# Selection of training programs for textile industry personnel using artificial intelligence

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# Selection of Training Programs for Textile Industry Personnel Using Artificial Intelligence

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**Abstract.** The quality of an organization's human resources is determined by the set and level of competencies of its employees. The digital transformation of business processes is leading to a rapid obsolescence of staff knowledge and skills, which requires the organization to develop effective human resource development plans. At the same time selecting the best program for staff training and development is a priority task for HR professionals. An effective tool in this process is technology based on Big Data and artificial intelligence capabilities. The author proposed a methodology to determine the competencies of employees and their level, to select training courses to improve existing skills and obtain the missing competencies, to evaluate the effectiveness of training program. The objective of the study was to develop new tools for the selection of human resource development programs of light industry enterprises. The objectives were to choose the method for analyzing skills and competencies of the organization staff and to develop the means for its implementation; to develop a technology for selecting training courses in the online space; to analyze the effectiveness of the developed method for selecting programs for human resource development in the organization on the example of JSC «Vitebsk carpets». When collecting empirical base of research using artificial intelligence and Big Data technologies, 474,000 CVs and 56,000 job vacancies were collected by scraping from job search websites and 1.66 million competencies were extracted from them [1]. The research work resulted in the development of software product architecture for extraction and analysis of current information on the competencies required by the market; employee competency assessment technology and job competency matrix compilation; algorithm of automatic search in the Internet space, selection and ranking of corporate employee training programs; methodology for assessing effectiveness of training programs completed by the organization employees. The developed technology for selecting and assessing the effectiveness of training programs using artificial intelligence allows HR-specialists to significantly save time by automating routine operations and increasing the efficiency of their work by releasing time to perform tasks that involve human decision-making.

## INTRODUCTION

In modern economic conditions, a key factor of competitiveness of the organization is the quality of human resources that is determined by a set of staff competencies. A systematic collection of information about employees' competencies, analysis of their skill level, acquisition of lacking or insufficiently formed knowledge and expertise by staff training and career enhancement is necessary for implementing the company development strategy.

This process is important due to the following factors:

- modern market conditions require the resource-based view for the development of competitive strategy of the organization;
- accelerated scientific and technical progress entails introduction of innovative production technologies and, as a result, growth in the scope of information used in the workflow and accelerated obsolescence of professional knowledge and skills of employees;
- digitalization of economic environment dictates new requirements for staff knowledge, skills and competencies.

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Currently, the quality assessment of human resources in the organizations is performed when the employees undergo attestation by interviewing direct managers or by entering and calculating the staff key performance indicators. The data obtained in such a way does not consider individual skills and competencies of employees but is used by the management for developing the advancement strategy for the existing staff, planning the staffing requirements, creating the employee pool. At this, the real picture of the quality of the existing human resources cannot be received. Therefore, it is necessary to develop staff assessment competency-based tools, methods of identifying the lacking knowledge and skills, technologies for selection of staff training and career advancement programs.

## RELEVANCE OF THE USE OF DIGITAL TOOLS FOR PLANNING THE DEVELOPMENT OF HUMAN RESOURCES OF THE ORGANIZATION

The researches on the necessary use of the competency-based approach in HR management have been conducted since 1980s. As of today, there are the behavioural (White 1959; McClelland 1998; Boyatzis 1982), functional (Cheetham and Chivers 1996) and integrated concepts (Tremblay and Sire 1999; Le Deist, Stringfellow and Winterton 2006) that served as a basis for development of the competency frameworks in the international and national standards ("IPMA Competence Baseline" 2015; Bologna project "TUNING" 2006; standard "The Guidebook for Project and Program Management for Enterprise Innovation (P2M)" 2005, etc.). The efficiency of development of the competency frameworks in the HR management has been evidenced by the works of the authors (Trunovich, Shlygin 2008; Spencer, sr. Spencer 2005; Whiddett, Hollyforde 2003, etc.).

The problem of formation of strategic HR development plans of the organization with the use of the competency-based approach is closely connected with the analysis of massive scope of disaggregated and often non-systematized data, considerable temporary and financial expenses. This identifies the necessity in using the Big Data and artificial intelligence technologies when forming the competency matrices, assessing the staff and developing the staff career advancement plans that suppose implementation of the following stages:

1. Formation of the list of professional competencies and compilation of staff competency matrices;
2. Diagnostics of staff competencies and skill level;
3. Identification of non-conformities between the existing and required staff competencies;
4. Search, analysis and selection of training and career advancement programs in the Internet;
5. Analysis of staff training effect.

