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INFORMATION TECHNOLOGY OF PERSONALIZED CHOICE OF PROFESSION IN SMART CITIES

Abstract. The information technologies help solve the most difficult problems, qualitatively change the provided educational services and create conditions for comfortable living and development for each inhabitant in particular, and the city's community as a whole. In the context of the implementation of these projects, the procedures for the selection and acquisition of a profession are important, taking into account the personal characteristics of applicants and the needs of the city's community. The decision-making process for choosing a future specialty starts even while studying at school, and is actualized during the selection of external independent evaluation subjects. Another important step in this chain is the choice of an educational institution for further education and specialization. The paper proposes an information technology of personalized choice of profession in accordance with the needs of a person and the requirements of the labor market in a smart city, which is presented in the form of five consecutive functional stages: determination of professional inclinations and abilities; monitoring of the urban labor market; a choice of the future profession; a choice of educational institution; formation of an individual learning trajectory. The models and methods of information technology support of personalized choice of a profession are described, in particular: model of data analysis for determination of professional inclinations and abilities of a person on the basis of the results of vocational guidance tests have been developed, which made it possible to optimize the process of determining the professional peculiarities of a person; the methods of monitoring the labor market of the city; using the methodology of constructing data hypercube, the method of analysis of educational activity in educational institutions in the city acquires the further development. The main characteristics of the developed one-page information technology web application are presented which combines all stages of training specialists in a holistic system taking into account the needs of a person and the requirements of the labor market in a large city.

Keywords: information technology; profession choice; professional orientation tests; single-page application.

1. INTRODUCTION

One of the most characteristic visions of the «city» concept in recent years is more increasing use of the concept of a smart city as a modern model of urban transformation, in which the most complex problems are solved on the basis of modern information technology. Implementation of the concept of a smart city implies modernization of the city infrastructure with fundamentally new centralized management capabilities, high levels of services and security [1].

A new transformational paradigm has emerged, which IBM experts call the "educational continuum", which includes: life-long learning technologies, data analysis on educational and institutional data and relevant indicators of the educational process efficiency (serving as the basic improvement of human resource allocation, the creation of training programs, etc.), personalized training trajectories that take into account individual learning opportunities, use of competencies acquired for development of the economy and the growth of the city as a whole [2]-[4].

General statement of the problem. Modern conditions for the functioning of the labor market and educational services of a city require the active use of the latest information and intellectual technologies for the professional orientation of the youth, the choice of the training direction and educational institutions that would take into account not only the possibilities of an educational institution, but also the subjective factors of the seeker, such as motivation, tendency to a certain type of activity, training level, etc.

Information systems that are used today in consulting systems are not sufficiently effective. In particular, there is practically no possibility in one information point to analyze data about a person as an object of vocational and educational work and to obtain comprehensive information and analytical data of the regional labor market and educational services. Information is mainly provided without proper authentication and structuring.

There is a certain disparity between the needs of users and the suggestions of well-known career choice systems. Comparative functional analysis of existing foreign and domestic online resources is given in Table 1 with the key parameters:

P_1 – definition of professional inclinations and abilities of a person;

P_2 – informing the searcher about the profession and its characteristics;

P_3 – informing about the market of educational services;

P_4 – analysis of the activity of the city's educational institutions;

P_5 – recommendations regarding the choice of the educational institution;

P_6 – formation of an individual academic trajectory.

Table 1.

Online resources of professional orientation

Name	Functional characteristics						Web address
	P_1	P_2	P_3	P_4	P_5	P_6	
SC Accelerate	-	+	+	+	+	-	*http://scaccelerate.com/*
Hobsons	+	+	-	+	+	+/-	*https://www.hobsons.com/*
What Career is Right for me	+	+	+	+	+/-	-	*https://www.whatcareerisrightforme.com/*
American Job Center Network	+/-	+	+	+/-	+/-	-	*https://www.onetonline.org/*
EktishafProgramme	+	+	+/-	+	+	+/-	*http://www.iktshaf.com/index.php*

Career Choice GPS	+	+	+/-	+	+	+/-	https://www.careerchoicegps.com
The Good Universities Guide	+	+	+	+	+/-	+/-	https://www.gooduniversities guide.com.au/
Mapa karier	-	+	+	+	-	-	https://mapakarier.org/
Praca.gov.pl	+/-	+	+/-	+	-	-	http:/www.praca.gov.pl
Infopraca	+	+	+	+	+/-	+/-	http://kariera.infopraca.pl/wzoryc v/
Postupi online	+	+	+	+/-	+/-	+/-	https://postupi.online/
Smartia	+	+	-	-	+/-	-	https://smartia.me/
Moe obrazovanie	+	+	+	-	+/-	+/-	https://moeobrazovanie.ru/
Kariera	+	+/-	+/-	+	-	-	http://kariera.in.ua/
Education.ua	-	+	+	-	-	+/-	https://www.education.ua
My career	+	+/-	+/-	+	-	-	http://mycareer.org.ua/job-choice

As a result of the analysis, it was concluded that the well-known information technologies and Internet resources have a specialized profile and are focused only on solving the problems that arise in the process of choosing a professional orientation.

