Future Competences for the European Software Sector: A Mixed-Method Approach

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The shortage for ICT personal in the EU is large and expected to increase. The aim of this paper is to disseminates information from the ESSA alliances needs analysis. The needs analysis research was to contribute to a better understanding of the roles and competences needed, so that education curricula can be better aligned to evolving market demand,by answering the research question: *Which competence gaps do we need to bridge in order to meet the future need for sufficiently qualified personnel in the EU Software sector?* In this research, a mixed method approach was executed by ESSA-partners in twelve European countries, to map the current and future needs for competences in the EU. The analyses shows changes in demand regarding technical skills, e.g. low-code and a stronger focus on soft skills like communication and critical thinking. Besides this, the research showed educational institutes would do well to develop their curricula in a practical way by integration of real live cases and work together with organizations.

Keywords: software sector, skills, future, roles, competences, curricula

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1 Introduction

Current education and training programs are unable to meet the rising demand for properly skilled staff in the European software industry (Saabeel et al., 2022). Several studies highlight the alarming figures concerning the increasing shortages of ICT professionals in a growing number of different roles with related skills requirements (European Commission, 2019; European Commission, 2020, Beckett & Daberkow 2019). To close this growing skills gap, Europe needs a new strategy for software skills that can accelerate workforce upskilling and reskilling (European Commission, 2017; Saabeel et al., 2022). Technological developments have changed the way software and ICT infrastructure are being designed, delivered, and managed (ESSA, 2021a). This enables the development of more services using new types of technologies such as cloud computing, AI, Machine Learning and Blockchain. Moreover, technological developments have increased the automation of aspects such as testing, deployment, management of new releases and introduced new approaches to working in teams to create software and services, like DevOps (ESSA, 2021a). This calls for shorter and more efficient education cycles. However, the pace of technological change makes it difficult for education and training providers to keep up and adapt their curriculums to the changing software skills demand of the market. Vocational education is seen as one solution to this problem as it provides an appropriate format for more flexible learning pathways and better connection with industry and employer needs (Aertsen & Saabeel, 2022).

The European Software Skills Alliance (ESSA) has the objective to close the gap between the demand and need of software skills in Europe. This consortium of both academia and practitioners have worked on a needs analysis in the sector during this second phase of this four year project. The needs analysis aimed to contribute to the timely anticipation of the expected future scarcity of sufficient and properly trained staff in the EU software sector. The ESSA-partners worked with the following research question:

- *Which competence gaps do we need to bridge in order to meet the future need for sufficiently qualified personnel in the EU Software sector?*

To be able to answer this research question, two sub-questions are answered:

- *What are the current profiles and competences needed in the European software industry?*
- *What are the future profiles and competences needed in the European software industry?*

The structure of this paper is as follows: In section 2 the methodology and its substantiation are described. In section 3, the findings of the ESSA's needs analysis are presented. The 4th section provides a description of the conclusions and finally in section 5 the limitations of this research and recommendations for further research are discussed.

2 Methodology

This chapter outlines the methodology used to investigate the current and future demand for ICT software development skills. To better understand the fast-changing software services environment and competences needed both quantitative and qualitative data is collected by the ESSA partners. Specifically, as "different methods have the potential to enrich our understanding of business problems and questions" (Molina-Azorin, 2016). Thus, the study employed a mixed-method approach, comprised of a literature review (in which both practice-based and scientific articles are included), focus groups and a job vacancy analysis. 21 European partner organizations, both academic and non-academic from 8 different countries, were involved in this study. The purpose of the study was to provide a comprehensive and accurate understanding of the current and future demand for ICT software development skills. Triangulation was used to validate the findings of the literature review with the results of the questionnaire, job vacancy analysis, and focus groups (ESSA, 2021). The literature review provided guidelines for the survey and the focus groups as it specified the foundation for the roles in ICT software development that are important.

The process and methods followed to identify gaps in the market need and provide recommendations is shown in figure 1. For the current demand, the primary data is found in labour market reports, as these reports focus on the types and numbers of skilled workers that are needed. Complementary to the labour market reports, during the expert group meetings the need for skilled workers and the way organizations fill these needs is discussed. Furthermore, the current need of ICT software

development skills is also analysed with data collected by a questionnaire. As a validation we collected and analysed job vacancies to determine if the competences mentioned in the text match the preliminary findings from our other data.

