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Which Are the Most Desired E-Competences of Future ICT Professionals?

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Abstract. *Nowadays, almost every business system faces challenges caused by the increase development and use of information and communication technologies (ICT). In this respect, there is an evident need for the ICT-skilled professionals who will be in charge of the development and implementation of new ICT solutions in different domains. This paper elaborates the acquisition of relevant e-competences directly and indirectly within higher education institutions, analyses the most desired competences of ICT professionals as perceived by employers on the current labour market and provides recommendations for the development of most desired e-competences within higher education needed for the development and implementation of new ICT solutions, based on the European e-Competence Framework.*

Keywords. ICT professionals, higher education, e-Competence Framework, job advertisement analysis

1 Introduction

Nowadays, information and communication technologies (ICT) are a key asset of any organization that wants to be competitive and succeed in today's dynamic and constantly changing environment. ICT affects changes on the global level, but as well on the institutional and individual level. Different profit organizations use the potential of ICT to optimize their processes, reduce costs, obtain competitive advantage etc.

The need for the ICT skilled workers and the lack of them on the labour market is recognized as an important issue at the European level. Latest statistics show that ICT skilled professionals are in demand, not only in the ICT sector, but across many other sectors (European Commission, 2016b; Eurostat, 2016). Even more, statistics show that 55% of ICT practitioners work in other industries than ICT (European Commission, 2012). Many latest European strategic documents indicate a need for more skilled ICT workers. One of the latest European initiatives, Digital Skills and Jobs Coalition, put emphasize on four main target groups, one of which are digital skills in education (European Commission, 2016a). Although there is a strong emphasis on the lack of skilled ICT professionals both within the relevant strategic documents and within the scientific literature, it should be stressed that digital skills are required in all types of jobs, which indicates the importance of the development of such skills not only from ICT students, but from the students in different domains and within a variety of job profiles (European Commission, 2014). Moreover, the effective use of ICT and other relevant digital competences are considered nowadays as one of the key generic and lifelong learning competences (European Commission, 2007; Tuning Educational structures in Europe, 2008). Consequently, in the context of higher education, there is a pressure on higher education institutions (HEIs), as the main generator of highly educated and skilled workers, to provide high quality processes of teaching and learning that enable student development of relevant digital competences.

This paper first elaborates different types of digital competences and then describes the need for student acquisition of digital competences within higher education from two different aspects – the digital competences developed indirectly through the use of different ICT solutions that support higher education processes (learning, teaching, administrative and managerial processes etc.) within different study domains and the digital competences developed directly through the curriculum for students in the ICT study domain. Further focus of this paper is put on competences of students in the ICT domain that should be developed directly through the curriculum, based on the empirical research. The empirical research presents the analysis of job advertisements for the ICT sector in order to detect the most desired e-competences of ICT professionals on the current labour market, as it is evident that ICT specialists are employed across the all industry sectors. Therefore, the main research question is: *Which e-competences are most desired from employers on the current labour market and should be developed to a large extent within higher education of future ICT professionals?*

Further work proposes the research about the digital competences in study domains other than ICT from two aspects – the development of certain digital competences within study period and the need for such competences at graduates' job positions.

2 Requirements for e-competences

The intention of this chapter is to explain the main terms related to digital competences and the ways of achieving them within higher education.

At the European level there are several relevant documents/initiatives elaborating digital competences. First, as a results of the European E-skills Forum, three main categories of e-skills were recognized: *ICT practitioner skills*, *ICT users skills and e-Business skills* (European Commission, 2004).

In the context of *ICT practitioner skills*, the European e-Competence Framework (e-CF) is developed as a common framework for ICT professionals in all industry sectors (European Committee for Standardization (CEN), 2014). This framework comprises 40 e-competences organized around five e-competence areas (plan-build-run-enable-manage), with indicated proficiency levels and a sample of knowledge and skills for each e-competence. As this framework covers all industry sectors, it may also be used to recognize the most important competences of future ICT professionals for the development and application of new ICT solutions. Except the *ICT practitioner skills*, it may be also said that the e-CF covers the aspect of *e-Business skills* which consider the exploitation of opportunities of new ICT solutions. This is evident from the areas *Enable* and *Manage*, which consider the strategic planning and exploring capabilities of new ICT solutions within organizations. However, most of the competences contained within the e-CF are related to the development of new ICT solutions, supported with their implementation and maintenance (areas *Plan*, *Build* and *Run*).