Analysis of recent researches and publications. The problems of choosing a future profession, professional self-determination and becoming a specialist are described in the works by Thomas Buser, Noemi Peter, and Stefan C. Wolter [5], Nadya A. Fouad [6], Laura Nota, Sara Santilli, and Salvatore Soresi [7], Charles Eesley, and Yanbo Wang [8], Frans Meijers [9], van Aalderen-Smeets, Sandra I., and Juliette H. Walma van der Molen [10], Ian Mann [11], Andrea Ceschi [12], van der Gaag, Mandy A.E., and Pieter van den Berg [13], etc.

The researchers reasonably argue that the right choice of a profession affects the success and productivity of professional activity in the future, the realization of personal potentials and, as a result, the person's satisfaction with their life. A number of researchers are proposing to use information technologies and information systems to accompany the processes of choosing a profession, in particular, by residents in smart cities. At the same time, existing profile information systems in this regard are not sufficiently effective yet.

The article's goal is to describe the development of information technology of personalized choice of profession in the educational social and communication environment of a smart city, which would combine the stages of specialist training based on the needs of an individual, economic and social development, the requirements of the labor market in the city, community or region and the systematic aspirations of the appropriate communities.

2. RESEARCH METHODS

The process of choosing a profession in accordance with the needs of the individual and the requirements of the city's labor market is a complex, multi-step, iterative process that requires consideration of a large number of parameters and prerequisites, and we present it as five consecutive functional stages (Fig. 1).

Stage 1. The determination of professional inclinations and abilities is based on the analysis of the accumulated results of professional orientation tests that help to identify the interests, professional inclinations and abilities of a person for a certain field of activity and allow you to choose a field of professional activity.

Stage 2. There is labor market monitoring in order to identify the trends of changes in the factors affecting the supply and demand of labor force in the city.

Stage 3. Choice of a future profession is carried out on the basis of the results of professional orientation testing and taking into account the needs of the city in skilled workers of a particular profile.

Stage 4. Choice of an educational institution. Taking into account the recommendations on the selection of the profession, selection of educational institutions functioning in the city is made on the basis of available complete and consistent information about them, namely: departmental affiliation, form of ownership, information about the faculties (departments), professional level of the teachers of the departments and laboratories, specialties, on which training is being conducted, available training areas, licensed training volumes of the professionals, etc.

Stage 5. Formation of an individual learning trajectory (ILT) is a personal program, the formation of student's professional competencies that are relevant to their abilities, interests, motivations, psychodynamic characteristics of individual age and the level of knowledge potential [14].
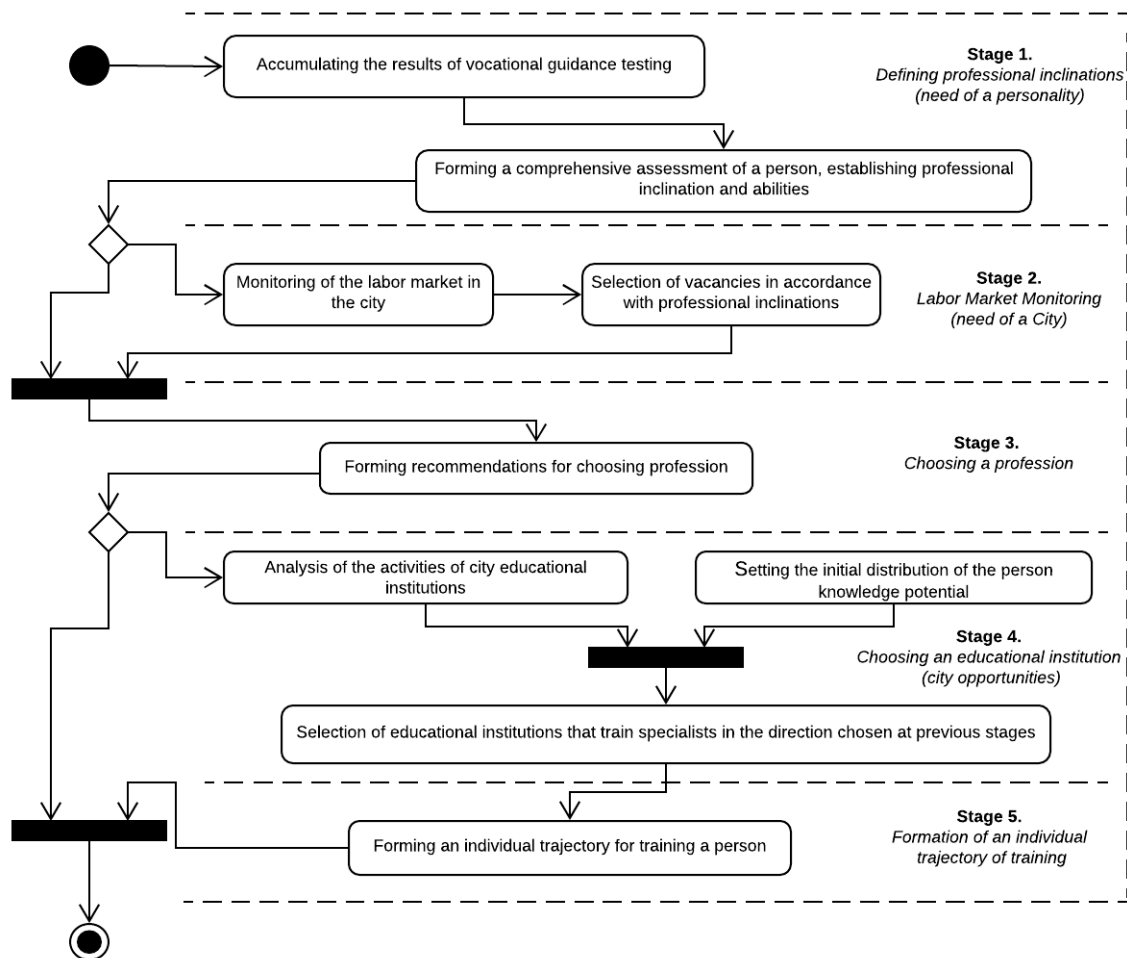