Necessity in using the Big Data and artificial intelligence technologies for analysing the information flows of the labour market is evidenced by a number of works (Bejger and Elster 2020, Vankevich and Kalinouskaya 2020, p. 38-51) and researches conducted by the companies (IDS and ABBYY 2019, ILO 2020). It is reasonable to use the artificial intelligence when planning the HR advancement in the organization (Fig. 1).

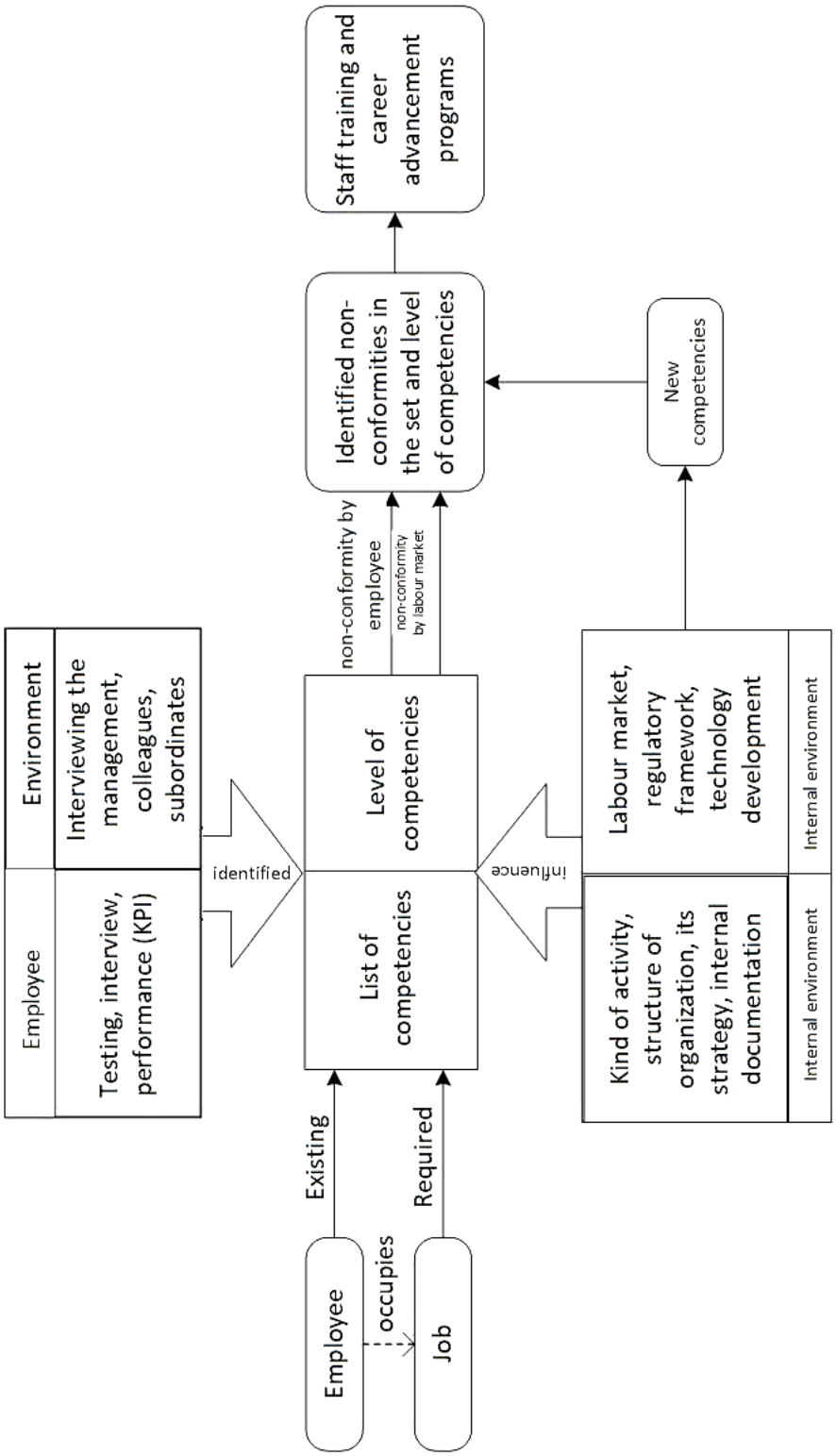


**FIGURE 1.** Technology of process implementation when planning the HR advancement in the organization

Source: compiled by the author.