The *ICT user skills* are covered within the Digital Competence Framework (DigComp) which identifies key digital competences for all citizens in general in five areas: 1) Information and data literacy, 2) Communication and collaboration, 3) Digital content creation, 4) Safety and 5) Problem solving (Vuorikari, Punie, Carretero, & Van den Brande, 2016). The set of competences presented within DigComp indicates competences needed in the digital era by all ICT users and not only the ICT professionals, as it is the case with the e-CF.

Except the distinction of three main types of digital competences, the usage of ICT may also be considered as one of the main generic competence as well as one of the key lifelong learning competence which are expected from all citizens and not only from graduates in the ICT domain. As this paper focuses on ICT professional skills based on the e-CF, the importance of digital skills expected from other graduates is not researched in detail, but is elaborated within the conclusion and further work.

It should be also stressed that previous relevant scientific literature recognizes different competences required from ICT professionals, including both technical (hard) and generic (soft) skills (Nelson, 1991; Lee, Trauth, Farwell, 1995; Todd, 1995; Gallivan, Truex & Kvasny, 2004).

As already mentioned in the introduction, from the aspect of achieving different types of digital competences within higher education, two main directions may be recognized – indirectly through the use of ICT solutions that support different processes within higher education (learning, teaching, administrative, managerial etc.) and directly through the curriculum for students in the ICT study domain. The next subchapter summarizes different types of information systems used in higher education and therefore indicate a need for students' ICT user skills in different study domains that are, to some extent, acquired by the usage of different ICT solutions during their higher education experience. Further empirical research is focused on e-competences that should be developed within the curriculum for study programmes in ICT domain.

3 ICT solutions in higher education supporting the development of *ICT user skills*

The usage of ICT in higher education is evident in all phases of student engagement with an HEI, from pre-entry, through several years of studying to their alumni period. Therefore, this considers the application of digital skills at certain proficiency level during their study experience. The level of proficiency to which students will acquire certain digital competences is certainly affected by number and complexity of different ICT solutions used within HEIs. Therefore, this chapter describes in short different types of ICT solutions that are used in HEIs, regardless the study domain.

First, in the pre-entry phase, information system assists high school graduates in the process of application for the certain HEI and when entering the HEI. This information systems do not only support students in the admission phase, but also provide HEIs information about the structure of the cohort entering the HEI, helping them to collect and organize information about freshmen in one place etc.

During their study period, students face with the ICT in the processes of learning and teaching. One of the most important role of ICT within education is enhancing the quality of student learning experience, while the appropriate use of different ICT resources support student centred learning and creates more creative learning environment (Fu, 2013). As an addition to the traditional face-to-face learning, numerous examples of different use of ICT in education can be recognized, organized around different types of e-learning: ICT supported face-to-face learning, blended learning and fully online learning (Begičević, Divjak, & Hunjak, 2007). In recent years, the trend of e-learning in education is

evident in the development and use of Massive Open Online Courses (MOOCs) (Baggaley, 2013), with the evident use of MOOCs in traditional classrooms as well (Bralić & Divjak, 2016). Along with the development of e-learning and MOOCs, learning management system (LMS) appears no longer to be enough, and the importance of the development of learning analytics systems (LAS) in education became a very popular issue (Greller & Drachsler, 2012). The use of mentioned ICT solutions to support learning and teaching processes within higher education indicates a need for all the competences contained within the DigComp framework, both from students and teaching staff.

Although the usage of ICT for supporting processes of teaching and learning is widely represented in literature, evidence on the use of ICT for supporting managerial and administrative processes also exist (Ghavifekr, Afshari, & Seger, 2013). Among the most important benefits of ICT in education is a huge number of variety of data collected through different information systems. Those data are very valuable managerial asset as they provide basis for the effective decision-making, benchmarking with other HEIs etc. Even more, the application of a comprehensive information systems, so called Enterprise Resource Planning (ERP) that support the provision of a whole range of educational services from the perspective of internal resources planning is evident in educational organizations (Abugabah & Sanzogni, 2010). The value of data collected through different information systems within higher education indicate the importance of student active usage of those systems during their higher education experience.