Fig. 1. "Diagram of the activity" of information and technological support of professional training

2.1. Data analysis of the professionally oriented testing

In order to identify the general dependency, on the basis of which the decisions are made, regarding the professional choice by a person doing testing, advanced analysis tools for guidance testing are proposed.

The model of the data analysis procedure of determining the professional inclinations and abilities of a person: $P = (P_1, P_2, P_3, P_4)$, where P_1 is the procedure for forming the subject area, P_2 is the procedure for preliminary data processing, P_3 is the procedure for determining dependencies, P_4 is the procedure for evaluating and interpreting the analysis results.

Model P_1 of the procedure of the formation of the subject area description is:

$P_1 = (A, V, r)$, where A is the number of people (agents) who participated in testing, V is the set of properties, r is the test results.

The set of properties V is divided into subsets $A = \{A_1, A_2, A_3\}$, where A_1 is informative properties, A_2 is psychological characteristics, A_3 is personal characteristics. Each object is assigned to a set of values of the attributes of the decision-making table T.

We will consider the general features of the procedure of previous data processing in the application of methods of rough sets which has the form: $P_2 = \left(T, Discr(age), EscC(v)\right)$, where the $Discr(age)$ function performs a discretization of the continuous values of the age using Boolean reasoning, the $EscC(a)$ eliminates the non-essential attributes by constructing the reducers using the Johnson algorithm.

The procedure model for detecting dependencies in data takes the form of

$P_3 = \left(T, Pat(v)\right)$, where the $Pat(v)$ function builds a classifier in the form of a set of classification rules.

The procedure model of evaluation and interpretation is presented as $P_4 = \left(T, \quad Evl(v)\right)$, where $Evl(v)$) is evaluation of the quality classification.

Detection of the excess attributes during the analysis of the decision-making table helps to optimize the process of conducting guidance tests to determine the person's professional characteristics.

On the basis of elaboration of the results of vocational guidance testing, a method for establishing a professional type of a personality has been developed, which consists of the following steps (Fig. 2):

Step 1. To accumulate and consolidate the test results for professional guidance.

Step 2. To pre-process the data (at this step, the user's responses are analyzed), especially to structure and unify, disassemble and process incompleteness.

Step 3. To select a set of decision-making attributes, apply the methods of intellectual analysis to pre-processed test data.

Step 4. To estimate and interpret the obtained results, determine the degree of affiliation of the consolidated results of professional testing with the established decision set of attributes.

Step 5. To identify the type of the professional personality.

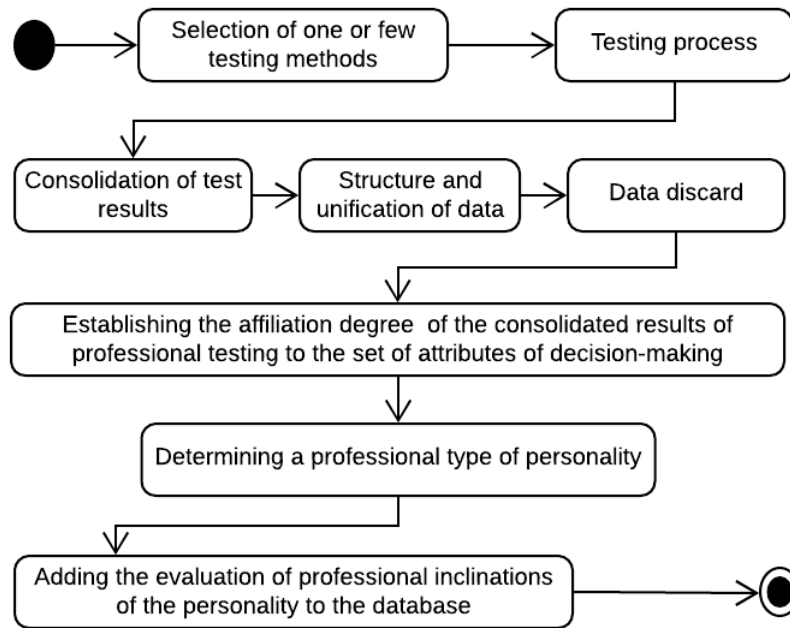*Step 6*. To add the evaluation of professional features of the user to the database.

