BASIS AND MODELS FOR INTELLIGENT DECISION-MAKING SUPPORT FOR ADMISSION TO THE UNIVERSITY

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Abstract. In paper is shown that methods traditionally used for decision-making in technical systems, and in particular in strategic management of complex dynamic objects, can also be applied to decision support in solving the problem of choosing a university career while entering university. Thus, the main aim of the work was to develop a DSS for determining preferable university career and to develop a knowledge base to support decision making process in admission to the University of Alicante.The basis of the proposed methodology for the construction of the DSS is ontological analysis and design of knowledge base for the decision support process.

Key words: future profession; university field of study; decision support system; Holland's method; academic performance; choosing a career.

INTRODUCTION

Recently, the acceleration of STP has made it increasingly urgent for any university entrant to choose the right course of study that will maximize his or her potential. This process turns into a multi-criteria task under uncertainty for the applicant. Therefore, in this paper the authors propose the development of an DSS to help an applicant with his/her career choice.

RELEVANCE OF THE CHOSEN ISSUE

Currently, we are dealing with the great number of problems of young people who are "lost" in the face of making decisions about their future profession. Topical nature of this issue particularly in Spain appears striking because of this country invests in education more than the average of OECD countries. Each student costs the government 9000 euros per year, into account while more than one third of students will be dismissed during the course. The high dropout rate and the high total duration of studies among undergraduate students represent a growing challenge to modern society. The adequate preparation of young people has become very important in the modern conditions of rapidly changing social, economic and family paradigms. The technological advances that have taken place in recent years make us more and more dependent on highly sophisticated devices and we become the peripherals of the machines, distorting our role as creative and conscious beings. Therefore at the same time the level of frustration, anger and restlessness, as well as

other negative feelings expand, leaving generations lost and misguided. The gap between the knowledge given by the educational institutions and the requirements of the labour market and society is increasing.

All mentioned above proves that the current solutions based on the accepted and recognized theories of professional consultants do not lead us in the desired direction, but rather increase the insecurity and uncertainty in success for young people especially in the times of COVID-19 by taking away their desire and motivation for self-development and as a consequence it slows down the global development of humanity by functioning as a time bomb that will explode. The investigation is dedicated to the search for method and scientific analysis of appropriate personal identification support systems so that people will apply the personalized information to make the accurate personal decisions to expose their potential and succeed in their lives without becoming dependent on the patterns and limitations instilled by the old frames of patronage and generalized education without taking into account how different each person is.

HOLLAND'S TYPOLOGY MODEL

It cannot be denied that personality predetermines one's perception of information, ways of thinking and attitude towards the world around us. Differences between individuals are largely determined by differences in their personality. A practical model that captures and determines these differences and is used in this paper is the Holland's Model. Holland's Typological Model [2] is a proposed model of personality that arises from the intention to generate an explanatory theory regarding the choice of a professional occupation, which we could call vocational theory [4]. John Holland's Theory of Career Choice (RIASEC) is centered on the notion that people tend to find comfortable environment for their job activities and tend to choose certain tasks for which they have a disposition. According to research made by this author, we tend to find people of thy same type and want to find a high level of congruence between our personality and the type of task we perform. The information obtained for the purposes of

our investigation from the University of Alicante was referred to the students having been entered to the different university's programs in 2017–2020 and included their entrance marks. Moreover, was used the data of 50 students who choose the TADE pathway at the University of Alicante and have answered Holland's inquiries. In carrying out this study, we interviewed students using the survey shown in Fig. 1. The aim was to examine the results of these university students in their first year according to their degree, grades and access routes, as well as their age and gender. With these data, data from two different variants were compared to give us a picture of exactly what information is used to choose a university career and university success.

Fig. 1. Sample survey

According to Holland, a person's choice of career path is determined by elements of the personality and it comes from these choices that harmony and a sense of job satisfaction are born. Holland developed a hexagonal model containing six basic personality types [3]. None of the suggested types is 'pure', each person carries a different set of qualities, so we can talk

about mixed and borderline types. In this case, a dominant personality type is singled out to facilitate professional choice.