Once graduates leave HEIs, HEIs can still use a certain information system to collect information about their alumni career progress and stay connected with them (Mijić & Janković, 2014). This is particularly important because graduate studies are recognized as a very valuable asset for improving the quality of education and aligning the educational processes with labour market needs. As such, graduate studies supported with an online system may provide increasingly important inputs for HEI management regarding different processes, including strategy development, improvement in curriculum design and delivery, organization of student support services and extra-curricular activities etc.

The presented short literature review indicated various types of information systems used to support a whole range of internal and external processes within HEIs. The usage of ICT in higher education requires certain ICT skills from teachers and there are numerous papers on this topic available in the scientific literature. Moreover, there are also requirements for ICT user skills needed from students in different study fields. Finally, there is also a need for skilled ICT professionals who would develop and implement such information systems. Therefore, this paper further puts focus on professional digital skills (e-competences) which are required for the development and implementation of new ICT solutions, and should be developed directly through curriculum for future ICT professionals.

4 Labour market requirements for the *ICT practitioner skills*

4.1 Methodology

Empirical part of this research includes the analysis of e-competences needed for development and implementation of new ICT solutions, which are required from ICT professionals on the current labour market. This research is based on qualitative analysis of job advertisements announced at the online portal MojPosao (http://www.moj-posao.net/). For purpose of detecting the most desired competences of future ICT professionals (current ICT students) and providing recommendations about competences that should be developed within ICT curricula, job advertisements in category "ICT & telecommunications" were analysed in period between 1st and 31st of April 2017. The analysis included 119 job advertisements that were active in that period. The analysis of job ads on this portal was chosen as appropriate method for several reasons: 1) actual job ads are a very good indicator of desired competences of ICT professionals on the current labour market from the employers' point of view, 2) job ads on this portal are structured in a way they contain job description with main tasks and responsibilities and the qualifications and skills for a certain job position so they are suitable for the analysis according to the e-competence framework with pre-defined competences categories.

E-competences were analysed according to the e-CF that comprises 40 e-competences organized around five e-competence areas (plan-build-run-enable-manage) which cover the entire ICT solution lifecycle. The *Plan* area is related to designing new ICT solutions, including innovation processes, *Build* area consider development of new ICT solutions (programming), the *Run* area supports implementation of developed ICT solutions in practice, the *Enable* area contains all supporting processes that enable implementation of new ICT solutions while the *Manage* area is related to managerial and quality assurance activities within process of new ICT solutions development and implementation.

The analysis within this research was conducted in a way that appearance of each e-competence in a certain job ad was marked in an Excel spreadsheet, rather than frequency of appearance of certain competence. This type of analysis is known as content analysis. It should be stressed that in some cases e-competences were not mentioned explicitly in the job ads but they were recognized from the context of a job description in relation to the description of knowledge

and skills available for each of e-competences within e-CF. For example, a description "documenting standard demo flows" within one job ad was recognized as a competence *B5 Documentation Production* from e-CF. This analysis follows the methodology presented in previous work of Pažur Aničić & Arbanas (2015), who used the same approach to initial analysis of the most desired e-competences and generic competences within job ads related to future ICT professionals.

4.2 Results

Fig. 1 shows presence of e-competences from e-CF in the set of analysed job ads according to these five e-competence areas. As can be perceived, the most desired competences are within the category *Build* which contains 6 competences, followed by the category *Plan* with 9 competences. Categories *Run* (4 competences) and *Enable* (12 competences) are almost equally represented within the analysed job ads, while the competencies from the category *Manage* (9) were recognized in the smallest number of job ads. Additionally, from the 40 e-competences contained within the e-CF, none of them is recognized in more than a half of analysed job ads. Around one half of competences are recognized in 10 or more job ads, which makes only around 10% of analysed job ads. Only four competences appeared in around 1/3 of ads or more. To provide more detail insight into the recognized competencies, graphical representation for each of five areas separately is presented below.