The provided technology supposes the coordination of classic research methods for staff competencies (testing, interview, calculation of performance indicators) and digital tools for their implementation (chat bot for surveys and interviews, automated online testing system, software product for collection and processing of information about competencies).

Introduction of the artificial intelligence technologies allows to automate some HR processes and relieve HR specialists of routine and complex analytical work, thus releasing time for them to perform strategic and current HR management tasks.

It is offered to distinguish the following areas for introduction of digital technologies as a tool for the HR specialist for planning the HR advancement in the organization:

- interviewing the management, colleagues, subordinates, and testing of an employee using the chat bot for establishing the existing competencies and assessing the skill level (Kalinouskaya 2020, p. 173-187);
- development of the artificial intelligence based software products to identify non-conformities in the sets of competencies (Vankevich, Kalinouskaya, Zaitseva, Korabava 2020) and their level for each employee, in particular, and the organization, as a whole;
- use of machine learning when developing the programs for current labour market analysis (Vankevich, Kalinouskaya 2020), identifying the process of competencies transfer from different professions and emergence of new professions;
- drawing up analytical reports with the use of the Big Data technologies according to the results of the conducted researches (Vankevich, Kalinouskaya 2020, p. 38-51);
- automatic search, selection and ranking of staff training programs in the Internet with the use of artificial intelligence;
- intellectual analysis of staff training effect.

The specificity of the offered program consists in combination of internal requirements of the organization for a set and level of competencies and current inquiries for a job position in the labour market. Therefore, an important tool of this technology is a set of artificial intelligence based programs combined in a single author's system "HR Analytics" and allowing for retrieving and analysing the current information about the competencies required by the market.

HR Analytics includes three program modules.

Data collection and aggregation module developed in Python language to retrieve information about the required competencies of the job being of interest for the HR specialist from online job portals and other Internet sources, as well as the internal HR base of the organization. The data is collected by using the public API and information scraping with Scrapy framework. The collected data is supplied and stored in the Mongo DB.

The analysis module is realized in the Python language with the use of specialized for machine learning libraries Tensorflow, Keras, Scikit-learn, Gensim. The collected competencies are analysed by means of the neural network language patterns.

The report module represents a web-application realized with the use of the JavaScript library "React" to generate a final report of employee's compliance with the job requirements. At this, the software application provides export of the Excel report to ensure further convenient work of the HR specialist with the data obtained.

The collected and analysed data on competencies is important for the organization as it provides for establishing high quality standards of the released products and the production process efficiency; expanding competitive advantages and improving competitiveness; justifying HR policy of the organization; fully meeting the customer inquiries, determining the company role in satisfying their needs; developing values and corporate culture.

## DEVELOPMENT OF DIGITAL METHOD FOR ANALYSIS OF COMPANY EMPLOYEES' SKILLS AND COMPETENCIES AND TOOLS FOR ITS IMPLEMENTATION

The development of method for analysis of company employees' skills and competencies with the use of artificial intelligence is necessary due to:

- automation of analysis and assessment of employees in terms of each job position;
- increased amount of the processed data, increased data processing rate;
- company switch-over from the employees' experience-based assessment method to the competency-based method;

– no methods providing for comprehensive, uniform, reliable, systemic, transparent and unbiased collection, processing, analysis and assessment of the company employees in terms of each job position.

The technology for staff competencies and skill level diagnostics is given in Fig. 2.