The types suggested by Holland are as follows. The type of tasks in which this type of personality tends to be found are all those that involve direct contact with other people with the aim to teach, help and inform. Psychologists, doctors, nurses, teachers or social workers usually have characteristics of this personality type.

REALISTIC

The person with the realistic pattern assess the world around objectively, they percept it as it comes to them. Tend to be pragmatic, realistic, patient and constant. It's not the asocial type, however socializing is not their priority.

This type of personality tends to feel more at ease in direct work, using and operating tools and equipment. The most favorable fields for this type would be agriculture and animal breeding, architecture or engineering.

INVESTIGATIVE

This personality type is prone to analysis and theory building, has an abstract mind and is endowed with a curiosity in discovering relationships between different phenomena. They are not particularly sociable and tend to have a rather theoretical approach to the world.

This personality corresponds to tasks mainly based on research. Physics, chemistry, economics or biology are some of the fields in which this type of personality is most often observed.

ARTISTIC

The artistic type is distinguished by a pronounced tendency to self-expression through various artistic and psychological means. Extremely high impulsivity, emotionality and intuitiveness make this type an in dependent individuals. Aesthetics and the ability to create are their main drivers. Actors. dancers, musicians, illustrators, photographers, writers are some of the professionals who tend to have this type of personality.

SOCIAL

The greatest value for the social personality type is interaction in society. They tend to be very empathetic and have a certain facility or taste for relationships and cooperation.

ENTERPRISING

The entrepreneurial personality type reveals a propensity for leadership, influencing and encouraging people, along with a strong ambition to achieve their goals. Not infrequently have an extrovert disposition and are also capable of taking risks.

Professions in which this type of person is prevalent are banking and business.

CONVENTIONAL

The Conventional type has an extremely high appreciation of order, without the urge to change it. They show themselves to be highly organized, disciplined, efficient and conformist. They tend to be agile and logical. Within this type of personality we find people with a vocation for aspects such as accounting, office work, secretarial work, and librarians. Holland's typological model, despite having limitations and having been criticized for numerous reasons (for example, it does not allow predicting whether within the same type of occupational environment one job or another may be more recommendable and it is also worth noting that there will be people whose characteristics overlap with more than one of the types), continues to be one of the most relevant models in career guidance today [4]. The Holland test results of 50 first-year TADE students allowed us to determine their profiles according to Holland's method. Fig. 2 presents an example of the test results of two respondents: number 38 with Entrepreneurial profile and number 20 with Conventional profile. To solve the research task and test the hypothesis about the correspondence of Holland's profiles with learning outcomes, we will use the information about the dominant profile. In the future it is proposed to use the triplets of values to clarify the learner profile.
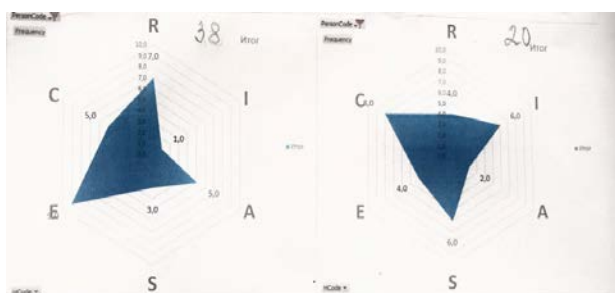
Fig. 2. Two examples of test results

The Holland Method applied in this study allows to manage the process of choosing a field of study in order to identify the direction of success in a student's professional life.

SETTING UP A PROBLEM OF OPTIMAL SOLUTION SEARCHING

The Holland profile is proposed to be the key to classification and will allow us to determine the career of study and then the speciality within the career Choosing and development of methods and models took place into the context of research on "Methods and models for intelligent decision-making support in the management of software projects implemented in a production enterprise environment" under grant no. 19-08-00937.