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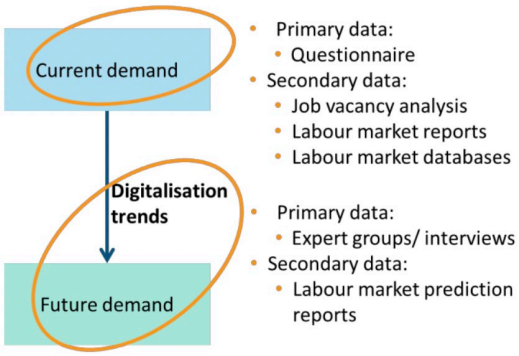

Figure 1: Research Process and methods

An overview of the data collected is shown in table 1. Below we briefly discuss each of the data collection methods.

Table 1: Quantitative characteristics data collection (ESSA, 2021)

Data collection in numbers	
Academic literature study	18 selected top papers for detailed analysis
Labour market desk research	63 national labour market reports
	14 national labour market databases
	905 job vacancies, 20 countries
Demand questionnaire	301 respondents, 21 countries
Expert groups in 9 different countries	10 national expert groups, 118 experts
	1 European expert group, 14 experts

Literature review

Scientific papers

In the systematic review, of the ESSA's (2021) needs analysis a Webster and Watson (2002) approach has been adopted. In an iterative approach four researchers together with their teams from four different countries and universities have comprised the following search terms: 'Software engineering ', 'software skills', 'Digital transformation', 'Industry 4.0', 'knowledge', 'software education', 'future', 'programming', 'computational thinking', 'logic'. These terms ware used to search in the following databases: Scopus, ACM, IEEE, Arxiv and the AIS Library. Only papers published from 2018 onward and peer-reviewed, are included in the analyses.

The initial 84 papers identified through the primary database searches, are analysed based on the abstract and title. This provided 44 Articles focused on software development competences and also provided a future orientation of needed skills (Scopus: 7, Acm: 10, IEEE: 6, Arxic: 11, AIS Library: 10).

All papers were discussed by all researchers to determine to which extent the papers were focused on the topic of software development skills. Based on this full paper analysis, 18 papers (see table 2) were included in our study (Scopus: 3, Acm: 2, IEEE: 3, Arxic: 4, AIS Library: 6). Complementary to the systematic review, a snowball-method has been adopted to review older papers, 1 has been included into the research because it contained some insights relevant for the research aims.

Table 2: Included papers and short characteristic or most revealing insight (ESSA, 2021)

Authors	Insights
Albino & Souza (2019)	Description of the gaps (skills, commitment) of firms going through a digital transformation by a literature review.
Beckett & Daberkow (2019)	Evaluation of challenges determining current and future competences in software sector by literature review.
Cico et al. (2021)	Integrate technologies and practices from software industry in curricula.
Duan et al. (2020)	Framework for adopting digital work in organizations.
Engelbrecht et al. (2018)	Necessity of context and comprehensive competences (+is challenging).
Föll et al. (2018)	Job vacancies and literature used to identify skills demand. Competence Framework are useful to develop curricula.
Garousi et al. (2018)	Prioritise the gap between software engineering and market needs.
Günay et al. (2020)	Description of need for and how to develop domain-specific critical thinking in education.
Heintz & Manilla (2018)	Students re-engineer the problem-solving process of computers.
Hoover et al. (2019)	Integration of AI and machine learning in creative domains like arts to establish deep learning and enlarge the programming awareness.
Licorish & MacDonell (2016)	Dependence of role types/engagement of project members and necessary skills.
Quezada-Sarmiento et al. (2018)	Emphasis in education for developing creativity and innovativeness.
Reinhart & Genovese (2019)	Experiences of group students taught software engineering skills.
Ryan (2020)	Develop curricula beyond Industry needs (e.g. ethics, social skills).
Shaba et al. (2019)	Effects on organizations after implementing Industry 4.0 technology.
Thorat & Kshirsagar (2021)	Identifies loopholes in software education and gives possible solutions.
Schmidt (2020)	Students collaborate in engineering projects representative for real-life.
Zabavnik et al. (2019)	UML skills for the Automotive Industry. Avoiding mistakes is key.

Labor reports

In addition, researchers from 14 different countries collected and analysed 63 national labour market reports and 14 national labour market databases. On European level statistics by Eurostat were also used for analyses. We focused on collecting data regarding ICT labour markets, and more specifically software development roles on a national or European level. Records found include white papers, formal government policy documents and professional bodies reports (such as commissioned research 'state of the art' reviews regarding software trends and competences). The selected databases are provided and maintained by a national statistics office, by other government agencies and a private institute depending on national context.

