An Approach to ICT Professionals' Skills Assessment based on European e-Competence Framework

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Abstract. The main aim of this research is to increase project effectiveness in the ICT domain. In order to achieve this goal, it was decided to focus on a process of team formation, since a strong team is undoubtedly one of the most significant components of a successful project. To build a stronger and potentially more effective team from a wide range of candidates with different skills and knowledge, it is vital to determine the most eligible ones. Therefore, it is necessary to assess available candidates and to make this process effective, it has to be formalized and then optimized. To perform a fairly objective assessment of a candidate for a role in a project an approach using a comparator identification method is proposed to increase the effectiveness of the whole process. The European e-Competence Framework and ICT Professionals' Role Profiles documents are used to support this approach, and the appropriate software tool is designed to implement its main functionality.

Keywords: European e-Competence Framework, ICT Professionals' Role Profiles, Competence, Role Eligibility, Assessment, Software Tool.

1 Introduction: Problem Actuality and Research Goal

Information and Communication Technology (ICT) specialist's competence assessment is a process of determining whether this particular specialist is suitable for a role, for which an assessment is conducted. Role suitability is an ability to perform actions associated with this role in full and successfully [1, 2].

Such decision is based in our case on European e-Competence Framework (ECF) and ICT Professional Role Profiles (PRP) documents in order to formalize this process. ECF is a document that describes 40 competences for the ICT field. A competence is a demonstrated ability to apply knowledge and skills in order to reach observable results [3, 4]. PRP is a document that describes 30 typical roles performed by ICT specialists. A role is a set of responsibilities and actions performed by an individual within the project [5, 6]. Each competence can be presented on several levels (minimum 1, maximum 5) and includes pieces of knowledge and skills needed for this competence [3, 4]. Each role, in turn, includes a set of competences (with minimum required levels) needed for this role [5, 6].

Comparator identification method is a special type of inverse identification. Input can be presented as a set of signals of any nature, output is 0 or 1. The idea is to determine whether input signals are in a particular relation, which is predetermined [7, 8].

As it is proposed in the integrated knowledge-based methodological framework for staff-training in IT-companies presented in [9, 10], it is critically important to elaborate an approach to an effective assessment of ICT professionals' skills.

The paper is organized as follows. Section 2 presents a short review of related work. It includes an overlook of several existing methods that can be applied to solve the problem, and a couple of software tools that use these methods. Section 3 provides a description of the proposed approach based on the comparator identification method with several detailed examples. Section 4 introduces an idea of what a software tool using proposed approach can seem like with its architecture design and user interface. Section 5 concludes the paper with a brief summary and an outlook on future work.

2 Related Work

2.1 Some Existing Methods in the Domain of ICT Professionals' Skills Assessment

Nowadays there are a couple of approaches that allow to determine one's ICT role suitability, but they are not agile and too subjective. That makes them ineligible for determination whether a specialist is suitable for a role or not in real projects. Consequently, the problem of role eligibility assessment is not formalized and does not have a specific solution, although several methods can be partially adapted for it.

Questionnaire method. Questionnaire method is an assessment method of a professional competence of a person in a chosen field based on self-rating [11]. Competence is assessed with competence index C, which is calculated by the formula:

$$C = \frac{C_o + C_a}{2} \cdot 100\%$$

C_o – Overall index, $C_o = 0.1 \cdot R$

R – Self-rating given on scale 1 to 10.

C_a – Aggregated index, calculated by a summarization of scores, obtained from a reference table on scale "Low", "Medium", "High".

All importance indices ($k/s_{i,[low/medium/high]} - c_i$) for each knowledge and skill are predetermined. Knowledge/skill rating equals $\alpha * c_i$. Respondent chooses between options low/medium/high. After that, all ratings are summed and C_a is obtained [11, 12].

Simple equation method. The problem of the definition whether an employee matches an ICT Role can be solved by using a simple equation [13]. In this case, the equation can be presented:

$$R = \sum_{i=1}^{n} \left(\frac{L_i}{L_i^*} \cdot c_i \right) \cdot 100\%, \qquad \sum_{i=1}^{n} c_i = 1$$

R – ICT Profile match degree presented as a percentage.
n – Number of Competences included in ICT Role description.
L_i – Level of respondents Competence.
L_i^* – Required level of Competence for ICT Role.
c_i – Competence importance index ($0 < c_i < 1$).

Respondents rate their competence level for each competence included in ICT Role description. Answers are then substituted into the equation [13, 14, 15].

Analytical model. There are plenty of methods regarding team formation automatization based on analytical models.

The idea to use analytical models to form project teams belongs to Zakarian and Kusiak. At first, their approach uses quality function deployment method to form project requirements. Then, a matrix of qualitative relations between requirements to the product and engineering skills is formed. Finally, team members are selected based on their skills with the help of analytical hierarchy process [16, 17].