To determine multi-criterial type of decision-making on the alternative under study, should be considered the meanings of the concepts: optimal, effective and rational decision.

In solving the problem of choosing a university degree, the main objective is to obtain the best solution, which means effective or near-optimal.

By making the best decision, we refer to the choice of that alternative among the possible ones, in which, taking into account the various conflicting criteria and requirements, the total value will be determined. All in all, it will maximize the achievement of the goal.

The multi-criteria problem is defined as follows:

$$X = \{x_1, x_2, ..., x_n\} = \{x_i, i = \overline{1, n}\}, \quad (1)$$

where X – multitude of alternatives (solutions)-alternatives, which adds difficulties in determining the values for each criterion and in determining the values for each criterion and in

choosing the best solution. The multitude of degrees offered by the University of Alicante to applicants (49 university degrees).

$$F = \{f_1, f_2, ..., f_m\} = \{f_j, j = \overline{1, m}\}, \quad (2)$$

where F – multitud of criteria that characterize the alternatives.

Here is solving a multi-criteria problem, where the relationship between multitud of alternatives X and multitud of deterministic outcomes Y, i.e. there is a single representation $X \xrightarrow{\varphi} Y,$ the function is performed $y = \varphi(x), x \in X, y \in Y$ and a set of criteria indicators. $f_j : Y \to R$, $j = 1, 2, ..., m$ (R is the set of real numbers).

Type of multi-criteria optimisation problem [6]:

$$f_j(x) \to \max_{x \in D}, f_j : D \to R, j = 1, ..., m; D \subseteq R^n, \quad (3)$$

Therefore, since given m functions or functionals f_i representing the joint D n dimensional vectors $x = (x_1, ..., x_n)$ in the range of real numbers.

Hence, it is assumed that all alternatives are parameterized and each of the solutions corresponds to a point $x \in R^n$. A set of X is called the set of admissible values and is designated by D i.e. selection of optimal values X is not performed in the whole n-dimensional space, but within a certain subset D, which in this study will be determined by the Holland method.

The following features should be kept in mind when solving the problem in question:

– the multi-level of the system of private (local) criteria and their mismatch (the criteria make different contributions to the overall assessment of the alternative);

– the need to take into account simultaneously quantitative and qualitatively specified criteria for evaluating alternatives;

– the need to ensure that expert opinions are agreed upon;

– multiple choice process;

– compatibility of objective and subjective characteristics of the problem's elements.

In addition to the previous factors, the object under study has a large number of alternatives, which adds difficulties in determining the values for each criterion and in choosing the best solution.

Since the object under study is mainly of a social nature, the major difficulty is the stage of information extraction and formalization and the process of processing information about alternatives, criteria and preference systems. The information retrieval procedure is mainly planned is proposed to be carried out based on the experience, knowledge and heuristic techniques of experts in the studied subject area.

METHODOLOGY FOR DEVELOPING A DSS OF CAREER CHOICE

Based on the chosen focus, a methodology for developing algorithms for decision support based on knowledge engineering is proposed, involving the creation of a topic domain ontology. The technology is presented step by step in Fig. 3.

Identification of the problem area is a universal stage in the development of any decision-making system [5]. At this stage, the tasks to be solved with the help of the decision support system are determined, its main functions are determined and the outline of the future system is described. As a result of this stage, a specification of the system is elaborated, a team of developers, a team of experts (specialists in the thematic area), with whom the knowledge engineer will interact, is determined. In addition, documentation is collected for further formalization in BPMN stage analysis and modeling of the subject area. BPMN analysis and modeling is carried out using Bizagi and involves the construction of a complex of BPMN models [1]. The result of this stage is the BPMN model of the management process and knowledge representation in the decision support system.