Fig. 2. "Activity diagram" of the process of determining the professional abilities of an individual

2.2. The method of finding the most demanded professions in the city's labor market

To identify the professions that are in highest demand in the labor market of the city, it is proposed to use two methods of data collection: the analysis of vacancies, declared by employers in the state employment service, by professions and content analysis of the places with vacancies.

Analysis of the information from the State Employment Service regarding the current needs of the labor market in terms of professions (specialties).

Within the framework of this component of the research, the analysis of the vacancies declared by employers to the State Employment Service, by profession, was carried out on the basis of the databases of the State Employment Service on the number of registered vacancies. A database was created for vacancies, declared by employers in the State Employment Service, by profession. The basis of the formation of the database is statistical information, which includes the following data:

− the code of the profession;
− a number of vacancies;
− a load on 1 free workplace.

Also, the analysis of the trends of prospective changes in the structure of employment by professions was carried out on the basis of the methods of forecasting the development of events and modelling the situation.

The information tables in which the information on vacancies and related specialties is stored are shown in Fig. 3.
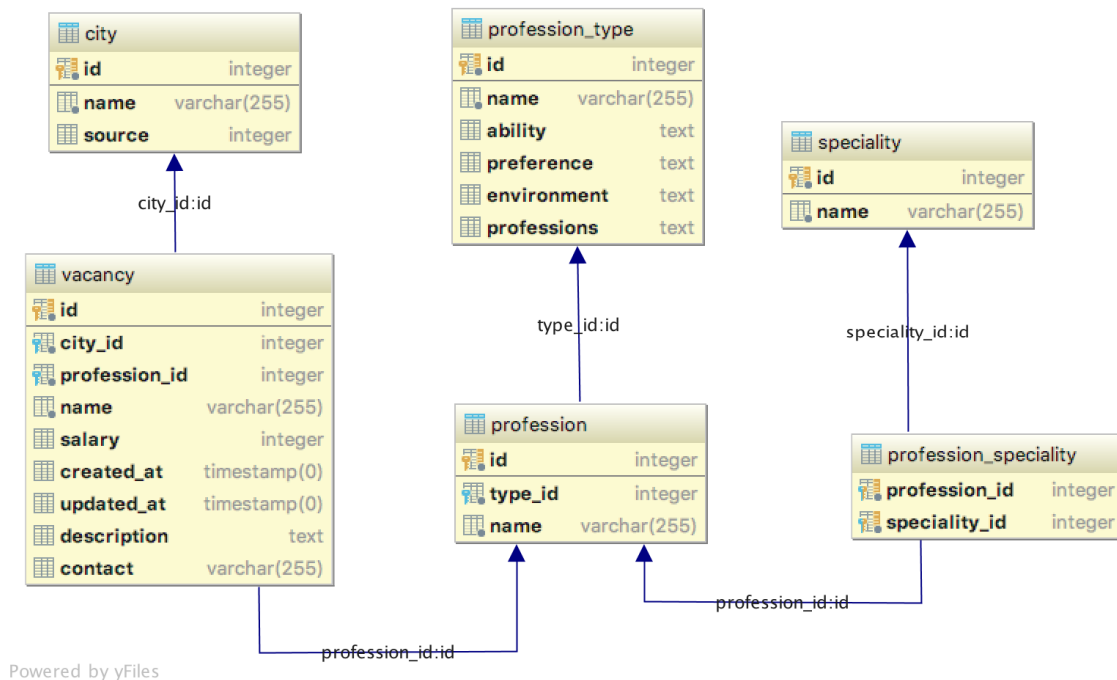
*Fig. 3. The information tables in which the information on vacancies is store*d

Content analysis of sites with vacancies.

The data source for analysis was most popular Internet sites for job search in the Ukrainian segment. The data collection was conducted using the parsers with contained templates to allocate data for 4 variables: x_1 is an occupation (position), x_2 is an approximate salary, x_3 is a type of employment, x_4 is requirements for education and experience.

The combination of two methods of data collection enables a comprehensive analysis of the situation on the labor market; since certain categories of employers do not systematically apply to the State Employment Service, while others, on the contrary, do not seek employees through the Internet.

2.3. The method of evaluation of educational activity in educational institutions

Recommendations concerning the choice of a particular educational institution (according to the chosen profession) are formed on the basis of the method of evaluation of educational activity in educational institutions.

It consists of the following steps (Fig. 4):

Step 1. To select data from the data warehouse of the activity evaluation of educational institution.