Zakarian and Kusiak approach was then improved by Chen and Lin. They took into consideration not only engineering skills, but multi-functional knowledge, teamwork capability, and personal compatibility as well. The soft skills assessment relied on Myers-Briggs type indicator for personality profiling [18].

Another variation of analytical modelling usage was proposed by Fitzpatrick and Askin. Their model uses disjoint categories obtained by the division of labor pool. Their method focuses on emphasizes the interpersonal relationships by assuming that employees have the same level of skills. Heuristic method based on Kolbe measures is used for team formation, which provides good social construction [19].

Fuzzy logic. Fuzzy logic is a quite popular approach when it comes to team formation.

One of the approaches was proposed by Tseng and others. This approach uses grey decision theory for assigning specialists to specific roles in a project taking into account project requirements and their skills. Employees' skills are assessed in terms of fuzzy levels by others (usually department managers) [20].

Another approach, proposed by Karsak, uses linear programming for assigning specialists for specific roles in a project. Just like in a Tseng's approach, specialists' skills are presented by fuzzy numbers. Fuzzy values of skill requirements and importance degrees form a job specification and are used for preferential ordering [21].

Disadvantages of the methods. The methods described above have some serious disadvantages that significantly influence their effectiveness.

Questionnaire method is not adapted to ECF and its results do not map to the ECF competences levels, which makes it less attractive for wide usage. Moreover, this method provides assessment only for competence levels and does not aggregate them into a role suitability level, which, in turn, makes it incomplete and usable only paired with another method that would calculate role suitability level based on competence levels.

Simple equation method does not consider specifics of each knowledge and skills competence pieces which significantly decreases its objectivity and makes its application in the real world questionable.

Methods based on analytical model are quite objective and accurate, but they tend to be very complex. Moreover, their adaptation to ECF and ICT PRP is either very difficult or even impossible which makes them inapplicable to our domain.

Methods based on fuzzy logic can be adapted to ECF and ICT PRP and provide result that is accurate enough. However, they are quite subjective since specialists' skills are assessed in fuzzy numbers by other people.

2.2 Available Tools for ICT- Competence Assessment Support

CEPIS e-Competence Benchmark. CEPIS has developed a free online tool for ICT professionals to assess their professional skills, based on European Competence Framework [14]. The tool allows respondents to check which of the ICT professional profiles matches them the best.

The assessment tool is presented by a questionnaire, where respondents select their own level of competence for each of them. Available level options are "None", "Knowledge", "Experience", "Knowledge and Experience". If the respondents select "Experience" or "Knowledge and Experience", their choice corresponds to competence level (Dimension 3 of ECF).

The algorithm is based on a simple equation method. At first, Proficiency Index is computed for each of the 36 competences identified in the ECF, based on the respondent's answers. The index (expressed in percentage), represents the degree of proficiency for each competence with respect to the ECF. These scores are then compared with what is required for each of 23 ICT profiles. Finally, the result for each profile is given in a Proximity Index, expressed in percentage. This index indicates a role suitability degree [14].

EXIN e-Competence Assessment. EXIN has developed an online tool based on ECF and ICT Professional Profiles similar to CEPIS's [15]. It allows ICT professionals to find professional profiles, which match their skills best.

Respondents answer a questionnaire, where they select a competence level (Dimension 3 of ECF) and an extend level ("General", "Partial" or "Superficial") for each of 36 competences.

The algorithm is based on a simple equation method and consists of two main steps. At first, a level of competence proficiency (expressed in percentage) for each of 36 competences is computed by multiplying competence level by it extension level. Then, these scores are compared with what is required for each profile of 23 ICT profiles. A result is represented in Proximity Index, which indicates a role suitability degree [15].

2.3 The Proposed Method

After the described above analysis of significant disadvantages in existing methods, it becomes obvious that it is necessary to develop a new approach that would eliminate those serious flaws in order to provide an optimal solution for the problem. The approach should be based on a comparator identification method, which should significantly increase objectivity and allow deep connection to ECF and ICT PRP.

Comparator identification method is a method of indirect identification, which uses predicate logic for calculation. This method takes any types of data (signals) for input, but output is always binary (true/false or 0/1). Basically, this method allows to determine whether objects are in a particular relation or not [7, 8].

Method's feature of taking any data type for input allows full compatibility with ECF and ICT PRP, therefore, this method can be easily adapted to our domain. Binary output, in turn, allows to obtain a definite answer, which is in our case, "whether a specialist is eligible for a particular role in project or not?".

The following Table 1 gives the result of the methods comparison.

Table 1. Methods comparison

Method	Accuracy	Objectivity	ECF adaptation	Complexity	Completeness
Questionnaire	High	Medium	No	Medium	No
Simple equation	High	Low	Yes	Low	Yes
Analytical model	Medium	High	No	High	Yes
Fuzzy logic	Medium	Medium	Yes	Medium	Yes
Comparator identification	Medium	High	Yes	Medium	Yes

A comparator identification method provides a differentiated result in a binary form. Although it is not as accurate as in other methods, it meets the requirement of determination whether a specialist is suitable for a role in a project.