The next step constitutes the ontological analysis of the decision support process, in which procedure the selection and systematization of factors affecting the

establishing of classes and relations is carried out; structuring (definition of input, intermediate and output variables for the hierarchical structure of the knowledge base), construction of a logical ontology model according to a specific structure. The basis of the ontological analysis is the concept structure. DSS developed in the form of BPMN diagrams. In order to clarify and develop the ontological analysis, a complex method of concept extraction is proposed. This method integrates the analysis of a complex of structural models taking into account the knowledge and experience of experts and an automated linguistic analysis of texts.

The methods of extraction of concepts from entities and relations between them are proposed to be examined. The main ones are highlighted:

– extraction of concepts and relations and their interpretation from graphical hierarchies;

– extraction of relations between entities from inductive logic;

– concepts are taken from the glossary of the BPMN model and can be specified manually;

– automatic selection of terms and relations from linguistic properties of nouns and inheritance hierarchy;

– clustering by matching concepts describing entities, heuristic rules from linguistic dependency relation, general association rules from machine learning.

In the knowledge base development stage, the definition of decision support system rules is carried out to improve the adequacy of the ontological model formed with experts. Consequently, this stage involves the formation and preparation of the required set of data and knowledge. The division of the ontological model into classes according to the hierarchy of the BPMN model is proposed. Implementation of the decision support system involves writing program code for DSS components, as well as physical filling of the knowledge base in the selected environment as a software robot (chat bot). The last step is to evaluate the effectiveness of the decision support system.
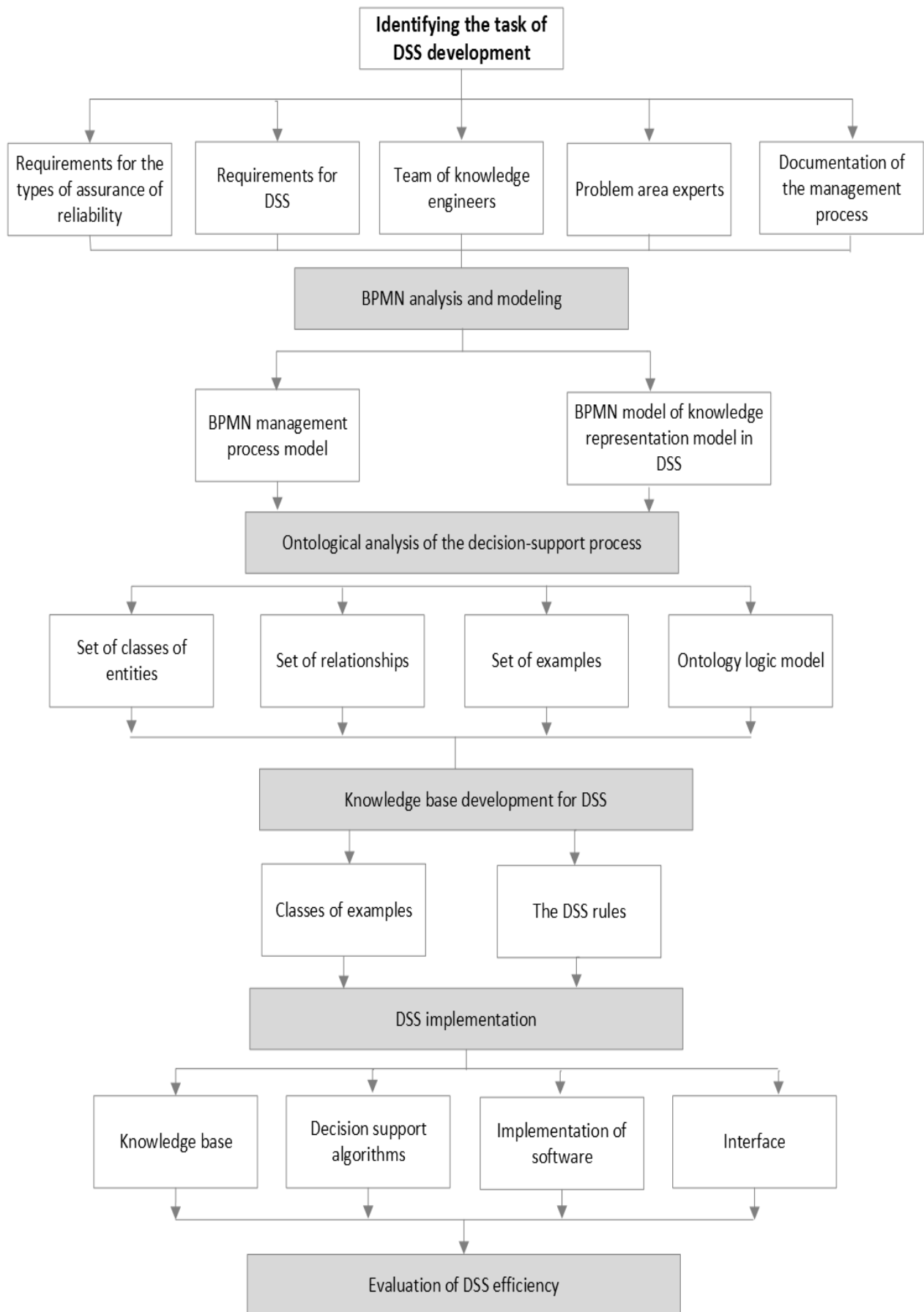
Fig. 3. Diagram of the stages of the methodology