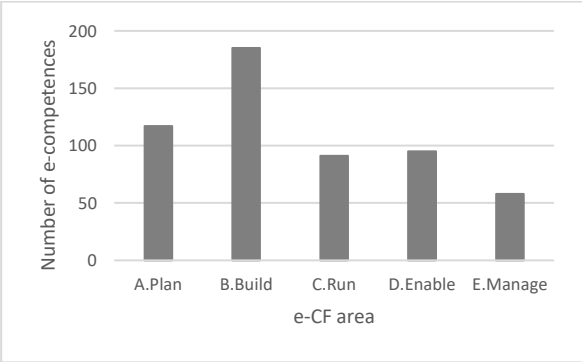


Figure 1. E-competences in job ads according to the e-CF competence areas

First category, *Plan*, represents a strategic area as it involves competencies necessary to detect organizational processes for which ICT may be used for improving efficiency and effectiveness. However, this area is not focused only on existing processes, but also requires strategic thinking about future organizational directions and how ICT may support future developments and contribute to the achievement of set goals. It is interesting to notice the most present e-competence from this category is *A.9. Innovating*, followed by the *A.6. Application Design* (Fig. 2). This innovating considers creative thinking about ICT solutions and it is closely connected with the *A.7. Technology Trend Monitoring* aimed at exploiting the latest technological developments and identifying their potential within organizations. Monitoring of new trends in ICT industry and innovative thinking are a prerequisite for designing of new ICT solutions (*A.6. Application Design* and *A.5. Architecture Design*) in accordance with customer needs. It might be noticed that competences related to the business planning and strategic development are recognized in considerably smaller number of job ads. The reason for this probably lies in a fact that analysed job ads are mostly for ICT practitioners and not managers in charge of strategic planning processes within an institution.

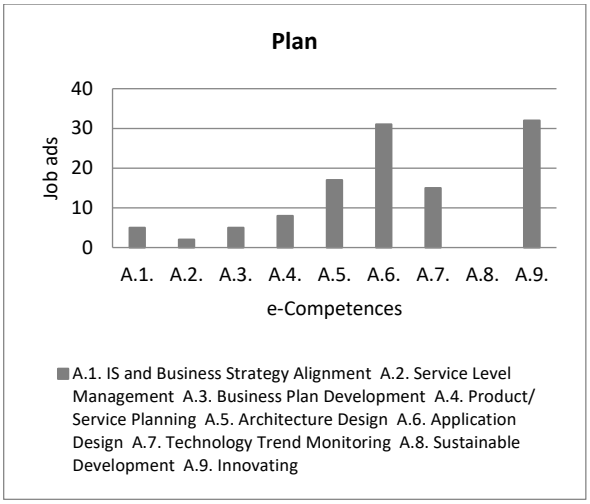


Figure 2. E-competences in the area *Plan*

The second area, *Build*, is associated with development and implementation of new ICT solutions. As its description says, and as it is evident from general results shown in Fig. 1 and more detailed results for this area shown in Fig. 3, competences within this area are the most important for the incorporation of new IT solutions in any organization. However, it should be stressed that successful development of innovative ICT solutions requires support in planning processes that precede development itself, but also the further provision and maintenance contained within processes in the *Run* area. Fig. 3 shows that the most desired competencies from the *Build* area are *B.1. Application development, B.5. Document Production and B.3. Testing*, followed by the *B.2. Component Integration* and *B.4. Solution Deployment*.

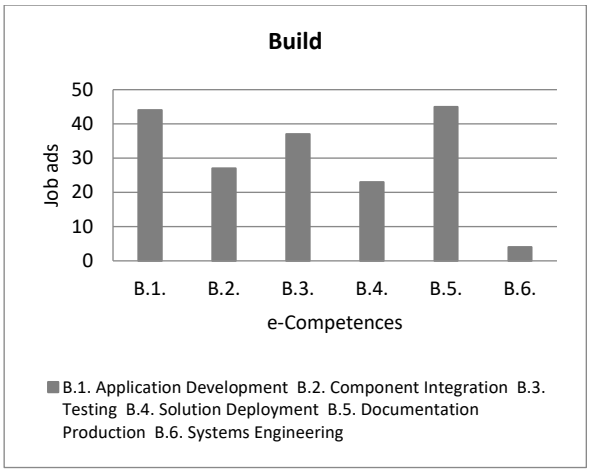


Figure 3. E-competences in the area *Build*

The *Run* area is the most important for successful provision of new ICT solutions developed within the area *Build*. Fig. 4 shows that the most desired competence is *C.2. Change Support*, which is focused on guiding the evolution of an ICT solution. Changes in ICT solutions may be caused by certain problems or incidents that occur so this competence is closely related to the *C.4. Problem Management.* Except dealing with needed changes and recognized issues related to the ICT solutions within an organization, this area contains also the competence *C.1. User Support* that consider clearly communication with users and providing them with instructions on how to implement and use new ICT solutions in their everyday tasks.

