Web-Service Management System for Job Search Using Competence-Based Approach

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Abstract. Many different web services for job serching create opportunities for employers and employees, but only a few of them have a focus on IT specialists for firms in different industries. There is a demand on applicants with the required soft and specific subject competencies with minimal time expenditures. The purpose of the research is to develop the architecture of a web service managenent system for job search at firms using a competent approach according to the international standards of eCF. In present there is no analogue of our web-service management system for job searching using competence-based approach for both employers and employees. The architecture and technical tasks for the participants of our web-based job placement service were developed and described in our research. Web-service includes data which can help to estimate how specific subject competences, age and sex of employees impact on average wage for their vacancies using RStusio packages.

Keywords: data structure, recruitment web-service, required competences, ICT for education.

1 Introduction

Today, in the modern Internet age, there are many different web-based services for job search, in which the number of CVs is significantly higher than the number of vacancies, but only some of them have a focus on IT professionals.

There are international standards for mandatory competencies of IT specialists and no web services that take them into account. So, there is a need to select applicants with the necessary soft and specific subject competencies with minimal time expenses.

After analyzing the existing web services, we were convinced that the advantage of the new web-based job search service is the process of evaluating candidates' competencies according to international eCF and EQF standards that would respond the needs of companies.

The goal of this paper is to develop an architecture for a web-based service for job search based on required competences. The developed web service architecture will allow to select business requirements, user requirements and functional requirements

for the project and submit them as engineering software requirements. It is also necessary to elaborate the development of the service modules in order to create a clear understanding of the structure of each of them separately and mechanisms for interaction with other modules, as well as for the further design of a flexible database architecture. Using data base of web-service employees can estimate how their specific subject competences, age and sex impact on average wage for their vacancies.

The paper has the following structure. The second part examines the literature of the management systems of web-based recruitment services. In section 3 is presented model of employer behaviour and payment using job search web-service. The fourth section has a module structure and software tools. The fifth section describes the experimental data analysis that will be exported from the web service and processed by language R, and the last section concludes.

2 Related Works

Integration of labor market and educational services via the transition from qualification models to mandatory competences of persons help to convert their individual development in professional career [1]. eCF and EQF standards unify competences for labor markets of various EU countries, allows job applicants and employers to act more productively using information about their learning results. The task of the information system UkrESCO is to provide an access to relevant competences for labor market at the moment and update them but does not analyze which types of jobs correspond to required competences [1].

Some persons need advice which type of competence they need in order to get a desirable job, because people with high education and part-time employees more likely to request the advice than low education persons and full-time employees correspondingly [2]. The majority found the advice interesting, relevant and motivating.

Next research in Korea considered the factors of the recruiting websites' service to investigate the relation between the service quality of specialized recruiting websites and user's behavior and perception. It was confirmed that recruiting websites had to adjust their strategic goals by target groups of users bacause customers' behavior concerning towards web service quality is heterogeneous [3].

Due to stochasticity of Web services for Job Search over the Internet, 'it becomes difficult to select reliable services taking into account non-functional requirements in service-oriented systems' [4]. To avoid the unreliable web services, we need to find several secure service candidates using multiple criteria. After that we can select services based on non-functional requirements. There are services which help to improve job characteristics of employees using web-based continuing learning. The results of the regression model disclosud that 'job control and social support positively associated with employees' attitudes toward web-based continuing learning', but demand on such learning was not significant [5].

Some researches revealed that employees' prefer web service where they receive 'adequate constructive feedback, have a good social support, and feel that the skills and

knowledge they are building are important to society' [6]. Another research study was to evaluate the impact of web-based training on the knowledge and perceived practice of community pharmacy staff. Following the recommendations from adult learning end experimential learning of theoretical frameworks, the proposed training engaged learners in a series of short online educational videos with preknowledge and postknowledge assessment. Training proved to be both effective and essential for pharmacy staff when web-services to ensure they have the necessary skills to be able to do their job well, and online training is an easy and efficient way to provide this training [7]. Paper [8] inclused next main fields of employers' requirements: soft skills, digital tools, and ability to use web services. In addition to previous skills, employers prefer applicants with project management skills, customer service approach, digital and data base collections, technology implementation in workload, problem solving skills under pressure and experience.

German and Polish firms of different industries need employees with digital competences and skills of business process automation. Core competences for employees in digital economy are 'technical, methodological, social and personal competencies' [9]. To verify how general and specific subject competences have to meet learning outcomes for different firms the following algorithm described in [10, 11, 12] can be used.