DEVELOPING A DSS KNOWLEDGE BAS

The proposed methodology allows developing a decision support system based on knowledge engineering, where knowledge consistency problems will be solved at the modeling stage.

THE MODULAR STRUCTURE OF THE KNOWLEDGE BASE

The developing DSS consists of a large number of rules describing the decision-making processes for choosing the best university career. The knowledge base, which contains hundreds of rules for decision making, is difficult to perceive, edit and use, the conclusion of such a knowledge base in the presence of a large number of rules becomes very long.

As a solution to the problem identified, it is proposed to build the knowledge base of the expert system in a modular way [5] so that the de-composition of the knowledge base into modules is performed in accordance with the hierarchy of decision-making processes established in the BPMN-model.

The construction of a process model allows us to highlight the processes of making decisions about "entering" the cluster and making decisions about the best choice for the selection of DSS modules (Fig. 4).

The advantages of the modular principle of building a knowledge base are the following:

– the modules provide means and methods for storing the knowledge base in separately stored files and the use of these files by various applications;

– the inference mechanism takes into account the division into KB modules during the operation to decision making;

– modules can be selectively activated and deactivated, which makes it possible to exclude inactive module rules from consideration.
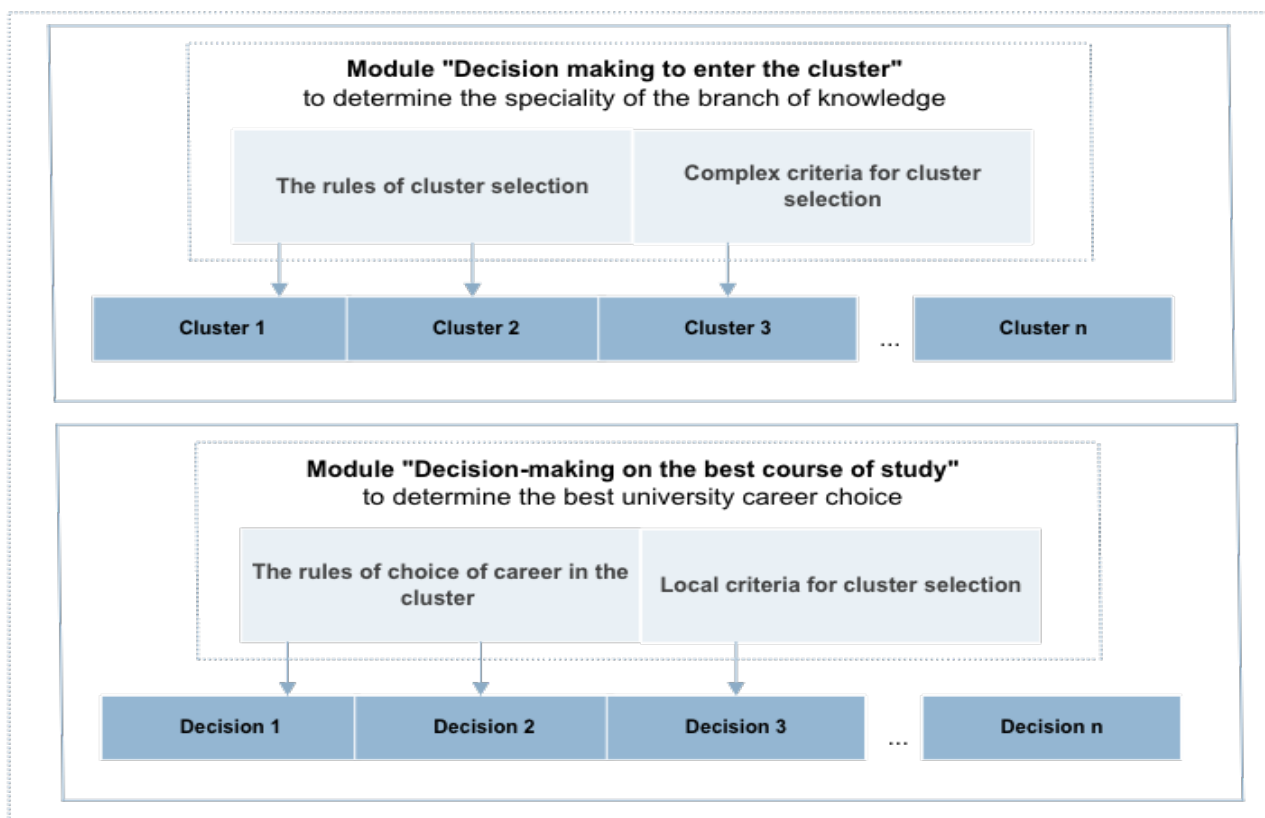

Fig. 4. Modular principle of DSS knowledge base construction

KB modules can be organized in a hierarchy, i.e. a module can be a higher level module or a sub-module associated with a separate object. The nesting level of the modules is equal to the nesting level of the decision-making model of the process, on the basis of which the modules of the knowledge base are built.