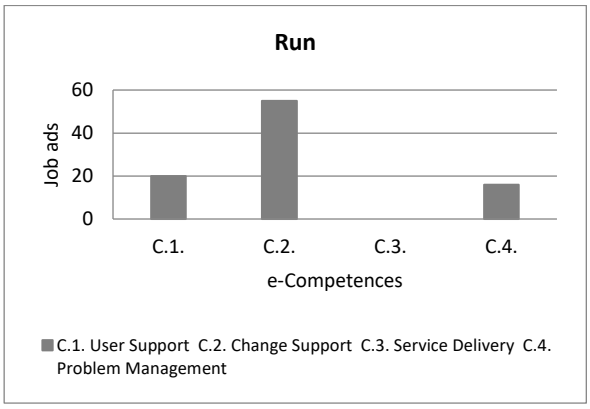


Figure 4. E-competences in the area *Run*

Enable area contains the highest number of e-competences – 12 of them. This comprehensive area may be described as a managerial horizontal area that contains competences need in all the phases of an ICT solution life-cycle. The most important competence in this area is *D.10. Information and Knowledge Management*, which consider identifying, gathering, storing, analysing and interpreting knowledge and information related to all segments of a new ICT solution development and implementation. Three additional competences from this area were found to be moderately represented in ICT job ads – *D.7. Sales Management*, *D.11. Needs Identification* and *D.12. Digital Marketing*. All the other competences from this area appeared in a few job ads (Fig. 5).

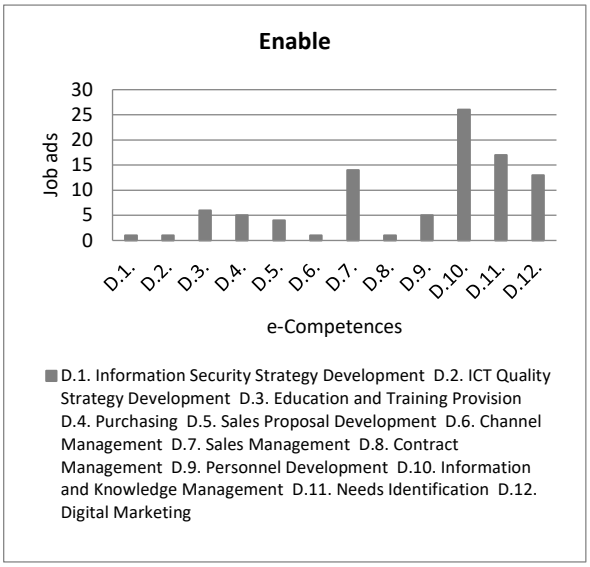


Figure 5. E-competences in the area *Enable*

Finally, the area *Manage* consist of competences needed for everyday administrative and operational tasks related to different ICT solutions in organizations (Fig. 6). *E.4. Relationship Management* is recognized as the most desired competence in that context, as it considers establishing and maintaining positive relationships with all stakeholders affected by the use of new ICT solutions within an organization. *E.2. Project and Portfolio Management* and *E.5 Process Improvement* are also recognized as important.

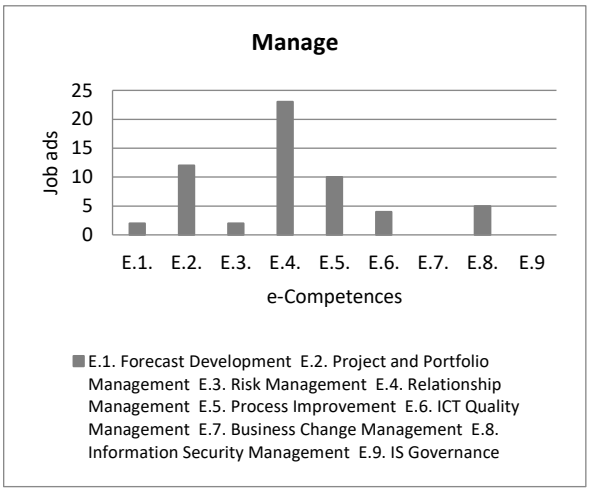


Figure 6. E-competences in the area *Manage*

This chapter provided overview of the most common e-competences which can be found in the active job ads for the ICT professionals. Except the comparison with the e-CF, the analysis also included the appearance of generic competences in job ads. As the generic competences are not in the main focus of this research paper, only those recognized in the highest number of job ads will be stressed here, which are: knowledge and