The main advantage of a proposed solution over other methods is high objectiveness and full compatibility with ECF and ICT PRP. High objectivity level is achieved by using predicate logic to strictly determine results for all possible cases. Flexibility of predicate logic, in turn, allows to fully adapt method to ECF and ICT PRP. All that makes the assessment process formalized and applicable in real projects.

3 Elaboration of the Proposed Approach

3.1 Assessment Methodology

Workflow description. An applicant for a role in a project is interviewed for knowledge and skills contained in the ECF competence description for each competence included in the Professional Role profile description. Based on the answers, a level for each competence and later – a role suitability degree – are determined using comparator identification method.

Algorithm. On the first step**,** respondent selects answers knows/doesn't know for each piece of knowledge and has/does not have for each skill (the fourth dimension) for each competence, needed for the role.

Then, the level of each competence is determined by the following predicate P_i:

$$P_i(x_1, \ldots, x_n, y_1, \ldots, y_m) = c_i, \qquad i = \underline{1, k}$$

k – Number of competences needed for the role
x – Pieces of knowledge
y – Skills
c_i – Proficiency level of i^{th} competence

The predicate includes only levels, available for this particular competence. The predicate has the following internal structure, where $c_i = c_i^{L_{min}}$ or $c_i = c_i^{L_{max}}$:

$$c_i^{L_{min}} = P_{L_{min}}(x_1, \ldots, x_n, y_1, \ldots, y_m)$$
$$\ldots$$
$$c_i^{L_{max}} = P_{L_{max}}(x_1, \ldots, x_n, y_1, \ldots, y_m)$$

L_{min} – Minimum possible proficiency level of competence
L_{max} – Maximum possible proficiency level of competence

The predicate is solved form bottom to top: if $P_{L_{max}} = 1$, then $c_i = L_{max}$, if $P_{L_{max}} = 0$, we go the predicate above and repeat algorithm until $P_{L_{min}}$ is reached. If $P_{L_{min}} = 0$, then the respondent does not have this particular competence.

Finally, after all competence levels are determined a role relevance degree is calculated by the following predicate:

$$P(c_1, \ldots, c_k) = r$$

$$r - role\ fitness\ degree\ (1\ or\ 0)$$

The result is obtained in the form suits ($r = 1$) or does not suit ($r = 0$).

3.2 Calculation of the Test - Examples

Example 1: Quality Assurance Manager. Let us suppose there are candidates for a vacant role of quality assurance manager in a new project, and they need testing in order to determine whether they suit this role (see Fig. 1).

Profile title	QUALITY ASSURANCE MANAGER ROLE (16)		
Summary statement	Ensures that processes and organisations implementing Information Systems comply to quality policies.		
Mission	Establishes and operates an ICT quality approach aligned with the organisation's culture. Commits the organisation to the achievement of quality goals and an encourages an environment of continuous improvement.		
Deliverables	**Accountable**	**Responsible**	**Contributor**
		• Quality Performance Indicators • ICT Quality Policy	• Quality Assurance • Risk Management Policy
Main task/s	• Establish and deploy the ICT quality policy • Organise and provide quality training • Provide ICT managers with quality performance indicators • Perform quality audits • Organise customer satisfaction surveys • Assist project team members to build and perform project quality plans		
e-Competences *(from e-CF)*	D.2. ICT Quality Strategy Development		Level 4
	E.3. Risk Management		Level 3
	E.5. Process Improvement		Level 4
	E.6. ICT Quality Management		Level 4
KPI area	Achievement of company quality goals		

Fig. 1. Quality Assurance Manager Role profile [5]

The role includes four competences. On the first step, our candidate will be tested to determine his proficiency levels for each competence. The determination of the competence level will be performed based on the answers in yes/no form for each piece of knowledge and each skill of the 4th dimension of the competence. The correctness of the results is supposed to be checked by company's technical specialists.

The first competence is D.2 - ICT Quality Strategy Development (see Fig. 2).

Dimension 1 e-Comp. area	D. ENABLE				
Dimension 2 e-Competence: Title + generic description	**D.2. ICT Quality Strategy Development** Defines, improves and refines a formal strategy to satisfy customer expectations and improve business performance (balance between cost and risks). Identifies critical processes influencing service delivery and product performance for definition in the ICT quality management system. Uses defined standards to formulate objectives for service management, product and process quality. Identifies ICT quality management accountability.				
Dimension 3	**Level 1**	**Level 2**	**Level 3**	**Level 4**	**Level 5**
e-Competence proficiency levels e-1 to e-5, related to EQF levels 3 to 8	–	–	–	Exploits wide ranging specialist knowledge to leverage and authorise the application of external standards and best practices.	Provides strategic leadership to embed ICT quality (i.e. metrics and continuous improvement) into the culture of the organisation.
Dimension 4 Knowledge examples *Knows/aware of/ familiar with*	K1 the major information technology industry frameworks, e.g. COBIT, ITIL, CMMI, ISO – and their implications for corporate IS governance K2 the information strategy of the organisation K3 the different service models (SaaS, PaaS, IaaS) and operational translations (i.e. Cloud Computing)				
Skills examples *Is able to*	S1 define an ICT quality policy to meet the organisation's standards of performance and customer satisfaction objectives S2 identify quality metrics to be used S3 apply relevant standards and best practices to maintain information quality				