Based on the table of analysis of the function of services-analogues (Table 1), we have substantiated the decision on what user requirements and functional requirements should have a web-based job of employment to confirm the competences of students of IT specialties according to eCF and EQF standards and requirements of the IT labor market –sector.

Web-based employment service validates the competences of IT students: future employees, employers (IT-companies) / IT-learning companies and administrators. Therefore, for groups of users, requirements can be divided into three groups.

Table 1. Compatarive analysis of management system for employment ('+' means full correspondence, '–' means absence of given characteristics, 'pc' means partial correspondence)

Characteristics	**work.ua**	**rabota.ua**	**djinni.co**	**linkedin.com**	**hh.ua**	**it-stars.ua**	**jobs.dou.ua/**
1. Scope of IT sector	–	–	+	pc	–	+	+
2. Opportunity to attach own CV	+	+	+	+	+	+	–
3. Filtering information by different parameters	+	+	+	+	+	+	+
4. Section with a robot for students	+	+	–	+	–	–	+
5. Enterprise rating	pc	–	–	pc	pc	–	+
6. Checking of applicants competencies	–	–	–	–	–	–	–

7. Chacking of enterprises information	+	+	+	+	+	–	+
8. Search for matching competencies	–	–	+	pc	–	–	–
9. Integration service of electronic educational resources	–	–	–	+	–	–	–
10. Opportunity of mutual coincidence at the level Employer - Applicant	–	–	+	–	–	–	–
11. Priority selection possibility for vacancies	pc	pc	–	pc	–	–	–
12. Fee payment services	+	+	+	+	+	–	–

On the basis of the above requirements, functional requirements for the employment service were developed. Detailed algorithm of each key functional unit is described in [13], [14].

3 Model of Employer Behaviour and Payment Using Job Search Web-Service

Suppose a risk-averse employer faces a possibility of incurring loss (*l*) due to absence of employee with necessary competences that will reduce his or her initial profit (W_0). The probability of loss is given by π, and this probability can be reduced depending ot the amount (*a*) that an individual spends on access to job search web-service. We can let U(W) represent the employer's profit in both state 1 (no loss) and state 2 (loss): $W_1=W_0$-a and $W_2=W_0$-a-l, and employers choses to maximize expected profit: $E=(1-\pi)U(W_1)+\pi U(W_2)$. Taking into account that π is a function of *a*, FOC for a maximum is therefore:

$$\frac{\partial \mathrm{E}}{\partial \mathrm{a}} = -U(W_1)\frac{\partial \pi}{\partial a} - (1-\pi)U'(W_1) + U(W_2)\cdot\frac{\partial \pi}{\partial a} - \pi\, U'(W_2) = 0 \qquad (1)$$

$$\pi U'(W_2) + (1-\pi)U'(W_1) = [U(W_2) - U(W_1)]\cdot\frac{\partial \pi}{\partial a} \qquad (2)$$

This result demonstrates that employer should use job find web-service up to the point at which the expected marginal cost (from reduced profit) of spending one more monetary unit on such activities (the left side of eq.(2)) is equal to the reduction ($\frac{\partial \pi}{\partial a} < 0$) in the expected value of the profit loss that might be encountered when employer lose key employers. Eq.(1) can help estimate maximal amount which employer can spend on job find web-service.

4 Module Structure and Software Tools

The web-based service to confirm the competences of IT students in eCF and EQF standards was decided to develop in two parts, the first is the frontend with which users

interact, the second is the backend part responsible for business logic and user data storage. The system was decomposed into main functional units. Some modules are universal, i.e. they are connected with different groups of agents. (Fig. 1). The interaction between these parts is implemented through the application programming interface (API).

