



2019

BIH SOFTWARE INDUSTRY SKILLS NEEDS ASSESSMENT

Authored by: Economic Institute of Sarajevo

Year: 2019



Norwegian Embassy
Sarajevo



This Study is published as part of the Economic Governance for Growth (EGG) Project, supported and funded by the Government of the Kingdom of Norway and implemented by the United Nations Development Programme (UNDP) in BiH. The contents and findings of this Study do not necessarily reflect the opinion of the Government of Norway or UNDP.

In cooperation with:



FOREWORD

When this study was first commissioned in 2019, the country's economy was growing at a solid rate. Most industries were reporting relatively steady employment figures and the economic outlook for the future mainly optimistic, if tempered by concerns over outward migration and lingering political instability.

Fast forward 12 months, and the situation is far more uncertain; the IMF expects the country's GDP to shrink by some 6.5% in the course of 2020 with tens of thousands of jobs lost. In addition, Covid-19, and the resulting recession, have exacerbated pre-existing labour market problems, such as low activity rates and high unemployment among youth. With the share of informal workers estimated at 20% of the workforce, it is expected that the recession will hit these jobs especially hard.

The coming recovery, however, represents a near unique opportunity to address underlying structural and systemic deficiencies that have for decades held back meaningful economic growth, with education featuring prominently as both a culprit and an area of opportunity. High youth unemployment, for instance, is not incidental but rather the result of a long-standing mismatch between supply and demand in the labour market and inefficiencies in the teaching process, as attested by the 2018 PISA results that place the country at the tail end of the regional rankings.

Nowhere is the gap between what the market wants - and what it gets - from the education sector more evident than in the information and communication technology sector, and particularly software industry. In less than a decade, software companies have seen their share in employment triple with size of remuneration far outstripping counterparts from other industries. Industry figures estimate that turnover could double once over in the coming several years if the right conditions are created.

The institutional response to this new and exciting development has, however, largely been underwhelming. Although vocational education is the bedrock of the education system in Bosnia and Herzegovina, there are no secondary programming schools in the country while fewer than 2% of all university students are pursuing a degree in programming or related fields. Meanwhile, public universities continue to produce graduates in social sciences that largely populate unemployment rolls or are forced to transition into other fields in search of employment.

With traditional industries struggling to cope with the effects of the pandemic, software companies are showing remarkable resilience, with demand for their services surging. As digital transformation grows in prominence driven by events, it is likely that the software industry will experience further growth, both globally and locally.

Bosnia and Herzegovina must do better to anticipate this labour market of tomorrow with a string of proactive reforms across all sectors of education, from primary to tertiary. This will not only dramatically improve the prospects of its economy but also enable the government to take full advantage of digital transformation as an enhancer of both effectiveness and efficiency of public services.

This study represents a record of a conversation with the software industry and it is my hope that it will be converted into a roadmap for how to better prepare the young generations of today for the jobs of tomorrow.

Steliana Nedera
UNDP Resident Representative to BiH

CONTENT

Executive summary	9
1. Introductory remarks	10
1.1. Description of methodology	15
2. Assessment of relevant documents and strategies related to the bih software industry	17
3. Mapping the present formal and informal educational institutions relevant to information industry	24
3.1. Formal education assessment	24
3.2. Assessment of informal education	30
	31
4. assessment of human resources and skills needs on the demand side (employers) of the BiH software industry	31
4.1. Educational and occupational profile of all present employees	31
4.2. Forecasted skills and human resource-based needs	38
4.3. Identification of major obstacles related to job vacancies and occupational gaps	39
4.4. Recruitment strategy(ies) and sourcing of new employees	41
4.5. Inflow and outflow of employees during the last 3 years	
4.6. Other specialists – non-IT – assessment of required skills for non-IT specialists	42
4.7. Compliance of education with the labour market in BiH	44
4.8. Additional training of employees after the formal schooling	
	45
5. Need for training and self-assessment of IT companies employees	
5.1. Supply side of the BiH software labour market – employees training needs and self-assessment of skills	47
5.2. Relevant data on educational background of employees (additional training and development skill programmes after graduation)	47
5.3. Employees skills gap assessment (time needed to meet the IT industry job after graduation, appropriateness and applicability of skills and knowledge obtained during the formal education)	51
5.4. Employees recommendations on changes in the formal education (e.g. Focus on practical trainings, better cooperation with the private sector etc.)	51
5.5. Training needs, impact of on-the-job trainings	52
	54
6. Skill mismatch as a crucial constraint to the BiH software industry growth	56
7. Key actions that the bih software industry should take to address the identified labour-related challenges	58
7.1. Action I: Introduction of Programming into primary education	58
7.2. Action II: Establishment of secondary vocational schools for information technology in BiH	60
7.3. Action III: Introduction of distance learning in IT higher education	62
7.4. Action IV: Additional training and retraining programmes in the sphere of IT in BiH	64
7.5. Action V: Declare the software industry as a strategic developmental industry in BiH at all levels of authority	65
Literature	67
Annex I: demographic characteristics of companies from the sample	68
Annex II: formal educational institutions contact information	70