Fig. 2. ICT Quality Strategy Development competence description [3]

The second competence is E.3 - Risk Management (see [3] p.44). The third competence is E.5 - Process Improvement (see [3] p.46). The forth competence is E.6 - ICT Quality Management (see [3] p.47).

The following Table 2 presents answers for each competence.

Table 2. Questionnaire answers

		c^1	c^2	c^3	c^4
K1	x_1	-	-	+	+
K2	x_2	+	+	+	+
K3	x_3	-	-	-	-
K4	x_4			+	
K5	x_5			+	
K6	x_6			+	
S1	y_1	+	+	+	+
S2	y_2	+	+	+	+
S3	y_3	+	+	+	+
S4	y_4		-		+
S5	y_5				+

The equation for determination of D.2 competence proficiency level is following:

$$\begin{cases} c^4 = x_2 y_3 (x_1 y_2 \vee x_1 x_3 \vee y_1 y_2) \\ c^5 = x_1 x_2 x_3 y_1 y_2 y_3 \end{cases}$$

The result for D.2 competence is: $P_1(\overline{x_1}, x_2, \overline{x_3}, y_1, y_2, y_3) = c^4$

The equation for determination of E.3 competence proficiency level is following:

$$\begin{cases} c^3 = x_2 y_1 y_2 \\ c^4 = x_1 x_2 y_1 y_2 (y_3 \vee y_4) \\ c^5 = x_1 x_2 x_3 y_1 y_2 y_3 y_4 \end{cases}$$

The result for E.3 competence is: $P_2(\overline{x_1}, x_2, \overline{x_3}, y_1, y_2, y_3, \overline{y_4}) = c^3$

The equation for determination of E.5 competence proficiency level is following:

$$\begin{cases} c^4 = x_1 x_2 x_6 y_2 y_3 \\ c^5 = x_1 x_2 x_3 x_6 y_1 y_2 y_3 (x_4 \vee x_5) \end{cases}$$

The result for E.5 competence is: $P_3(x_1, x_2, \overline{x_3}, x_4, x_5, x_6, y_1, y_2, y_3) = c^4$

The equation for determination of E.6 competence proficiency level is following:

$$\begin{cases} c^2 = x_2 y_2 y_5 \\ c^3 = x_1 x_2 y_2 y_5 (y_3 \vee y_4) \\ c^4 = x_1 x_2 y_2 y_3 y_4 (x_3 \vee y_1) \end{cases}$$

The result for E.6 competence is: $P_4(x_1, x_2, \overline{x_3}, y_1, y_2, y_3, y_4, y_5) = c^4$

After each competence level is calculated, it is possible to determine whether the candidate is eligible for the role. The following Table 3 presents the calculated competence levels.

Table 3. Levels of competences

D.2	c_1	c_1^4
E.3	c_2	c_2^3
E.5	c_3	c_3^4
E.6	c_4	c_4^3

The role suitability equation is given as:

$$r = c_2^3 c_4^4 (c_1^3 c_3^4 \vee c_1^4 c_3^3)$$

The final result equals: $P(c_1^4, c_2^3, c_3^4, c_4^4) = 1$ (The candidate fits the role).

Example 2: System Analyst Role. Let us suppose there is a candidate for a vacant role of system analyst in a new project, and this contender needs testing in order to determine whether he/she suits this role (see [5] p. 28).

The first competence is A.5 - Architecture Design (see [3] p.16). The second competence is B.5 - Documentation Production (see [3] p.24). The third competence is B.6 - System Engineering (see [3] p.25). And the last, forth competence is E.5 - Process Improvement (see [3] p.47).

The following Table 4 presents answers for each competence.