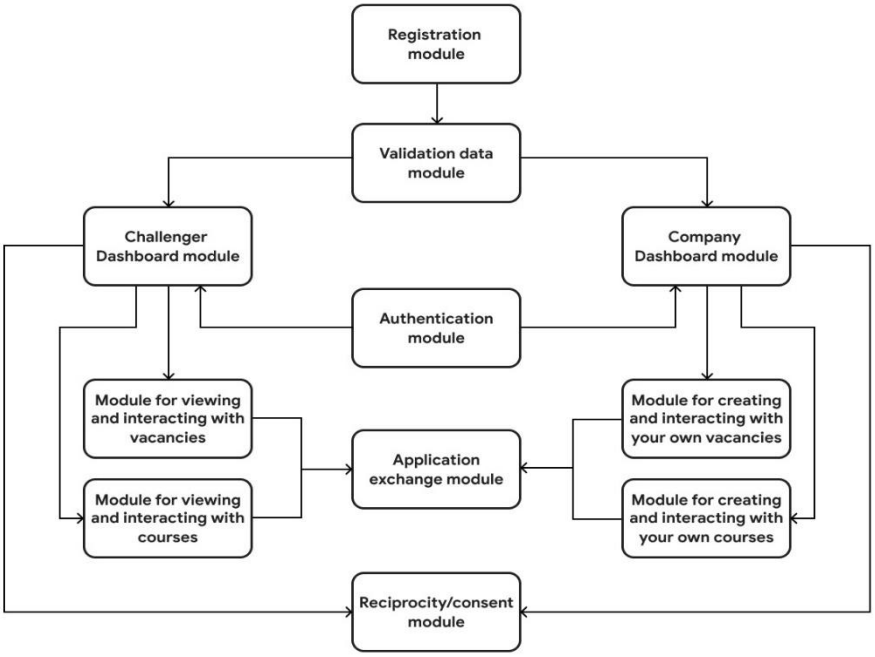

Fig. 1. High-level architecture of the web-service management system for job search

Software requirements include a set of requirements for properties, quality, and software features that determine what will be developed.

There are three levels of software requirements, according to Carl Vigers [15]:

- Business requirements - these are the requirements that determine the purpose of the software product, the goals that must be achieved by the developed software.
- User requirements - these are the requirements that define the list of user tasks that the program must decide, as well as the scenarios for their use in the system.
- Functional requirements are requirements that determine what a software product should do.

Based on the activity diagrams and use cases, the entities were identified and a relational model of the competence-based web service for the employment of IT specialists according to the eCF and EQF competency standards was developed. The model is presented in the form of an ER diagram (entity-relationship diagram) (Fig. 2). Based on all the entities and relationships between them, a database was created.

Validation module contains the main functionality of declared competencies verification of a potential employee by administrators, and also includes a mechanism for checking registered companies and user profiles manually.

Applicant and employer dashboard modules are responsible for the functionality of their own user account and the ability of easy access to other modules that are associated with user profiles. The module for viewing and interaction with vacancies gives an applicant the opportunity to get information about market of vacancies and companies, perform a search by competencies, view detailed data about the vacancy and choose from them.

The module for viewing and interacting with courses will allow the potential employee to obtain information about study programs or courses offered by advanced high educational institutions or IT companies.

Similar modules for employers will give them an possibility to prepare their own vacancies based on the currently required competencies, edit and close them to other agents as well as adding their own competencies to the existing list in the web-service management system.

Application exchange module will allow applicants and employers to determine the supply and demand for competencies, respectively, and also contains the functionality of submitting and processing an application for an study program or course.

Consent module will remove employers' bias against the applicant's identity via opening of full contact information for further communication and cooperation outside web-service based on mutual agreement.

Web-service will ensure the employer with the possibility to reject applicants who do not meet his/her set of required competencies. At the same time, web-service will entitle applicants to cancel proposals that are not interesting to them.