understanding of the subject area; understanding of the profession and the ability to apply knowledge in new situations; ability to communicate both in foreign language and mother tongue; teamwork and interpersonal skills. However, it should be stressed that the usage of ICT, which also appears on the list of generic and lifelong learning competences, was not observed as generic competence in the context of this research as it analyses e-competences as professional competences within ICT domain.

5 Recommendations about future e-competences in the education of ICT professionals

Based on the presented research results, this chapter provides recommendations for the development of e-competences in the education of future ICT professionals within HEIs, taking into account the most desired skills as resulted from the analysis. The e-CF showed five main areas of competences – plan, build, run, enable and manage. This framework indicates that, for successful implementation of new ICT solutions within an organization, it is crucial to cover competences from all areas. Moreover, the e-CF proposes needed e-competences at certain proficiency level for 23 ICT profiles, organized around six main families: *business management, technical management, design, development, service & operation* and *support*. (European Committee for Standardization (CEN), 2012). The recommendations within this paper are organized around these main ICT profiles' families, based on the results of actual job ads which indicate the most desired competences from employers at the current labour market. However, it is important to emphasize that diversity of required competencies within job ads on the labour market makes it hard to divide them strictly into one of proposed ICT profiles. In some cases, a combination of more ICT profiles may be recognized within one job ad. Therefore, these recommendations does not strictly follow the ICT profiles, but are rather organized by the authors of this paper around skills needed for the education of *business managers* as the main initiators of the implementation of new ICT solution and *lower level managers* responsible for the implementation of those solutions in practice. Further, there is a need for *ICT specialists* proficient in design, development and implementation of new ICT solutions and the *ICT support personnel* responsible to support all the stakeholders in the use of new ICT solutions.

The recommendations begin with a set of e-competences that may be considered important from future business managers in different organizations, which can be, in the context of e-CF related ICT profiles, recognized as *Business Information Manager*, *Chief Information Officer (CIO)* and *ICT Operations Manager*. Persons at those managerial positions should, first of all, have the vision and long term institutional strategic plans and recognize the potential for supporting the achievement of those plans with new ICT solutions (*A.1. IS and Business Strategy Alignment*). A very appreciate characteristic of managers is that they are familiar with the latest technology development in a certain field so they can recognize the potential of these new ICT solutions for achieving certain goals and optimizing processes within different organizations (*A.7. Technology Trend Monitoring*). When thinking about new ICT solutions, managers should be able to recognize the needs of all relevant stakeholders, both internal and external (*D.11 Needs Analysis*) and try to propose creative and innovative solutions that add a certain value to the stakeholders' experience with the institution (*A.9. Innovating*). Of course, it is well-known that managerial positions require certain work experience, but some general skills and knowledge for these positions should also be developed already during the study period. This particularly refers to the competences such as innovating and technology trend monitoring which are today considered, not only as e-competences, but also a kind of generic competences. Moreover, students' experience with the usage of different ICT solutions (LMS, MOOCs, ERP etc.) within higher education is also important as it provides them an overview of the complexity of such solutions and processes they support within a concrete organization.

While business managers are responsible for recognizing the potential benefits of new ICT solutions on the organizational level, their role is usually not to plan those solutions in detail. The operationalization of implementing new ICT solutions should be a task of technical level ICT managers, such as *Quality Assurance Manager, ICT Security Manager, Project Manager* and *Service Manager*. As a bridge between the management decisions about new ICT solutions on one hand and ICT professionals who should implement those solutions on the other hand, a persons in charge of that role should have high level of technical skills, but also understanding of the domain in which the technology will be implemented. In that sense, the e-competences recognized as the most desired from higher level managers (*A.7. Technology Trend Monitoring, A.9. Innovating* and *D.11 Needs Analysis)* are also desired from technical managers. However, technical managers are additionally expected to be proficient in more operational tasks, including the design of new ICT solutions both on the level of hardware and software (*A.5. Architecture Design* and *A.6. Application Design*). Although it is not expected that technical managers themselves develop new ICT solutions, they should be very well versed in programming skills in order to monitor and direct the work of ICT professionals in the process of new ICT solutions development. To summarize, the technical manager takes responsibility to manage the entire project of new ICT solution development and