Table 4. Questionnaire answers

		c^1	c^2	c^3	c^4
K1	x_1	+	+	+	+
K2	x_2	+	+	+	+
K3	x_3	-	+	+	+
K4	x_4	-	+	-	-
K5	x_5	-		-	-
K6	x_6			-	+
K7	x_7			-	
K8	x_8			-	
S1	y_1	-	+	+	+
S2	y_2	+	+	-	+
S3	y_3	-	+	-	+
S4	y_4	-	+	+	
S5	y_5	+		-	
S6	y_6			+	
S7	y_7			-	

The equation for determination of A.5 competence proficiency level is following:

$$\begin{cases} c^3 = x_1x_2y_2y_5 \\ c^4 = x_1x_2x_3x_4y_2y_5(y_1 \vee y_4) \\ c^5 = x_1x_2x_3x_4x_5y_2y_3y_5(y_1 \vee y_4) \end{cases}$$

The result for A.5 competence is: $P_1(x_1, x_2, \overline{x_3}, \overline{x_4}, \overline{x_5}, y_1, \overline{y_2}, y_3, \overline{y_4}, y_5) = c^3$

The equation for determination of B.5 competence proficiency level is following:

$$\begin{cases} c^1 = x_1x_3y_1 \\ c^2 = x_1x_3x_4y_1y_4(y_2 \vee y_4) \\ c^3 = x_1x_2x_3x_4y_1y_2y_3y_4 \end{cases}$$

The result for B.5 competence is: $P_2(x_1, x_2, x_3, x_4, y_1, y_2, y_3, y_4) = c^3$

The equation for determination of B.6 competence proficiency level is following:

$$\begin{cases} c^3 = x_1x_2x_3x_5x_8y_1y_2y_3y_4y_6 \\ c^4 = x_1x_2x_3x_5x_8y_1y_2y_3y_4y_5y_6y_7(x_4 \vee x_6 \vee x_7) \end{cases}$$

The result for B.6 is: $P_3(x_1, x_2, x_3, \overline{x_4}, \overline{x_5}, \overline{x_6}, \overline{x_7}, \overline{x_8}, y_1, \overline{y_2}, \overline{y_3}, y_4, \overline{y_5}, y_6, \overline{y_7}) = c^0$ (The contender does not have this competence).

The equation for determination of E.5 competence proficiency level is following:

$$\begin{cases} c^4 = x_1x_2x_6y_2y_3 \\ c^5 = x_1x_2x_3x_6y_1y_2y_3(x_4 \vee x_5) \end{cases}$$

The result for E.5 competence is: $P_4(x_1, x_2, x_3, \overline{x_4}, \overline{x_5}, x_6, y_1, y_2, y_3) = c^3$

After each competence level is calculated, it is possible to determine whether the candidate is eligible for the role. The following Table 5 presents the calculated competences levels.

Table 5. Levels of competences

A.5	c_1	c_1^3
B.5	c_2	c_2^3
B.6	c_3	c_3^0
E.5	c_4	c_4^3

The role fitness equation is given as:

$$r = c_1^3c_4^4(c_1^3c_3^4 \vee c_1^4c_3^3)$$

The final result equals: $P(c_1^3, c_2^3, c_3^4, c_4^3) = 0$ (The contender does not fit the role).

4 Development of Software Tool for ICT- Professionals' Skills Assessment

4.1 Main Design Solutions

The software system is designed for ICT companies with a medium-to-large number of employees. Its mission is to automate the process of team formation, which should increase an overall project success.

The system should provide a functionality for project data management for company directors, team management for project managers and personal data management for all employees. Moreover, it should provide an opportunity for project managers to send employees project participation invitations and an opportunity for employees to apply for projects. Finally, one of the main of its features is an opportunity to test personnel for role eligibility to determine the best candidates and form an optimal team squad.

The defined functional requirements are shown on Fig. 3 in a form of a use case UML diagram.