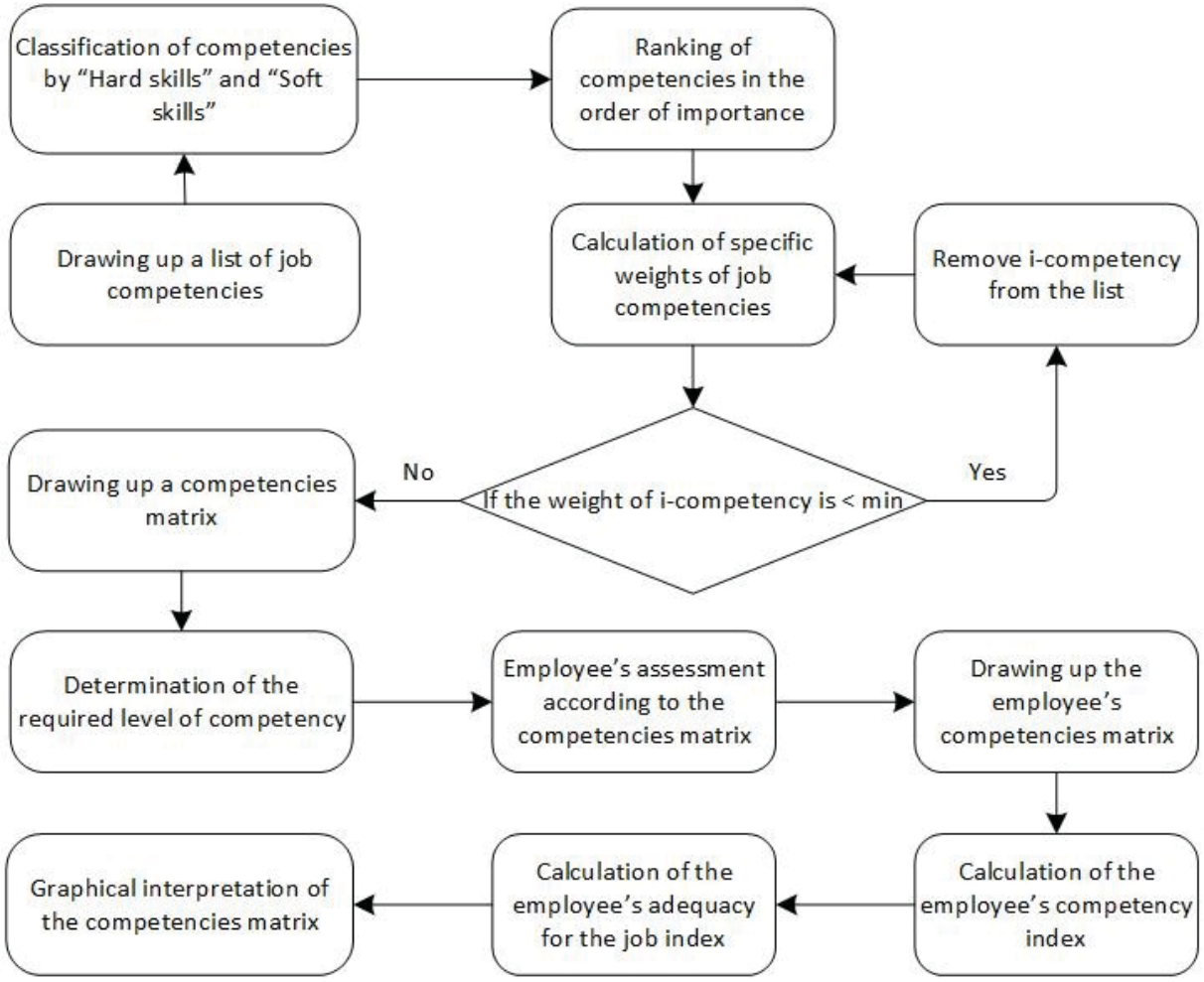


**FIGURE 2.** Employee's competencies assessment technology

Source: compiled by the author.

The technology of drawing up the staff competencies matrix includes 10 stages.

1. Retrieval of competencies from the company HR base formed from the information about competencies from job descriptions (internal information base of the company) and competencies required by the labour market (external information base).
2. Classification of identified competencies by "Hard skills" and "Soft skills" (Bikkulova 2020).
3. Formation of the full list of job competencies.
4. Ranking of competencies in the order of importance includes:
   1) development of classifications by levels of job competencies.
   2) formation of knowledge and skills classification for level of competencies.
5. The specific weights of vacancy competencies ($W_j$) are calculated with the use of weight factors specifying the relative value of each competency for a particular job. Each competency is assessed according to the scale from 1 to 9. For better differentiation of weights of competencies, the point step equal to 2 is chosen. The weights of competencies are assessed by the head of the department and/or the project manager.

Then, the weight of each competency ($Wj$) is assessed as a share of the obtained point of the j-competency in the sum of points of all identified competencies.