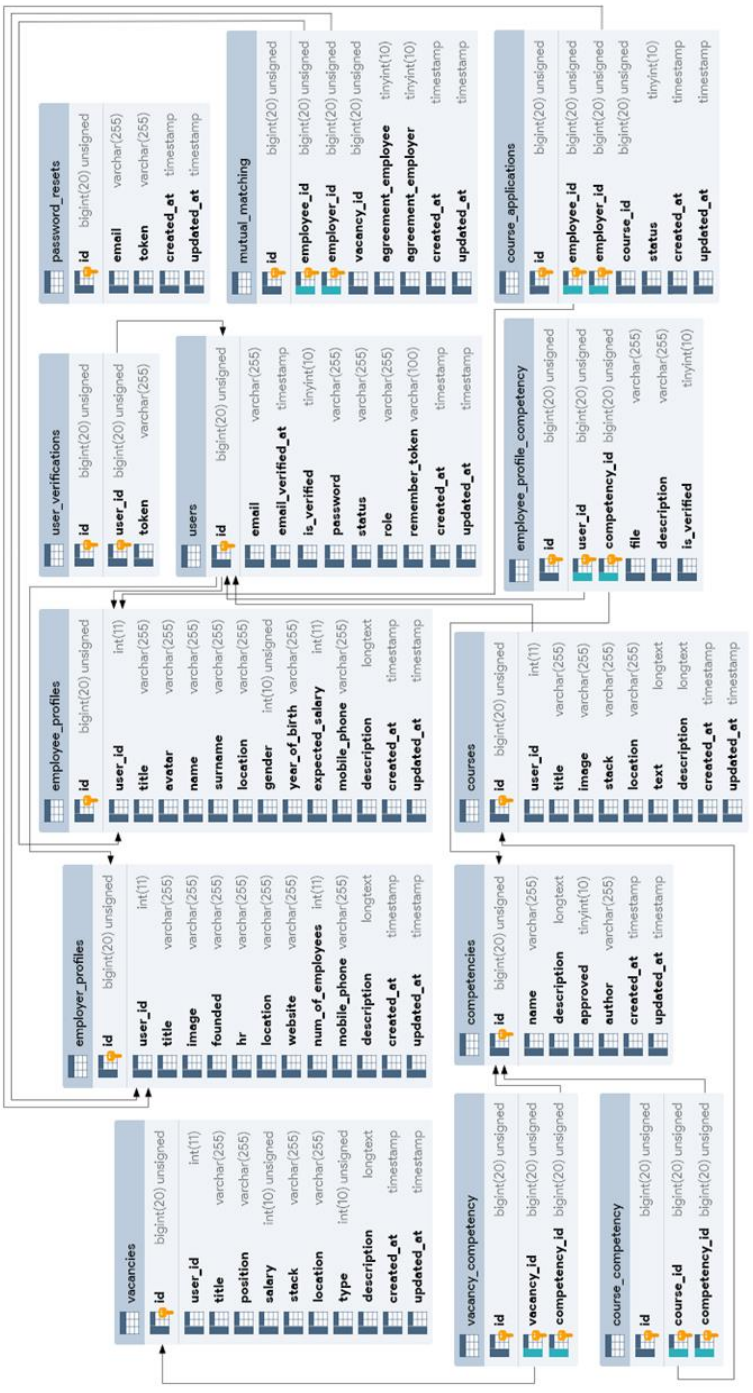

Fig. 2. Entity-relationship diagram

The purpose of e-CF is to provide general electronic competencies that can later be adapted to different business contexts of engineering enterprises, such as e-commerce, e-banking, etc. EQF system that makes it easy compare qualifications from different countries. This is achieved by standardizing the learning outcomes for each qualification to make them more transparent and easier to understand. Thus, EQF supports the cross-border mobility of higher education applicants and workers and promotes lifelong learning and professional development across Europe. The web-based job placement service to validate the competences of IT students at eCF and EQF standards has the following business objectives:

For a potential worker (Fig. 3): to prepare complete demonstration of an applicant concerning the mandatory competencies for the human resource managers on behalf of employers;

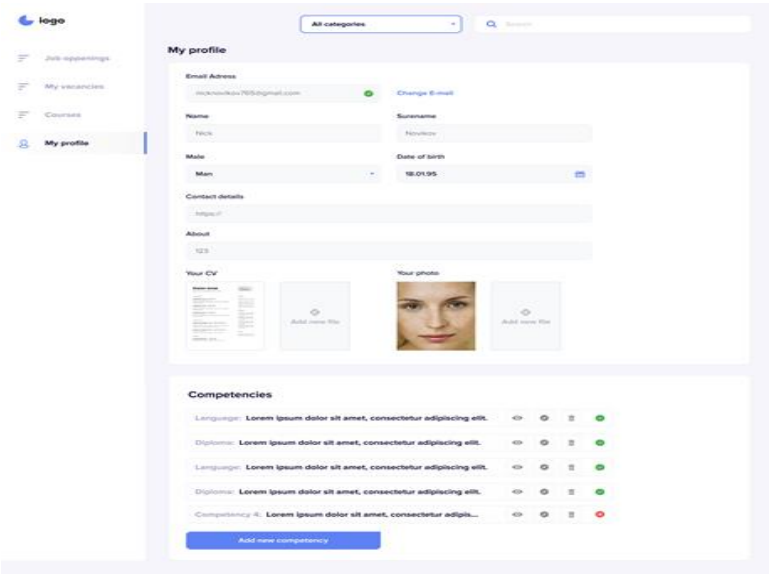

Fig. 3. Potential workers settings of web-service

For the employer: to find quickly the necessary company workers with a structured resume for certified competencies (Fig. 4)