EXECUTIVE SUMMARY

2019 BiH Software Industry Skills Needs Assessment is made as part of the Economic Governance for Growth (EGG) Project, implemented by the United Nations Development Programme (UNDP) and funded by the Government of the Kingdom of Norway aimed at defining the steps to improve the competitiveness of the BiH software industry in the sphere of human resources and skills development.

The software industry development in Bosnia and Herzegovina has been foreseen by state, entity and cantonal level policies, strategies and action plans in the sphere of BiH information society development. The said documents recognise the need for the ICT human resources development wherefore the general measures first aim at aggressive investing in human resources through the enhancement of education systems and promotion of the software engineer job as the job of tomorrow for young generations in BiH. The measures also include the support to software industry start-ups, enhancement of IT entrepreneurship, stimulating tax policies for the software industry companies with a view to generating higher employment rate and reducing the brain-drain etc. The BiH IT sector development policies, strategies and action plans, however, are implemented at a very slow and limited pace, and so the expected support to the BiH software industry is lacking. This is why the capacities for economic development are underused.

Mapping of the existing BiH formal and informal educational institutions relevant for the BiH software industry generated the analysis of public and private educational institutions which provide formal and informal higher education in the sphere of information technology in BiH. The analysis covered 21 formal and 9 informal educational institutions. The mapping generated a table consisted of 34 information and computer science programmes. The contents of vocational educational subjects and availability of technical elective subjects were analysed. This chapter also contains the views and opinions of key representatives of software industry in BiH about the quality of educational institutions in Bosnia and Herzegovina. The study gives a clear comparative overview of the institutions with information science programmes focused on globally dominant software technologies and transfer of practical IT knowledge to students and the institutions with programmes still focused on theoretical knowledge only. Educational programmes vary from one to another in terms of keeping up with modern trends in the IT industry and in terms of the intensity of practical work related to projects. The leaders in this regard are the institutions that adapted their programmes to the ones of most prestigious world universities and set an appropriate balance between theory and practice in teaching the most demanded computer science technologies. Three groups of institutions producing the resources for the labour market have been identified. The entire programme of the first group of institutions is focused on programming skills and transfer of knowledge for the application of programming languages in various environments. The curriculum includes both individual and group projects related to technologies that are actively used in the IT industry. Considering that the said skills are in the highest demand at the labour market, the students from these institutions get employments even prior to their graduation. The institutions in the second group strive to transfer general information science knowledge and their students can later choose the field of specialisation, often by online distance learning platforms or postgraduate studies. The third group of institutions is dealing with the information science by focusing on economic aspects such as the information system management and the service application in those industries that are going through a digital transformation and business automation.

Considering the domestic IT industry needs and the highest deficit of programming occupational skills, it is safe to say that the first group of institutions is making the largest contribution to the resolution of the lack of technical skills demanded by the labour market.

There is a long-standing mismatch between supply and demand in the BiH software industry labour market. The demand for IT specialists is considerably higher than the supply, wherefore 41.9% vacant IT specialist posts remain unfilled. The said mismatch in Bosnia and Herzegovina is caused by the lack of harmonisation between the IT education enrolment policies and the software industry needs, hence an underwhelming number of information and computer science graduates who are not able to satisfy the software industry demand in IT specialists. Faced with the IT expert shortage, the software industry companies are forced to provide on their own education to their new and present IT specialists. Identifying the skills mismatch and the need for improvement is most significant when it comes to technical skills, such as fundamental knowledge of programming languages and IT systems and practical work in complementary technologies and project management. As for other employees' skills: teamwork skills, knowledge of foreign languages and ability to learn fast are deficient. Due to shortages in terms of graduates and inadequate skills of IT specialists in the labour market, 60% of the software industry companies employ persons without the required qualifications and then train them to be able to meet the needs of the job. The software industry companies need about 4 to 6 months on average to train the information and computer science graduates for the software industry work. Considering the IT specialists knowledge and skills mismatch, the software industry companies advocate a wide range of changes in IT educational institutions and the majority of our sample respondents state their readiness to revise curricula and adapt them so to meet the technological changes, to be open for new teaching methods, to focus on practical classes, to organise practical training and internships in software industry companies, etc. One half of the companies has had some form of cooperation with educational institutions, but it entailed upon an individual approach of certain educational institutions and proactive individuals who wanted to use the software industry information towards the enhancement of their teaching methods. A systematic approach is needed in order to have more significant effects such as harmonisation of skills and competence of the IT educational institutions. Such an approach would include not only software industry representatives but also line ministries of education mandated to resource for the introduction of changes relative to IT occupational enrolment quotas, curricula, methods and practices.