If the calculated weight of competency is less than the limit value obtained from experiment for each job position, such competency can be removed from the list and then the weights of the remaining competencies are recalculated.

6. Drawing up the template of the competencies matrix including the job name, list of competencies (preliminary broken down into the groups "Hard skills" and "Soft skills"), employee's level of each competency and required level of job competency, weights of each competency in terms of the specified job position.
7. The required level of competencies is determined by experts (heads of departments and/or project manager). The level of competencies is represented by the point from 0 to 4 that corresponds to the level L0 – L4.
8. Filling the competencies matrix by the HR Analytics automated system.
9. Calculation of the employee's competency index ($\mathbf{I_K}$) according to formula (1).
10. Calculation of the employee's adequacy for the job index ($\mathbf{I_K}$) according to formula (2).

According to the employees' competency assessment result, the competencies matrix is filled in as given Table 1.

**TABLE 1.** Job competencies matrix

| Job | Competency | Required level of competency, $L_k$ | Employee's level of competency, $C_K$ | Weight of competency, W |
|---|---|---|---|---|
| Job (R) | Competency 1 (K1) | $L_K$ (R, K1) | $C_K$ (R, K1) | W (R, K1) |
| | Competency 2 (K2) | $L_K$ (R, K2) | $C_K$ (R, K2) | W (R, K2) |
| | … | … | … | … |
| | Competency n (Kn) | $L_K$ (R, Kn) | $C_K$ (R, Kn) | W (R, Kn) |

Source: compiled by the author.

This method offers the following employee's assessment indicators:

- employee's competency index ($\mathbf{I_K}$) (Kuruba 2019):

$$\boldsymbol{I_K} = \sum_{j=1}^{n}\left(\frac{\boldsymbol{C_{K_j}}}{4}\times \boldsymbol{W_j}\right), \tag{1}$$

where $\boldsymbol{C_{Kj}}$ - employee's level of j-competency assessed from 0 to 4;

$\boldsymbol{W_j}$ - weight of j-competency representing the relative importance of this competency for a specific job;

$\boldsymbol{n}$ - number of competencies.

- adequacy for the job index ($I_K$) (Kuruba 2019):

$$\Delta_{\boldsymbol{K}} = \sum_{j=1}^{n}\left(\frac{\boldsymbol{C_{K_j}} - \boldsymbol{L_{K_j}}}{4}\times \boldsymbol{W_j}\right), \tag{2}$$

where $\boldsymbol{L_{Kj}}$ – required level of j-competency assessed from 0 to 4.

The adequacy for the job index varies from (-1) to 1.

According to the results of competencies matrix and calculations of competency and adequacy for the job indices, it is concluded about the existing or absent non-conformities by the set and the level of competencies of employees (according to the internal requirements for the job) and by the labour market. These non-conformities make signals to necessary staff training.

According to the staff training results, their competencies matrix is filled in again, the employee's competency index and the adequacy for the job index are re-calculated. The training effect index is calculated:

$$\boldsymbol{I_E} = \sum_{j=1}^{n}\left(\frac{\boldsymbol{C'_{K_j}} - \boldsymbol{L_{K_j}}}{4}\times \boldsymbol{W_j}\right) - \sum_{j=1}^{n}\left(\frac{\boldsymbol{C_{K_j}} - \boldsymbol{L_{K_j}}}{4}\times \boldsymbol{W_j}\right) \tag{3}$$

where $\boldsymbol{C'_{Kj}}$ - employee's level of j-competency after training assessed from 0 to 4.

# TECHNOLOGY FOR CHOOSING THE STAFF TRAINING COURSES IN THE INTERNET WITH THE USE OF ARTIFICIAL INTELLIGENCE

To draw up a full list of training courses, the information about which can be found in the Internet and which can be held both online and offline, the algorithm of automatic Internet search, selection and ranking of training and career advancement programs with the use of the artificial intelligence technologies has been developed.

By the example of choosing career advancement courses for economists of the Labour Organisation and Remuneration Department, Production Scheduling and Control Department, CACS Department, Financial Department, Marketing and Sales Department, Branded Trade and Advertising Department, and Procurement Department of JSC "Vitebsk Carpets", we will consider the offered technology for choosing the staff training courses in the Internet with the use of the artificial intelligence.