Step 2. To pre-process the selected data.

Step 3. To form data hypercube of functioning of educational institution $H_{NZ}(V,A)$ from the set of dimensions V and the set of attributes A.

Step 4. To conduct multidimensional data analysis.

Step 5. To form a multi-level hierarchical structure, containing an integrated indicator of the rating assessment of the quality of educational services at the upper level, on the next ones there are partial criteria.

Step 6. To set the value of weight coefficients for group and detailed indicators by experts.

Step 7 To calculate integrated indicator $I=I_1+I_2+I_3+I_4+I_5$, where I_1 is the quality index of scientific and pedagogical professionals, I_2 is the student capacity index, I_3 is the access and the scale index, I_4 is the index of resource support of the educational process, I_5 is the index of international activity.
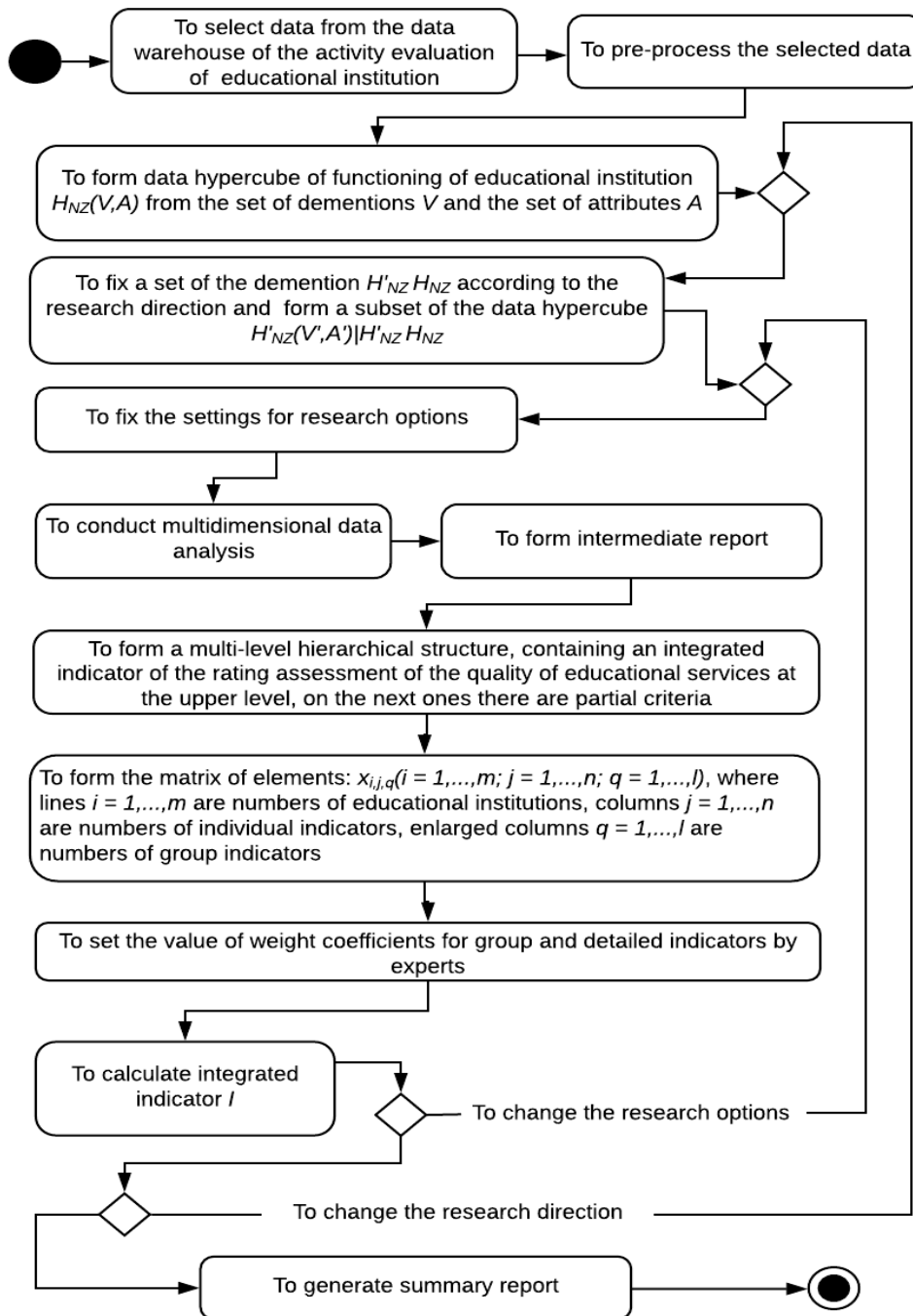

Fig. 4. Diagram of the analysis process of educational institution

Step 8. To generate summary report.