implementation. This requires knowledge and skills associated to the e-competences *E.2. Project and Portfolio Management*, *E.5. Process Improvement* and *E.8. Information Security Management.* The implications for HEIs in this context are the involvement of project-based lessons and embedded work-related activities based on the complex real-world problems and teamwork, so the students can acquire the needed competences. In that context, collaboration with employers within formal curriculum should be a high priority, as well as student internships as an integral part of curriculum.

The demanding job of development of new ICT solutions proposed by higher level ICT managers and further designed by technical managers is on ICT professionals. Their main tasks are organized around the *Build* and *Run* area from e-competence framework, which are in the context of ICT profiles divided into *Design* and *Development*. Therefore, they are expected to be proficient in a whole set of skills related to the development of new ICT solutions (*B.1. Application Development*, *B.2. Component Integration*, *B.3. Testing*, *B.4. Solution Deployment*, *B.5. Documentation Production* and, to smaller extend, *B.6. Systems Engineering*) and skills that enable the implementation of those solutions in practice. This considers the successful service delivery and supporting the evolution of an ICT solution (*C.2. Change Support* and *C.4. Problem Management*), but as well the support for end users (*C.1. User Support*). This latest set of skills may be found within the ICT profiles categories of *Service & Operations* and *Support*. In the context of HEIs, the development of this set of competences requires a lot of laboratory work, which enable students' practical work on the development of new ICT solutions in different programming languages. Job ads also indicate that many companies give advantage to candidates with knowledge of specific programming language. Therefore, HEIs should rethink about the flexible curriculum that enable students' acquisition of a wide range of programming skills, according to their own preferences or the preferences of their desired future employers.

Finally, end users of new ICT solutions are expected to have skills necessary for using those solutions in an effective way to support their daily activities. However, the end-users' e-competences are not in the scope of this research, but it should be stressed that end-users should be provided adequate support for using the new ICT solutions. Except the already mentioned e-competence *C.1 User Support*, this also requires ICT students to have knowledge and skills related to the e-competence *D.3. Education and Training Provision*.

6 Conclusion and further work

This paper is based on the analysis of job advertisements in the ICT domain, which indicated the most desired competences from ICT professionals on the current labour market, based on the e-Competence Framework. The results of this analysis provided insight into the competences that should be included to a larger extend into the curriculum for the ICT professionals, in order to educate students that will have potential to find meaningful employment on the labour market. Recommendations on the development of future e-competences are organized according to the several main types of ICT-related jobs, including business managers, technical managers, developers and user support personnel. It is interesting to notice that some of the most desired e-competences are today also considered as generic and transversal competences, such as *innovating*. In order to enable the development of a wide range of recognized e-competences within HEIs, a new student centred learning and teaching approaches should be used within higher education, such as problem-based learning, project-based learning, work-based learning etc. The value of different student centred approaches lies in a fact that they enable the development of a wide range of e-competences, but as well support the development of generic competences. Moreover, these approaches often consider the collaboration with employers and students' work on real-work projects. Employer active involvement in curriculum is among the most desired university-business cooperation strategies as it has direct impact on the development of students' competences that increase their employability potential.

One of the main limitations of this research is a focus to only the job ads in the Republic of Croatia. Further work should include more job ads from different countries. Moreover, more ads included in the analysis could lead to more detailed recommendations related to certain ICT families or even on the level of ICT profiles. However, from 40 e-competences contained within e-CF, the analysis extracted smaller number of them which appears to be the most important from the employers' point of view.

Except the e-competences needed from the ICT professionals, the introductory chapters of this paper indicated the need for the acquisition of digital competences from the professionals in other domains. Therefore, plans for further work include the analysis of the requirements for e-competences in domains other than ICT, but also the analysis of the level to which digital competences are developed within different study programs and the level to which such competences are required at different types of workplaces. This kind of analysis will provide an overview of the need for digital competences as one of the main generic skills across a spectrum of domains.

Acknowledgments

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