We will draw up a list of professional competencies of the economist determining his skills and knowledge included in the competencies matrix. This list has been formed on the basis of job duties of the economist of the mentioned departments of JSC "Vitebsk Carpets", vacancies of employers and information from the applicants' CVs for the position "Economist" in the consumer goods industry. Therefore, the professional competencies matrix includes:

- knowledge of legislative and normative documents for planning, accounting and analysis of the company activities;
- knowledge of planning and budgeting methods;
- knowledge of business review;
- skills in calculating material, labour and financial costs for production and sales;
- knowledge of economic, marketing and financial analysis methods;
- knowledge of statistical analysis methods;
- skills in business plan development;
- MS Excel skills;
- MS Word skills;
- MS PowerPoint skills;
- MS Outlook skills;
- MS Access skills;
- knowledge of 1C: Enterprise 8;
- knowledge of 1C: Accounting;
- skills in working with large amounts of information;
- skills in using the electronic system "Consultant Plus: Republic of Belarus";
- knowledge of accounting fundamentals;
- knowledge of operational and statistical accounting methods;
- knowledge of internal document management;
- English skills level A2.

Considering the requirements for the job "Economist" at JSC "Vitebsk Carpets" and the most in-demand competencies in the labour market of the Republic of Belarus for this job in the consumer goods industry, let's make a list of five competencies recommended for advancement:

- Office program skills;
- knowledge of 1C: Enterprise 8;
- knowledge of 1C: Accounting;
- knowledge of statistical analysis methods;
- English skills level A2.

To implement the algorithm of choosing training courses, the software product has been developed in Python language and included in HR Analytics to receive data on possible training courses and programs from the Internet. The information about the found training courses is then processed, the courses are ranked on the basis of the cost and duration of training, opportunity to take training work-based and other factors of importance for the company. The technology of information collection, processing and analysis, that is realized by scraping methods, "SpaCy" and machine learning, includes the following stages: retrieval of data about courses from web-sources, ranking of the found courses on the basis of the specified terms, their cleaning, deduplication, classification of competencies, saving of the collected data in the company HR base. At this, new competencies obtained by the personnel from

training courses are identified. To process such information, the analysis module is used. For the purposes of visualization of the analysis of the identified competencies and creation of history of their emergence in the job, "Superset" and "Neo4j" programs are used.

Cost of training, work-based training, adequacy of the training program to the required competencies were specified as the main constraining search factors. As a result of analysis of the found and chosen courses on the educational platforms, the list of career advancement courses has been made:

1. in the area "Office program skills": "Training courses on Offie programs and presentation proficiency", "MS Excel: effective solutions for office employees. Online course", "MS Office vs. Google Drive: confident computer user - computer course";
2. in the area "Knowledge of 1C: Enterprise 8": "Course 1C: Enterprise 8", "Course of analysis and diagnostics of business processes", "Course 1C: Enterprise 8. Use of application solution 1C: Accounting 8 for Belarus";
3. in the area "Knowledge of 1C: Accounting"; "Course 1C: Accounting 8.1", "Use of application solution 1C: Accounting 8 for Belarus", "Chief Accountant - Training Course";
4. in the area "Knowledge of statistical analysis methods": "Course Econometrics: identification and analysis of statistical models", "Course of analysis and diagnostics of business processes", "Webinars for data analysis and maintenance in Data Science";
5. in the area "English Level A2": "Online English Course", "Online English for Entire Belarus", "English Course for Business and Career".

## CONCLUSION

The use of the Big Data and artificial intelligence technologies in the HR management when solving the tasks of staff competencies assessment and planning the staff advancement programs allows to:

- significantly save the time of the HR specialists due to automation of routine operations on collecting the data on staff competencies and improve their performance by providing more time for the tasks to be solved by a man;
- collect, process and analyse real time the information from the company internal sources and external online resources by competencies and skills of human resources;
- draw up the staff competencies matrices, conduct the surveys and interviews, estimate key parameters for determining the company staff competence, visualize the obtained results;
- automate the process of choosing the training programs in the Internet considering the established key search factors;
- analyse the efficiency of the taken staff training and career advancement courses.

The architecture of the software product for retrieval and analysis of the current information about competencies required by the market; technology for assessment of employees' competencies and drawing up the job competencies matrix; algorithm of automatic search in the Internet, choosing and ranking of the company staff training programs; method of efficiency assessment of the training programs taken by the company employees have been developed in the course of the conducted research.

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