In addition knowledge base is also convenient in the process of use, as it improves the performance of the inference engine.

In the suggested DSS, the whole set of knowledge is assumed to be stored in the form of a tree structure: "graph Y-O (AND-OR)" and should be a hierarchical decision tree in the form of an oriented ontograph without feedback. Based on the identified factors and their clustering into a modular structure, the DSS is constructed. The basis of the KB of the decision support system in the critical situation of life path choice will be the developed and constantly analyzed ontology of this system.

CONCLUSION

The paper proposes a methodology for developing a DSS for the career choice and also proposes a Holland personality questionnaire to determine the applicant's psychological profile and consequently their preferences for choosing a major when entering higher education.

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МЕТАДАННЫЕ

Аннотация. Показано, что методы, традиционно используемые для принятия решений в технических системах, и в частности в стратегическом управлении сложными динамическими объектами, также могут быть применены для поддержки принятия решений при решении

проблемы выбора университетской карьеры при поступлении в университет. Таким образом, основная цель работы заключалась в разработке DSS для определения предпочтительной университетской карьеры и развитии базы знаний для поддержки процесса принятия решений при поступлении в Университет Аликанте. Основой предлагаемой методологии построения DSS является онтологический анализ и проектирование базы знаний для процесса поддержки принятия решений.

Ключевые слова: будущая профессия; университетская область обучения; система поддержки принятия решений; метод Голландии; академическая успеваемость; выбор карьеры.

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