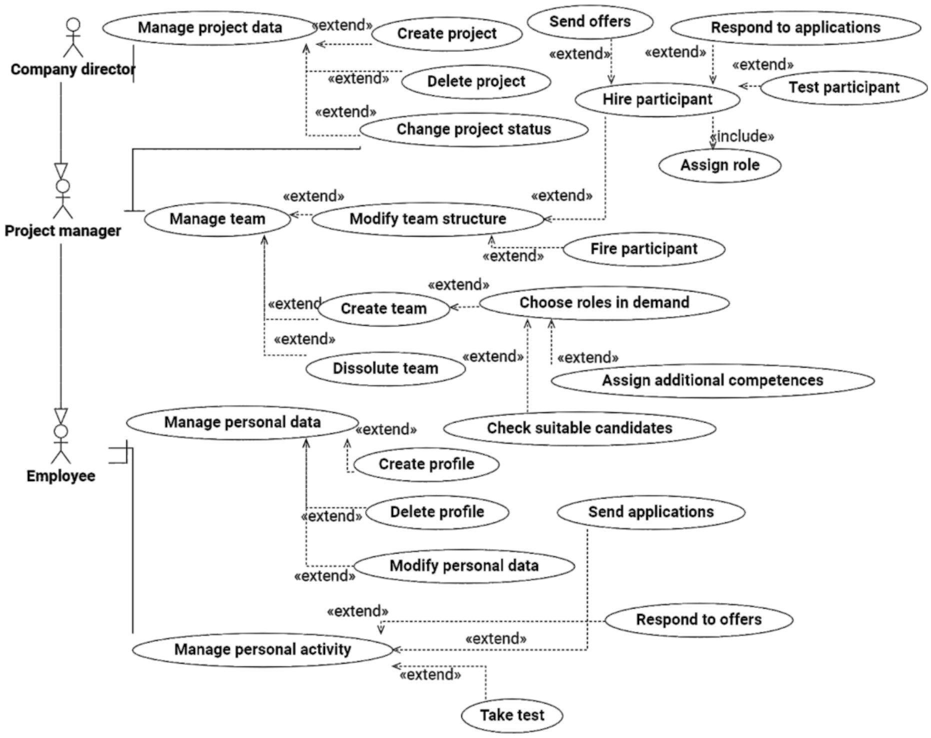

Fig. 3. Use case diagram for the functional requirements

Conceptual data model is given in the form of UML class diagram (see Fig. 4).

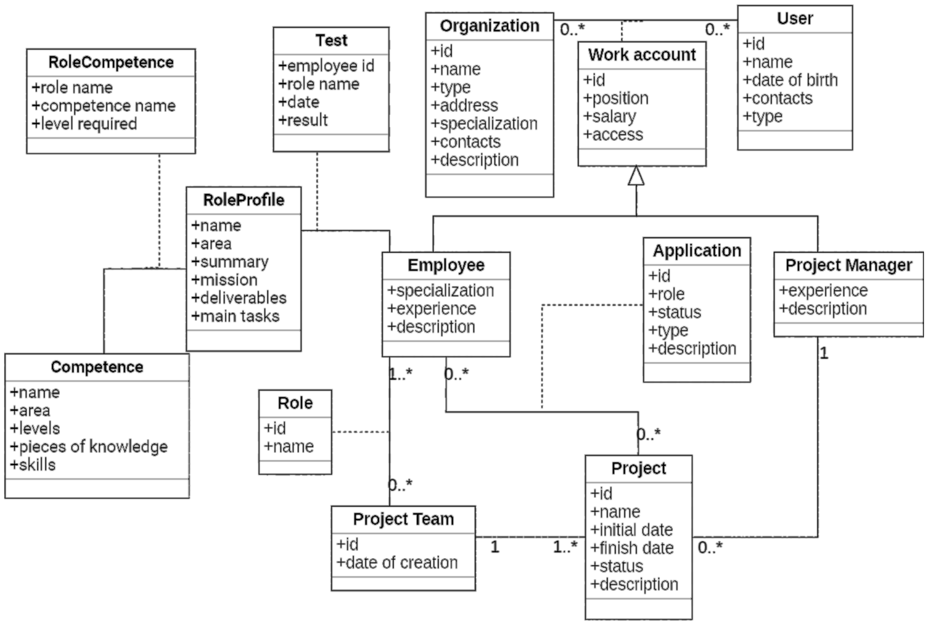

Fig. 4. Class diagram for the elaborated conceptual data model

"Competence" entity represents a competence from the ECF with all its attributes. "RoleProfile" entity represents a role profile from the ICT PRP with all its attributes. "RoleCompetence" entity represents a particular competence with its required level, included into a particular role.

These three entities are used to store ECF and ICT PRP documents in the database.

Database stores project managers ("Project Manager" entity) separately from all the other employees ("Employee") because of their relation to projects ("Project" entity). Projects can have any amount of employees of any specializations ("specialization" field in "Employee" entity), but one and only one project manager.

"Project team" entity represents a group of employees that work on a particular project or several projects. All employees in a project team are assigned specific roles ("Role" entity), which they have in this particular project team.

"Test" entity represents a test taken by a particular employee for a particular role.

"Role" entity represents a role of a particular employee in a particular project team.

Several factors determine optimal architecture. The first factor is target platforms (mobile devices in our case). The second factor is database and server provider (Firebase by Google in our case). It was motivated by high accessibility and the fact that Firebase provides both server and database management system.

Considering these two factors, Rich Mobile Application architecture was chosen (see Fig. 5).