Job vacancy analysis

A job vacancy analysis was conducted to validate the current demand for software roles and competences in the EU. The methods and strategies to gather the information was left to the twelve national research teams. During the period of two months this analysis was executed the research teams exchanged the methods and the strategies for gathering their data in project meetings, so adjustments and insights were shared. 905 job vacancies from 20 countries were included. The job vacancy data were analysed to identify the most in-demand software roles and the level of proficiency required for these jobs. This data is used as input for both the results and to validate the findings of the questionnaire and focus groups.

Questionnaire

A questionnaire was designed to collect data on the current and a perception of the future demand for ICT software development roles based on the project requirements and input from partners. The first phase was to invite partners to provide questions they considered relevant in the questionnaire. The first version of the questionnaire was drafted based on the requirements of the project and this input. This version was improved based on feedback from the partners. The next version was implemented in the EU Survey and tested by 17 people. The adjustments made based on this test resulted in the final version which was distributed via the partners of the consortium. 301 respondents have filled in this

questionnaire, working in various industries in various roles (mainly HR and management). The questions were designed to collect data on the demand for software development roles, the proficiency required and possible upcoming roles. The questionnaire consisted of 4 parts, 1) 4 general questions on the country and type of organization in which the respondent works, 2) 7 questions about what are considered the most relevant ICT professional role profiles, 3) 5 questions on software skills that are not yet met in the organization, and 4) 11 questions on what the views of the organization are on training needs in relation to the identified roles and skills.

Focus groups

In 10 national focus groups, 118 experts participated. These meetings were held both online and offline in 2 to 3 hours sessions with 6 to 20 experts. In addition, one international focus group was held with 14 experts from different European countries. The focus groups were led by moderators who ensured the experts would feel free to discuss knowledge exchange and building new insights.

The experts were selected based on their insights into future ICT developments. There was a mix of experts from HR, ICT, people working in the software sector and the research field. Types of candidates who were involved were:

- Heads of HR departments of ICT companies (responsible for the staffing strategy);
- Managers of employment agencies or recruitment agencies specialising in ICT;
- CIOs of large companies (responsible for ICT strategy and sourcing).

The participants were asked to reflect on their practices regarding the future demands for software roles, competences, needs and ICT-training.

3 Findings

The results of the executed research components were analyzed, evaluated and discussed in international working groups, composed by method and overall across all research components. The most important findings based on all components of this mixed-method research are discussed and presented in this section.

During this data evaluation phase, it appeared that some of the valuable insights were not just about the roles or competences of the future of the software sector but were more about the learning process. For this reason, in this section the results are divided into three sections. The first two sections discuss the results to answer the two sub-questions (roles and competences). A third section is added which describes the insights and results on a more abstract level, the educational needs.

What roles are needed in the future?

1. Developers needed most.

Overall, we found that the role of developer is still the most important role for the software sector. More than half of all respondents are currently looking for extra developers. Both the current as predicted future demand for software developers is high. However, there is a shift toward a new kind of developers, like full stack developers and low code developers. Another important progress mentioned is that the importance of developers increases as they are more integrated in the regular organization (business) instead of working from a separate entity (IT department). Soft skills and knowledge of the business are therefore increasingly important for developers to be able to function.

2. Growing importance of the DevOps engineer

We found a growing attention for the DevOps expert role which can be explained by the need for better integration between software production and the rest of an organization. Most DevOps job vacancies are from large companies. The DevOps role integrates development, deployment and maintenance and is the developer in agile environments using e.g., continuous integration and continuous delivery.

3. Great need for solution designers

The outcomes of the analyses shows there is a great need for solution designers in various industries. Solution designers play a critical role in developing effective solutions for complex problems. The largest number of vacancies are found in respectively in the programming sector 24,8% followed by the consultancy branche (18,3%). Furthermore, we found that many companies are looking for solution designers with senior-level experience, making it challenging for entry-level designers to find suitable job opportunities.

What competences are needed for future software development roles?

1. Programming principles

It is not clear which new programming languages emerge or which of the current languages will last in the long run and are needed in the future. Therefore, it is difficult to determine which programming languages to include in a software training program to meet changing market requirements. A way to solve this problem is to make sure that software professionals have a solid foundation in understanding the underlying programming principles. This will help to adapt quicker to new languages and make software professionals more flexible and future proof.

2. Important profession related competences

Because of its importance, security needs to be an integral part of the whole cycle of designing, developing, deployment and maintenance. Although currently not considered highly important, it is expected that in the (near) future sustainability management and sustainable software development will become important. Besides these, also an understanding of the business and its needs (Business-IT-alignment) will continue to grow in importance. These types of profession related competences are rapidly becoming more important for software professionals and should therefore have a prominent place in educational programmes.