The highest percentage of IT specialist in BiH software industry companies clearly identify the need for a continuous enhancement of technical skills in the sphere of fundamental knowledge of programming languages and IT systems, working experience with complementary tools and project management. They also identified the need of enhancing other skills such as organisational skills, communication and teamwork, ability to understand the clients' needs and problem-solving ability. The mismatch between the skills obtained and the skills needed at workplace is caused by the current IT specialist education method and so it takes 4 to 6 months for most of graduates to meet the requirements of the workplace, while one third of graduates needed even more than 7 months to that regard. Therefore, IT specialists submit that the vocational education must be more flexible when it comes to revising and changing the curricula so that they can keep abreast of the technological changes. They also submit that the education should be updated and should contain more practical training /internships, and that educational profiles should be defined and updated in line with the needs of the labour market. A majority of employees receive a continuous advancement within internal on-the-job trainings and trainings in external educational intuitions co-financed by their companies. As for additional trainings, one third of them is conducted in the sphere of professional technical skills and two thirds in non-technical skills. In general, workers in a majority of companies have different models at disposal towards the enhancement of the existing and obtaining of new skills and competences.

Skills mismatch as a constraint on the software industry growth has been identified on three levels. Horizontal mismatch has been constantly present at the labour market in the sphere of the BiH software industry. Inadequate enrolment policies, insufficient number of enrolments at the computer and information science faculties result in an insufficient number of graduates that would be able to fill vacant posts in the software industry companies. Horizontal mismatch in the BiH software industry labour market is 41,9 % on an annual basis, hence 388 out of 926 vacant posts or 41,9% will

not be filled due to the insufficient number of IT graduates from computer and information science faculties in Bosnia and Herzegovina. Skills mismatch/gap, that is, a difference between the skills of IT graduates acquired during formal schooling and the skills needed for a workplace in the BiH software industry, is best reflected by the time needed to train new IT employees to be able to work in the software industry companies. The research shows that more than a half of surveyed companies (60%) spend 4 to 6 months on average to train new IT employees, while in some cases of new IT employees the duration is shorter (1-3 months) but for some longer (7-9 and more months). Overeducation gap is present at some software industry entry points, which do not require expert engineering knowledge with a wide range of computer, information and mathematical knowledge and skills. Duties and tasks of junior posts such as testers or developers require knowledge and skills that can be acquired in short educational cycles. More specifically, such posts do not require engineering education level, wherefore, it is safe to say that engineers working at the said posts are overeducated and that their knowledge and skills overreach the needs of the said posts.

Critical activities when identifying the challenges and constraints are focused on harmonising the software industry labour market, the needed growth in the numbers of educated IT specialists available to the software industry. To that regard, Activity 1 pertains to the introduction of Programming as the primary education subject and an approach to learning of programming with the same importance as to learning of mathematics, learning how to write and read or learning a foreign language. Activity 2 pertains to the establishment of secondary vocational schools for information technology, which would provide workforce for junior developer and tester posts. Activity 3 pertains to the introduction of distance learning in IT higher education with a view of increasing the capacities or increasing the number of students and graduates. Activity 4 is about creating the programme of retraining and additional training in cooperation with the software industry companies. These programmes would be funded for unemployed persons registered with the employment bureaus, with a capacity to re-qualify for software industry work. Activity 5 includes the initiative for the enrolment policy change and increase in the enrolment quotas at public universities in Bosnia and Herzegovina aimed at a significant increase of the number of students and graduates.