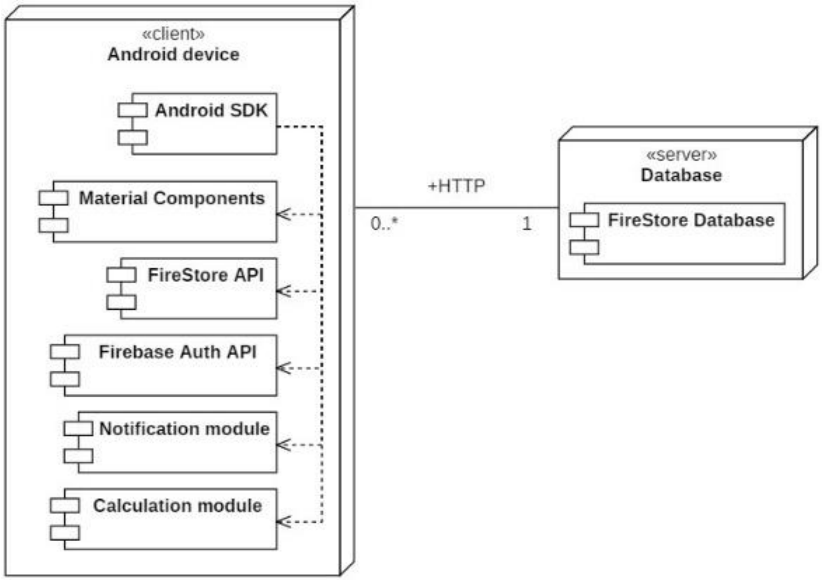

Fig. 5. Deployment diagram for the system architecture

On the basis of designed architecture and with regards to functional requirements, a software tool can be built. The prototype of such tool is shown in the next subsection.

4.2 Software Tool Prototyping

According to the functional requirements (see Fig. 3), the appropriate database model (Fig. 4) and the chosen architecture (see Fig. 5) as a prototype of a software tool was developed. Especially, on Fig. 6 and 7 the user's interface fragment is shown. Fig. 6 demonstrates options to analyze the project characteristics (Fig 6,A) and look through team's requirements (Fig 6,B). Fig. 7 demonstrates options to choose the appropriate workers from the list (Fig 7,A), and finally observe result of their skills testing with the ability to approve one of them for each project role (Fig. 7,B).

Fig. 6, 7 demonstrate the next case: There is a project (named "Example") for which a project team is needed. Currently, a team has a business analyst, a system architect, a tester and two developers approved. The next step is to approve an employee for a role of quality assurance manager. There are 3 candidates for this role with only two of them being suitable for it. A person responsible for a team squad formation chooses one of them and approves him/her for a role.

Usually, this process requires more people and time, as it is needed to form a pool of potential candidates, test every one of them, decide if they are eligible for the role, choose the best candidate and finally, inform everyone about the result. The suggested software tool automates this process so the choosing the best candidate is the only step that has to be performed manually.

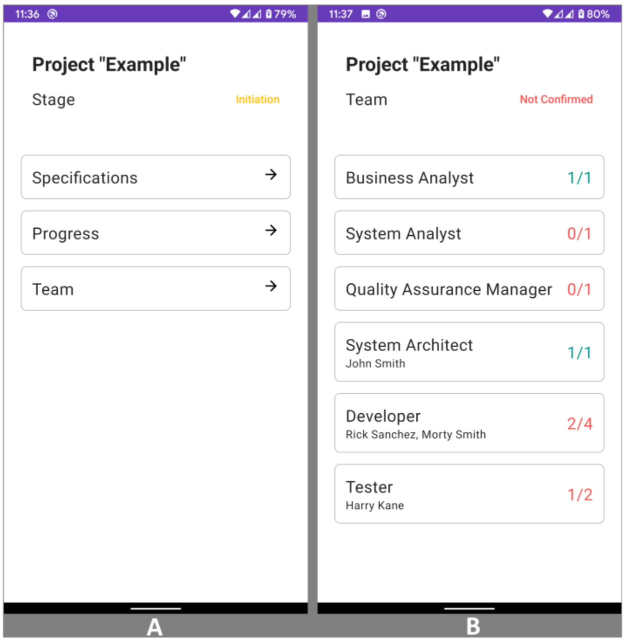

Fig. 6. Software tool prototype: candidate's data processing

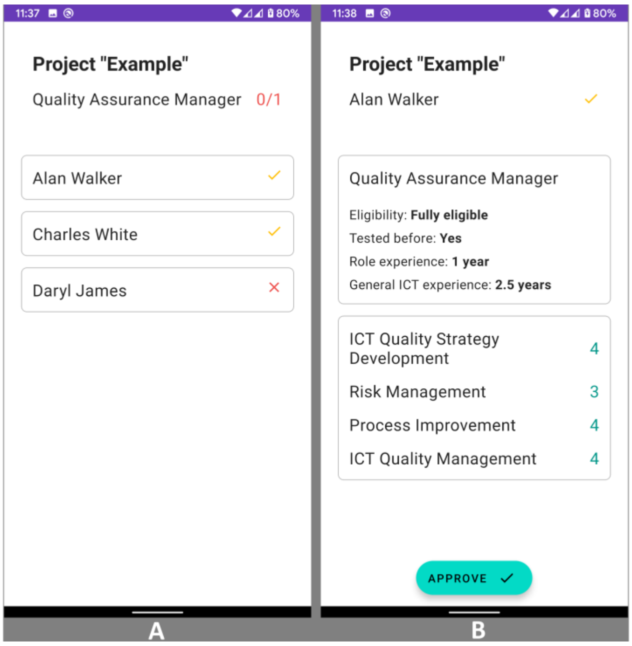

Fig. 7. Software tool prototype: final result for decision making

The experimental usage of the developed approach in the practice of candidates evaluating for an employment in the IT-company “Academy – Smart” LTD, Kharkiv [22] showed the processing time for appropriate data was reduced about 22%.

