines, taking into account the order of study. As a control act IES, PS, FSES, the criteria for selecting subjects and software. The mechanisms are DSS, expert and decision maker. The result is the study program.

The block "Comparative analysis" examines the selected subjects taking into account the evidence base and the processing of the list of disciplines on the basis of the comparative analysis. The output is a set of disciplines for the basic and variable parts. The first block of decomposition - 'Forming the basic part of the educational program taking into account the FSES and the processing of the list of subjects on the basis of a comparative analysis "- allows the output range of disciplines of the basic part and a new list of disciplines. The second block of decomposition - "Choice of subjects in the light of professional standards and processing of the list of subjects on the basis of a comparative analysis" - gives at the output a set of disciplines of the basic and variable parts and the new list of disciplines.

The third block of decomposition - "Choice of subjects taking into account the IES and the processing of the list of subjects on the basis of a comparative analysis" - gives at the output a set of core disciplines and variable parts to be included in the SP.

In the block "Calculation of complexity" complexity of the chosen subjects is calculated using mathematical software.

The block "Coordination and approval of the SP" means the formal recognition of the developed SP.

Analysis of the professional educational standards for IT-professions shows that in the description of each educational standard for each qualification level (including the level bachelors of Informatics are eligible for) there is a list of knowledge and skills an applicant must possess to hold the appropriate position.

In developing basic educational programs it is necessary to include such disciplines which would allow the student to get the required knowledge, skills and competences. This raises the need to relate the relevant knowledge, skills and competencies with the curriculum subjects. The solution can be obtained through the use of models of knowledge representation in the form of semantic networks (Fig. 4) and rules of inference (Table 1), the

fact tables. The decision also uses the knowledge of the sequence of the study of subjects (Fig. 5).

On the basis of expert opinions there have been defined rules of inference for the selected discipline to be included in the SP.

If the term ti contains a range of attributes, and this term is contained in the professional standard PS and this term is contained in the chosen discipline dk, and the chosen discipline does not belong to the basic part Baz of any cycle, then the discipline dk is included in the educational program EP.

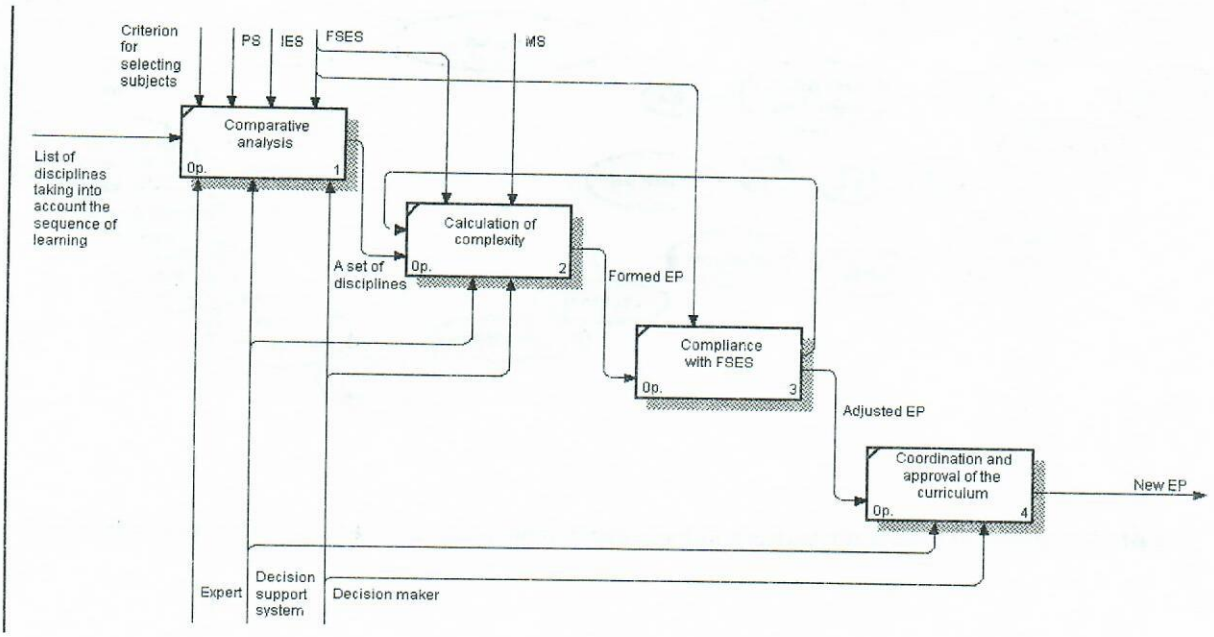

Fig. 3. Functional model of the EP

Table 1

Rules of inference to include the discipline in SP

	general view of rule of inference
Rule i	***If*** *tl= <a11, ..., a1k>, ..., tn= <an1, ..., anm> u tl ∈ PS, ..., tn ∈ PS* *u tl ∈ dk, ..., tn ∈ dk u dk ∉ Baz,* **then** *OP=OP ∪ {dk}*