3. Interpersonal soft skills

People in software roles need interpersonal soft skills since many activities require collaboration. The most relevant skills found in our study are teamwork and general communication skills. During the focus group meetings, it was also often mentioned that the ability to communicate in English is increasingly important as it is often the standard language in software development projects. An additional benefit is that having good English language skills can increase job mobility which could benefit both the professionals as organizations searching for employees.

4. Personal soft skills are key

Across all aspects of this research, the growing importance of personal soft skills for people in software roles was clear. The most important seem to be critical thinking & analysis, problem solving and self-management. These soft skills are also truly transversal since these three skills are also the top three skills of which the World Economic Forum (2020) concludes that they will be increasingly in demand by 2025 in the total population of organizations. In other words: these skills are important for people in any working environment and certainly for software professionals.

Future educational needs

Based on the analyses of the transcripts of the expert group meetings we found that besides roles and competences there is also a need for educational processes to change. In Europe there seems to be a focus on educational programmes for entry-level software roles. However, given the large and growing demand for software professional reskilling and upskilling is essential. As time for training is limited, short and modular programmes focusing on new technology trends are necessary. Collaboration between businesses and educational providers is needed to bridge the gap between education and practice, for example through company academies. Especially large organizations can (and already do) organise their own tailormade educational programmes.

Participants of the expert meetings even went as far as stating that flexible, lifelong learning of software professionals should start ideally in primary school with a focus on programming logic and should continue throughout their careers to adapt to new

situations and technologies. Providing micro credentials can enable professionals to build up their resumes.

4 Conclusions

Based on the needs analysis (ESSA, 2021)we conclude that the developer role is the most crucial and in-demand role. The shift towards new types of developers, such as full-stack and low-code developers, highlights the need for developers to possess soft skills and business knowledge. The growing attention towards DevOps engineering further emphasizes the need for better integration between software production and the rest of the organization, this is also true for the solution designer role.

Organizations face a challenge in finding applicants with the necessary competences, and employees often lack the opportunities to train themselves while on the job. The educational field needs to educate and train people to possess the right competences to fill these job vacancies. Based on the survey we also found that large organizations have a more significant need for people in software roles and implement solutions like a company academy to reskill and upskill personnel.

Furthermore, we found that soft skills are becoming increasingly important for software professionals. Personal soft skills like adaptability, resilience, and problem-solving abilities are key to succeed as a software professional. Interpersonal soft skills like teamwork and communication are foundational, and English language skills are crucial. Additionally, we found that project management and security management are profession-related skills that are also becoming more important.

The research indicates that time for training is limited, making upskilling a challenge, therefore initial education is crucial for reducing the competence gap in entry-level software roles. Collaboration between businesses and educational providers is needed to bridge the gap between education and practice. Besides this, training with micro credentials are seen as enabler to further close the competence gap and keep software professionals up to date.

5 Reflection and directions for further research

As with all research there are some limitations that need to be discussed. First, the literature review focused on a short period for publications and had a strict set of search criteria to limit the number of findings. This means that important relevant literature might have been missed. Second, during the expert meetings the questions started interesting discussions that often needed to be cut short due to time constraints which might mean we have missed additional needs. Third, the amount of data across the different methods made analysis very time consuming. Therefore, it was conducted by multiple researchers from different countries who then came together to combine their findings. However, it would have been better if parallel analyses of data were evaluated more often to get more alignment between the different researchers during their analysis process.

To counter these limitations, we recommend that this research is conducted on a yearly basis. Hereby it is possible to keep up with the technological developments and the fast-emerging roles and competences needed in the (near) future.

An important research question that remains unanswered in this study concerns the way in which the enormous and still growing shortage of ICT professionals can be reduced. To close the gap between supply and demand in the future, it is important to also identify the supply side of educational programs. This enables organizations to choose the right training strategy that can train people to become exactly these professionals that the market demands.

Recommendations for practice

Prioritize initial education to close the competence gap for entry-level software roles, as the limited time for training makes upskilling challenging.

Develop short, modular, and micro credentialing programs to help software professionals stay up to date with the newest technologies and trends. Integrate the development of soft skills and broader education for software professionals to become T-shaped and Pi-shaped professionals who can bridge the gap between different disciplines.

Encourage collaboration between businesses and educational providers to create better-tailored education and training programs that include real-life examples and environments for practice. And let businesses support the learning process by providing opportunities for software professionals to apply their skills to real-world problems. Just be aware of the risks of this collaboration like ethical contradictions or a superficial learning process due to a practical interest of business.

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