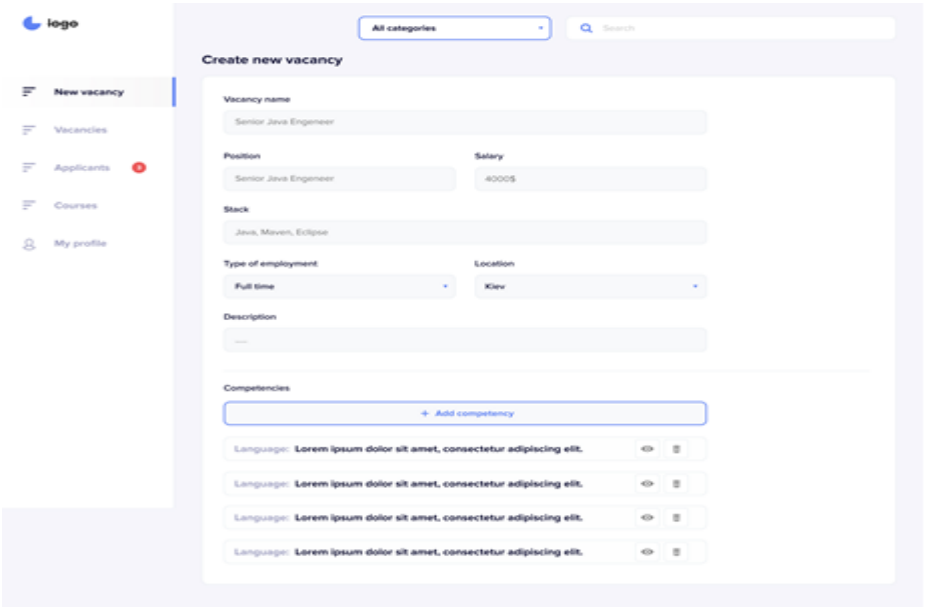

Fig. 4. Creation of new vacancy of web-service

5 Analysis of the Data of the Web-Based Employment Service in R

On the basis of processing data applications from employers about wages, required ("1") and unclaimed ("0") competencies, work experience, higher education, etc. are received. Data export and statistical analysis allows to identify which competencies are in demand and what kind of educational programs are necessary to acquire demanded competences on a job-seeking competence-based website. We will process the data using R package, which allows to quickly process and interpret big data from the web-based employment service.

To do this, we will use the following libraries: library("dplyr") - manipulations with data, library("psych") - descriptive statistics, library("lmtest") - tests for linear models, library("glmnet") - methods of relaxation of multicollinearity LASSO + ridge, library("ggplot2") - graphs, library("sjPlot") - graphical data analysis.

We will add to the R exported from the job-seeking website data in the form of a txt file (number 4 indicates the number of competences that employers need): h <-read.csv ("wagesmicrodata4.txt", sep = "\ t", header = TRUE, dec = ","). Next, we estimate the impact of regressors (key competencies COMP1, COMP2, COMP3, COMP4, demanded by employers, sex, age and work experience) to the dependent variable of wages in the following form (where employers considered following competences from eCF standards): (i) Specifying technical tasks; (ii) project management using IT infrastructure, (iii) preparing of business plan, (iv) quality assurane management:

$$\text{WAGE} = b_0 + b_1 \cdot COMP1 + b_2 \cdot COMP2 + b_3 \cdot COMP3 + b_4 \cdot COMP4 + b_5 \cdot SEX + b_6 \cdot AGE \quad (3)$$

The results of the calculations are presented in Fig. 5 for different combinations of competences (model 2 is preferable taking into account AIC criterion: the less value the better quality of the model):

	model_0	model_1	model_2
(Intercept)	-0.766***	-0.650***	-0.459***
	(0.098)	(0.094)	(0.121)
log(totsp)	1.301***	1.264***	1.219***
	(0.023)	(0.022)	(0.028)
brick: 1/0		0.129***	-0.350
		(0.009)	(0.193)
log(totsp) x brick: 1/0			0.112*
			(0.045)
R-squared	0.6	0.6	0.6
adj. R-squared	0.6	0.6	0.6
sigma	0.2	0.2	0.2
F	3194.4	1865.1	1248.6
p	0.0	0.0	0.0
Log-likelihood	422.7	522.4	525.5
Deviance	78.9	71.6	71.4
AIC	-839.3	-1036.8	-1041.0
BIC	-822.5	-1014.3	-1012.9