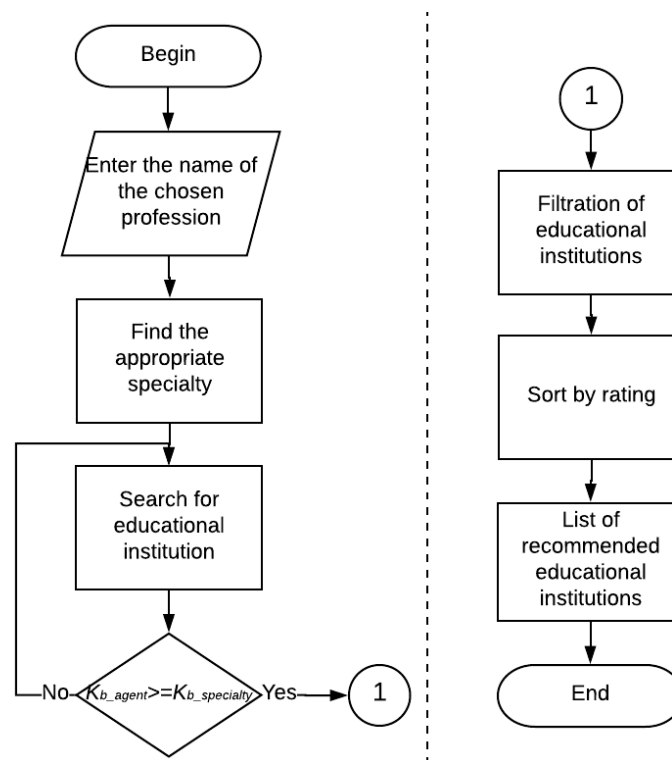The flow diagram of the algorithm for personalized search of educational institution is shown in Fig. 5.

Fig. 5. Algorithm for personalized search of educational institution

At the first step, a name is introduced, determined by the results of vocational guidance testing of a person, a profession and the search for the corresponding specialty is done. At the next step, for a person living at a certain address, a network of available vocational and higher educational institutions within the city is selected, $Nz = (Nz_1, Nz_2, Nz_3, ..., Nz_n)$ where n is their total number. From available educational institutions those are selected that correspond to the level of knowledge potential of a person, their competitive mark, $K_{bagent} \geq P_{bspecialty}$ where K_{bagent} is the competition mark of the person (applicant), $P_{bspecialty}$ is the pass mark of the specialty. Next, the sorting of educational institution is carried out in accordance with the described above method of rating assessment of educational activities in the educational institution, the obtained results are interpreted, and proposals are made for individuals (users) regarding the choice of an educational institution functioning in the city.

3. THE RESULTS AND DISCUSSION

On the basis of the proposed above models and methods, the information technology of personalized support of the choice of the profession (IT "PSCP") was developed, the structural model of which includes: the subsystem of determination of professional abilities, the subsystem of multidimensional analysis of the educational institutions activity, the

subsystem of vacancies, the subsystem of the individual learning trajectory formation, as well as database and system interface (Fig. 6).
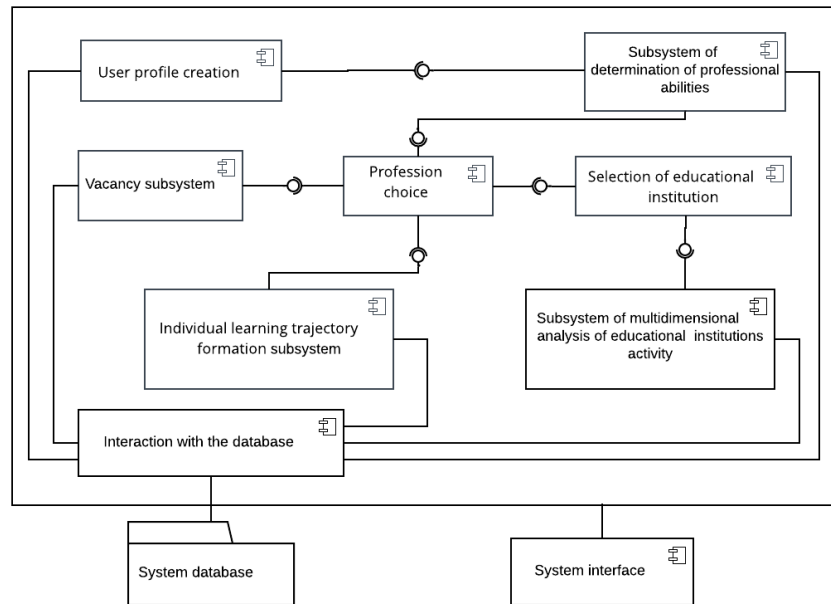

Fig. 6. Structural model of information technology in personalized support of profession choice

IT "PSCP" is developed in the form of a single-page application, the architecture is designed on the basis of a client-server technology, which allows you to work both in local and network mode.