5 Conclusion and Future Work

This paper includes the overview of some existing methods, which can be used to perform an assessment of a specialist’s suitability for a particular role in ICT competences domain. Their weak points were determined and a new approach was proposed in order to eliminate them. Our approach is fully compatible with ECF and PRP documents and it is based on the comparator identification method that helps to increase the objectivity of the assessment result, because it calculates the quantitative parameters for this purpose. The experimental usage of this method has shown its feasibility in some real test – cases of IT-staff’s assessment.

Next steps to be done is a modification of our approach to increase its objectivity, in order to obtain more precise results that will help to make better decisions about potential team squad. In our future efforts, we also would like to elaborate a comprehensive methodology to test our approach not for selection of prospective candidates only, but with respect to a possible software product quality improvement in a target IT-company.

References

1. Dzvonyar, D., Henze, D., Alperowitz, L., Bruegge, B.: Team composition in Software Engineering Project Courses, SEEM’18, Gothenburg, Sweden (2018)
2. Aasheim, C., Shropshire, J., Li, L., Kadlec, C.: Knowledge and Skill Requirements for Entry-Level IT Workers: Longitudinal Study. In: Journal of Information Systems Education: Vol. 23, Issue 2, Article 8 (2019)
3. European e-Competence Framework 3.0 – CEN Workshop agreement (2018)
4. European e-Competence Framework 3.0 – User guidelines – CEN Workshop agreement (2018)
5. European ICT professionals role profiles 2.0 – CEN Workshop agreement (2018)
6. European ICT professionals role profiles 2.0 – User guidelines – CEN Workshop agreement (2018)
7. Shabanov-Kushnarenko, S. Yu. Komparatornaya identifikatsiya protsessov mnogomernoy kolichestvennuy otsenki [Comparative identification of multidimensional quantitative estimation processes]. Saarbruecken, Germany, PalmariumAcademicPublishing (2015)
8. Cherednichenko, O. Yu, Grinchenko, M. A., Vasylenko, A. V., Matvieiev O. M.: The method of data search and analysis from the internet resources for the formation of actual requirements for candidates. In: Bulletin of NTU “KhPI”, Kharkiv, NTU ”KhPI”, Vol. 1 (1277), pp.31-38 (2018)
9. Sokol, V.E., Tkachuk, M.V., Vasetka, Y.M.: Adaptive Training System for IT-companies Personnel: Design Principles, Architectural Models and Implementation Technology. In: Bulletin of NTU “KhPI”, Kharkiv, NTU ”KhPI”, Vol.51 (1272), pp.38-43 (2017)

10. Tkachuk, M. V., Sokol, V. E., Bilova, M. O., Kosmachev O. S.: Classification, typical functionality and application peculiarities of learning management systems and training management systems at IT-companies. In: Modern Informational Systems, Vol. 2 (4). pp.87–95 (2018)
11. Grabovetsky, B.S.: Economic forecasting and programming. Vinnitsa, VDTU (2001)
12. Kovalenko, I.I.: Expert assessments in innovative projects control. Nikolaev, NUK (2007)
13. CEPIS, e-Competence in Europe - Analysing Europe's Gaps and Mismatches for a Stronger ICT Profession, European Report (2014)
14. CEPIS e-Competence Benchmark // www.cepisecompetencebenchmark.org.
15. EXIN e-Competence Quality // http://www.e-competence-quality.com.
16. Zakarian, A., Kusiak, A.: Forming teams: An analytical approach. In: IIE Transactions, Vol. 31, pp 85–97 (1999)
17. Campelo, M., Figueiredo, T., Silva, A.: The sociotechnical teams formation problem: a mathematical optimization approach. In: Annals of Operations Research, Vol. 286, Issue 1–2, pp 201–216 (2018)
18. Chen, S.-J., Lin, L.: Modeling team member characteristics for the formation of a multifunctional team in concurrent engineering. In: IEEE Transactions on Engineering Management, Vol. 51 (2), pp. 111–124 (2004)
19. Fitzpatrick, E. L., Askin, R. G.: Forming effective worker teams with multi-functional skill requirements. In: Computers and Industrial Engineering, Vol. 48 (3), pp. 593–608 (2005)
20. Tseng, T. L, Huang, C. C., Chu, H. W., Gung, R. R.: Novel approach to multi-functional project team formation. In: International Journal of Project Management, Vol. 22 (2), pp. 147–159 (2004)
21. Karsak, E. E.: A fuzzy multiple objective programming approach for personnel selection. In: Proceedings of the 2000 IEEE International Conference on Systems, Man, and Cybernetics, Nashville, TN, USA, Vol. 3, pp. 2007–2012 (2000)
22. Official Web-site of the "Academy - Smart" IT-company // https://academysmart.com.ua/