Fig. 5. Statistical estimation of impact of factors on wages

According to the results of estimations, we get that English is more preferable for foreign enterprises than for domestic ones using wage as dependent variable (Fig. 6)

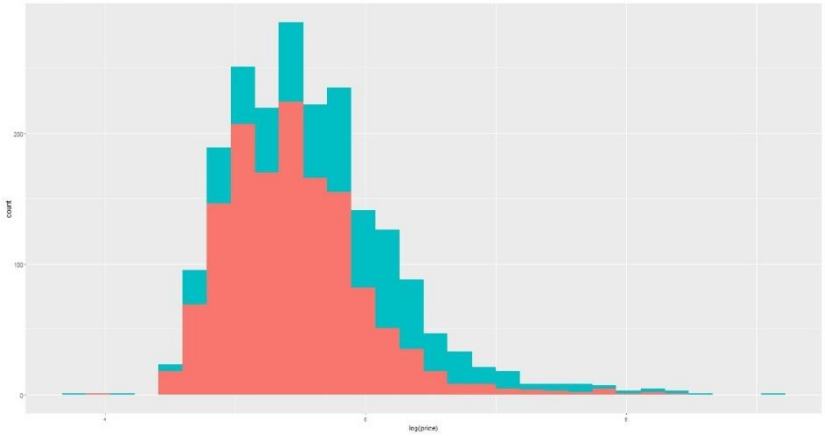

Fig. 6. Statistical estimation of impact of English on wages

Men at these vacancies earn more than women an average for senior positions than for junior ones (fig. 7)

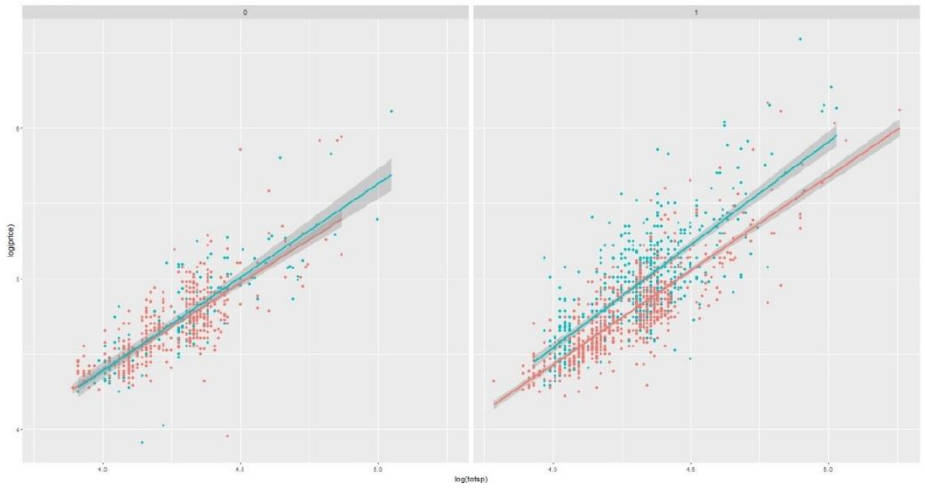

Fig. 7. Graphic estimation of the significance of factors influenced on wages

For the first two main components, we will construct a graph using cluster analysis in R: > biplot(h.pca,xlim=c(-1,1))

Fig. 8 reflects part of job applicants who have necessary competences form e-CF pool. Grey color means that data is enough to make such conclusion. Blue color shows that data is more than enough to conclude about per cent of employees with necessary competences. Red color means that data is enough to guarantee such conclusions.

Fig. 8. Mosaic functions to estimate proportions of competences

6 Conclusions and Outlook

The results of the work allowed us to fully form the vision of the project, to distinguish its strengths and weaknesses. Consideration of software requirements has helped to systematize the implementation of the web service and present them unambiguously,

the necessary functions of each group of users and project owners in the form of unambiguous business requirements, and the requirements of the user to submit in the form of a detailed specification requirements. The preformed requirements specification allowed the formation of a relational database model for a web-service management system for job search using competence-based approach. Based on the specification and model of the database, and also taking into account the architectural features of the selected software framework, the description of the necessary functional units within the framework of the program units of "controllers" was carried out.

Data export and statistical processing enabled us to identify which competencies are in demand and for the acquisition of which educational programs are required on a job placement website. Based on the data received from applicants and employers, the benefits of using data processing with the help of RStudio for this service have been demonstrated.

The obtained results are the basis for further program development and testing of the system for assessing the competence of applicants for eCF standards and the selection of vacancies for future employment.

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