Fig. 7 provides an algorithm for the functioning of the IT "PSCP".
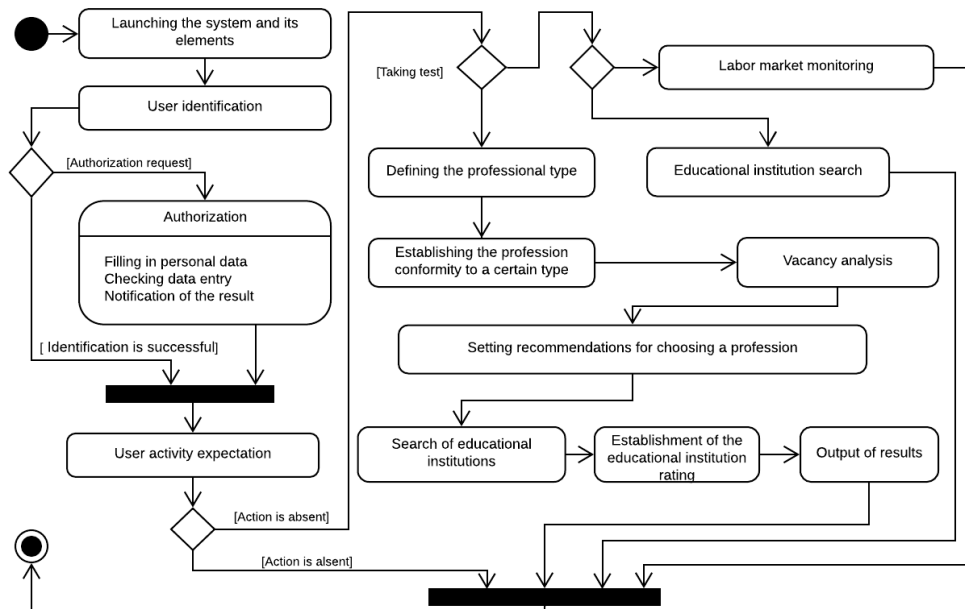

Fig. 7. Diagram of functioning of the information support system in the specialist training

One of the most important components of a Web application is the user interface, which consists of a set of visual presentation tools, for a quick understanding and perception by a user with any level of experience in interacting with information systems.

To build the web interface, the HTML markup language is used along with cascading tables of CSS stylesheets, the dynamic functionality is implemented using JavaScript and third-party libraries. JQuery is used for asynchronous requests and interactions with HTML. The page display is implemented using the Model View Controller (MVC) pattern, where each database table has its own JSP page (View) that displays the table content; the choice of the table for display is performed by the Controller class.

For example, Fig. 8 illustrates and interprets the results of the method of determining the professional type of personality.
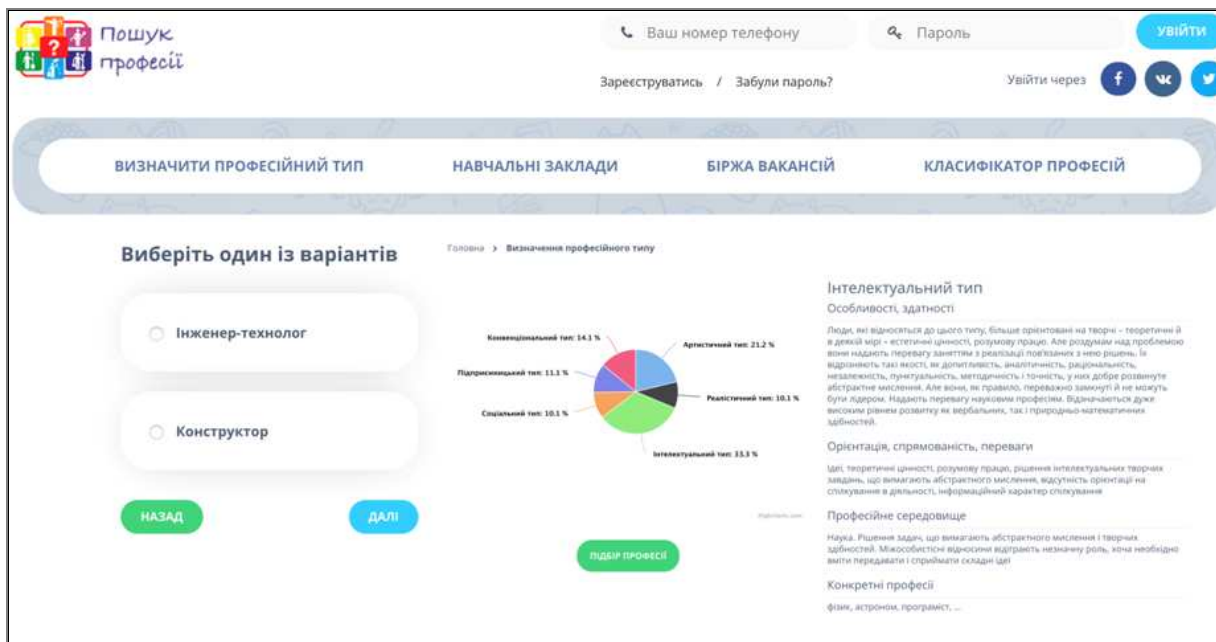

Fig. 8. Results of determining the professional type of personality

As IT "PSCP" works online, users do not need to install and reserve space on a permanent storage device (owning a separate server), only an Internet connection is required, and all application features are executed regardless of the operating system of users.