To assess the similarities when comparing objects by attributes there is used a binary similarity measure proposed by Paul Jaccard in 1901. This is the first known factor of similarity and has the form:

$$C(S_j, S_k)_I = \frac{m(S_j \cap S_k)}{m(S_j \cup Sk)}.$$

In terms of set theory:

$$S = \{S_j \mid j \in J\}, J = \{j \mid j - целое\_число, j = \overline{1,2}\}$$

$$S_j = \{x_{ij} \mid i = I, j = J\}$$

$$Z = \{Z_i \mid i \in I\}, I = \{i \mid i - целое\_число, 1 \le i \le p\},$$

$$Z_i = \{x_{ij} \mid i \in I, j \in J\}, x_{ij} \in \{0,1\},$$

where S - an indexed set with elements Si (description alphabet), Sj – j-oe object description; Z - indexed set with elements Zi (the alphabet of signs or their values); Zi - i- th attribute (its value); Xij - one of the two values $\{0,1\}$ of i-th attribute of j-th object (xij = 1 if the j-th object has i-th attribute, otherwise xij = 0); I and J - index sets.

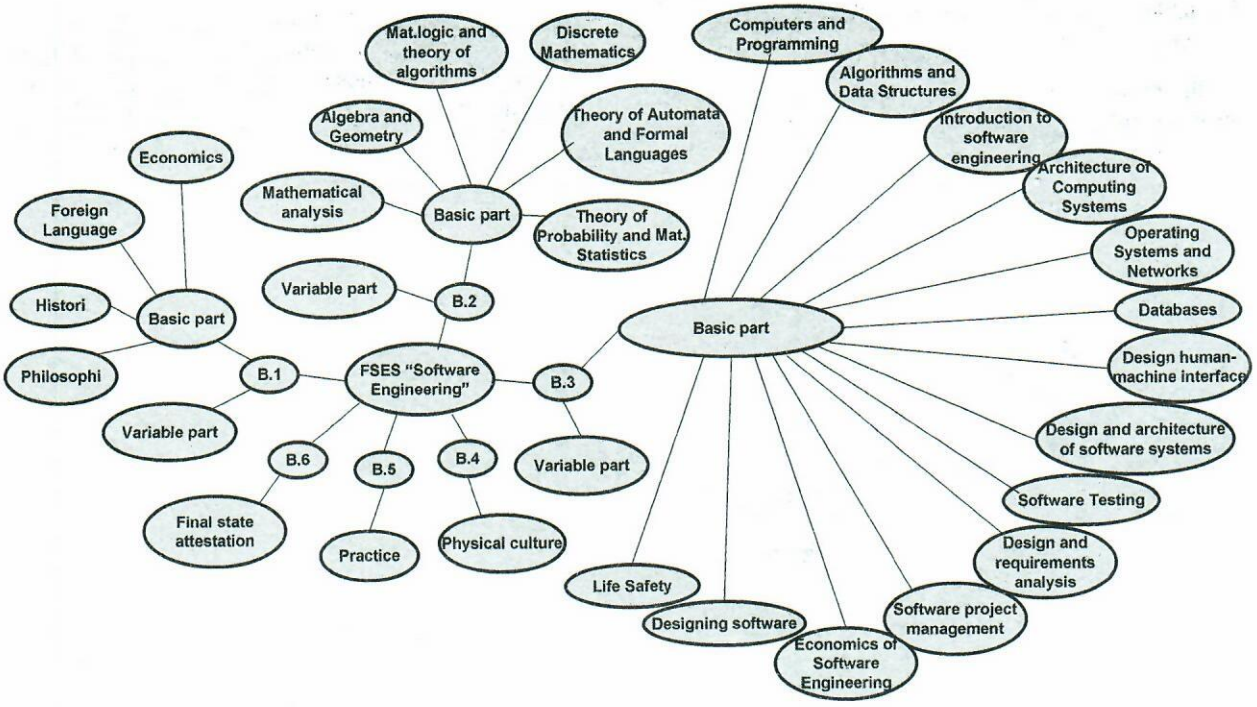

Fig. 4. A fragment of a semantic network of basic educational program of FSES "Software Engineering"