4. CONCLUSION AND PROSPECTS FOR FURTHER RESEARCH

The process of choosing a profession is a complex, multi-step, iterative process that requires consideration of a large number of parameters and prerequisites. The authors of the paper, based on the analysis of existing information technologies and systems used to accompany the specialist training, proposed a conceptual scheme of the stages of modeling and support of specialist training in the educational social and communication environment of a smart city in accordance with the needs of an individual and requirements of the labor market. The model of data analysis procedure is developed for determination of professional inclinations and abilities of a person. Using the methodology of constructing hypercube data, a method for evaluating the activity of educational institutions in the city has been developed

based on the formation of an integrated indicator of rating assessment of the quality of educational services.

The recommended information technology, developed by the authors in the form of web applications, allows us to formulate well-considered recommendations for choosing a future specialty.

The directions of further research include filling the database and system debugging of all components of the developed IT "PSCP", as well as testing in real conditions on the basis of Ternopil city.

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ІНФОРМАЦІЙНА ТЕХНОЛОГІЯ ПЕРСОНАЛІЗОВАНОГО СУПРОВОДУ ВИБОРУ ПРОФЕСІЇ В «РОЗУМНИХ МІСТАХ»

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Анотація. Інформаційні технології допомагають вирішувати найскладніші проблеми, якісно змінювати освітні послуги і створюють умови для комфортного життя і розвитку кожного мешканця зокрема та громади міста в цілому. У контексті реалізації цих проектів процедури вибору і здобуття професії важливі, беручи до уваги особисті характеристики та потреби громади міста. Процес прийняття рішень щодо вибору майбутньої спеціальності починається ще під час навчання в школі й актуалізується під час вибору предметів для зовнішнього незалежного оцінювання. Іншим важливим кроком у цьому ланцюгу є вибір навчального закладу для подальшої освіти і спеціалізації. У роботі запропоновано інформаційну технологію персоналізованого вибору професії відповідно до потреб особистості та вимог ринку праці «розумного» міста подавати у вигляді п'яти послідовних функціональних етапів: визначення професійних нахилів та здібностей; моніторинг міського ринку праці; вибір майбутньої професії; вибір навчального закладу; формування індивідуальної навчальної траєкторії. Описані моделі й методи інформаційної технології супроводу персоналізованого вибору професії, зокрема: модель аналізу даних для визначення професійних нахилів і здібностей особи на основі результатів профорієнтаційних тестів, що дало змогу оптимізувати процес визначення професійних особливостей особистості; методи моніторингу ринку праці міста; з використанням методології побудови гіперкубів даних набув подальшого розвитку метод аналізу освітньої діяльності навчальних закладів. Подано основні характеристики розробленої, у вигляді веб-застосунку, інформаційної технології, яка поєднує в цілісній системі всі етапи підготовки фахівців з урахуванням потреб особистості й вимог ринку праці великого міста.

Ключові слова: інформаційна технологія; вибір професії; тест на профорієнтацію; веб-застосунок.

ИНФОРМАЦИОННАЯ ТЕХНОЛОГИЯ ПЕРСОНАЛИЗИРОВАННОГО СОПРОВОЖДЕНИЯ ВЫБОРА ПРОФЕССИИ В «УМНОМ ГОРОДЕ»

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Аннотация. Информационные технологии помогают решать самые сложные проблемы, качественно изменять образовательные услуги и создают условия для комфортной жизни и развития каждого жителя в частности и общества города в целом. В контексте реализации этих проектов процедуры выбора и получения профессии важны, учитывая личные характеристики и потребности общества города. Процесс принятия решений по выбору будущей специальности начинается еще во время учебы в школе и актуализируется при выборе предметов для внешнего независимого оценивания. Другим важным шагом в этой цепи является выбор учебного заведения для дальнейшего образования и специализации. В работе предложена информационная технология персонализированного выбора профессии в соответствии с потребностями личности и требованиями рынка труда «умного» города подавать в виде пяти последовательных функциональных этапов: определение профессиональных склонностей и способностей; мониторинг городского рынка труда; выбор будущей профессии; выбор учебного заведения; формирование индивидуальной учебной траектории. Описанные модели и методы информационной технологии сопровождения персонализированного выбора профессии: модель анализа данных для определения профессиональных склонностей и способностей человека на основе результатов профориентационных тестов, что позволило оптимизировать процесс определения профессиональных особенностей личности; методы мониторинга рынка труда города; с использованием методологии построения гиперкубов данных получил дальнейшее развитие метод анализа образовательной деятельности учебных заведений. Представлены основные характеристики разработанной в виде веб-приложения, информационной технологии, которая сочетает в целостной системе все этапы подготовки специалистов с учетом потребностей личности и требований рынка труда большого города.

Ключевые слова: информационная технология, выбор профессии, тест на профориентацию, веб-приложения.