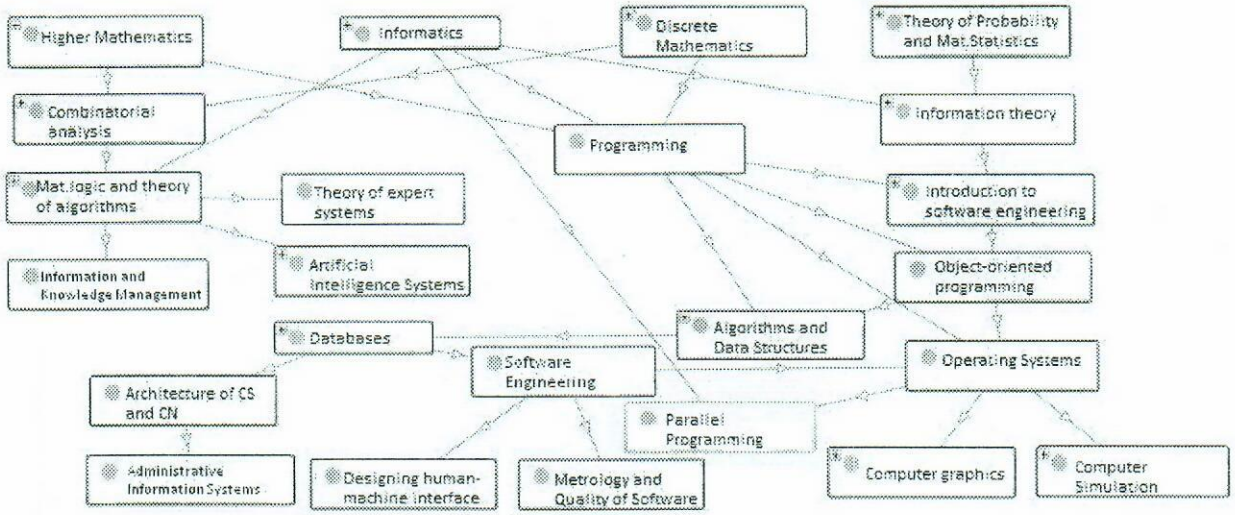

Fig. 5. A fragment of semantic network "Sequence of learning disciplines"

The binary matrix to calculate the measure of similarity between the two objects is as follows:

$$B = \left\| x_{ij} \right\| \begin{matrix} j = \overline{1,2} \\ i = \overline{1,p} \end{matrix}.$$

The proposed DSS is supposed to use an expert analysis for decision making. The educational program EP is formed with a view to the objectives C and constraints Q:

$$B = \left\| x_{ij} \right\| \begin{matrix} j = \overline{1,2} \\ i = \overline{1,p} \end{matrix}.$$

$OP^* = OP \otimes C \otimes Q$; in turn the purpose is formed to meet the requirements of T (consumers of educational services) $C^* = C \otimes T$. Requirements $T^* = T \otimes I$

are formed on the basis of knowledge derived from professional standards. A generalized criterion is as follows:

$(I \cap OP) \otimes O$, where O – the limitations imposed by FSES. Taking into account the criteria $q=(q1, q2, \ldots, qn)$ there is formed a set of alternatives Y and is selected the final decision Y^* as $extremum$ $(\beta 1, \beta 2, \ldots, \beta n)$, where βi – coefficient of importance of i-solution:

$$Y^* = \varphi(q_1, q_2, \ldots, q_n) = \sum_{i=1}^{n} \beta_i q_i .$$

при этом

$$\beta_{ij} = \frac{C_{ij}}{\sum_{i=1}^{n} C_{ij}}; \beta_i = \sum_{j=1}^{m} g_j \beta_{ij}; \sum_{j=1}^{n} g_j = 1,$$

where Cij – expert assessment j of the relative value of criterion i (the method of successive preference), gj - the competence of the expert, m - number of experts.

3. Conclusion

Functional models are developed in the view of the concepts of functional modeling methodology, based on the analysis of information resources, tasks and process control features of the formation of SP are the basis for the development of DSS. Integrated representation of knowledge in managing the process of formation of SP to meet the requirements of the labor market is ensured by the use of the models of knowledge representation in the form of semantic networks, inference rules and the fact tables. The basic functional element of the semantic network is the structure presented by the components of the vertices (objects (concepts) of the subject area) and arcs (relationships between them). Semantic networks provide for such categories of vertices: concepts, characteristics, values.

To make decisions with intelligent technologies we have proposed to use the rules of inference. The fact tables are the basis of the rules of inference.

Search for solutions in forming SP to meet the requirements of the labor market consists in selecting one of the possible alternatives, obtained by evaluating the similarity of the knowledge, skills, experience, competences, instances of classes of disciplines selected for inclusion in the SP and the knowledge, skills, competencies specified in the requirements for the PS. Thus, it is necessary to solve the problem of matching the objects based on the Jaccard similarity measure.

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