1 INTRODUCTORY REMARKS

The world is currently at the brink of the fourth industrial revolution¹. One of its fundamental features is the fusion of technologies and erasing the boundaries between physical, digital and biological sphere². The speedy technological development, without any precedent, had certain repercussions on all economic and social aspects. Speed at which the technology is developed is fundamentally changing the way we study, work and relate to one another. All of this entails the gap between the digital economy/needs of society in terms of education and skills required for work and growth in digital economy, and the education and skills currently available at the labour market. Automation is expected to have more or less impact on close to 60 percent of workplaces globally, wherefore some kind of retraining will be needed for persons who are currently employed at those posts. Changes are so prominent that some estimates suggest that close to 65% of children currently in primary schools will work at the posts that are still not existent to date³.

Simultaneously, the education policy, curricula, enrolment policies, that were developed in the circumstances of previous technological development, mainly remain unchanged and so they do not reflect the needs of knowledge and skills of future jobs. This is in particular case with the information technology education. The software industry represents a new potential of the economic growth in Bosnia and Herzegovina. In order to be fully utilised, that potential needs to be assisted and supported by government and education system. If adequately supported by the government and public educational institutions, BiH software industry has a potential of producing a sufficient number of workplaces and thus considerably help in reducing the unemployment of youth, emigration, brain drain, and supporting digitalisation of BiH economy, administration and society thus contributing to the economic development in general.

The said argument is clearly supported by the IT industry indicators, as shown in the table below.

1 Fourth industrial revolution – or as we put it, Industry 4.0- is the era of intensive development of digitalisation: from digital connections of products and services through “smart” cities and factories to automation of businesses and services at our homes and at workplace. This is also the era of intensive data gathering and analysis, which lead to decision-making and anticipations in real time.

2 Each industrial revolution was marked by a specific technology that changed the world. First industrial revolution started in Great Britain around 1760 with an invention of steam engine that led to new production processes and creation of factories. Second industrial revolution happened about one century later, and was marked by mass production in new industries such as steel, oil and electrical energy traffic and communication development. Third industrial revolution was marked by the inventions of semiconductor, computer and internet in the sixties of 20th century. We also refer to it as “digital revolution”.

3 World Economic Forum, The Future of Jobs – Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution – January 2016

Table 1 - Employment and salaries in the IT industry in FBiH in 2012-19.

	2012	2013	2014	2015	2016	2017	2018	2019	Growth 2019/12
FBiH IT employment	1,495	1,651	1,998	2,449	2,843	3,740	4,348	5,122	242.6%
FBiH IT average net salary	1,145	1,152	1,206	1,201	1,316	1,373	1,472	1,607	40.3%
FBiH total employment	437,331	435,113	443,587	450,121	457,074	505,201	519,800	531,483	21.5%
FBiH total average net salary	830	835	833	830	839	860	889	928	11.8%
IT ratio in employment in FBiH	0.34	0.38	0.45	0.54	0.62	0.74	0.84	0.96	
IT ratio in average salary	37.95	37.96	44.78	44.70	56.85	59.65	65.58	73.17	
Equivalent of workplaces with average salary in FBiH	2,062	2,278	2,893	3,544	4,459	5,971	7,199	8,870	
FBiH IT employment – women	454	516	587	708	818	1,062	1,299	1,610	
Women ratio in IT employment	30.37	31.25	29.38	28.91	28.77	28.40	29.88	31.43	
RS IT employment	525	558	647	669	472	797	919	1,144	117.9%
RS total employment	238,178	238,640	241,544	245,975	253,305	260,608	266,309	272,366	14.4%
IT ratio in employment in RS	0.26	0.28	0.32	0.32	0.22	0.36	0.41	0.50	
BiH IT employment*	2,020	2,209	2,645	3,118	3,315	4,537	5,267	6,266	210.2%
BiH IT average net salary	1,077	1,046	1,174	1,176	1,337	1,330	1,449	1,582	46.9%
BiH total employment*	675,509	673,753	685,131	696,096	710,379	765,809	786,109	803,849	19.0%
BiH total average net salary	826	827	830	830	838	851	879	921	11.5%
IT ratio in employment in BiH	0.30	0.33	0.39	0.45	0.47	0.59	0.67	0.78	
IT ratio in average salary	30.39	26.48	41.45	41.69	59.55	56.29	64.85	71.77	
Equivalent of workplaces with average salary in BiH	2,634	2,794	3,741	4,418	5,289	7,091	8,682	10,763	

* consolidated FBiH and RS (without BD)

Source: our own calculation based on the data of FBiH and RS Statistics Institutes

As we can see, in late 2019 there were 6.266 persons employed in the BiH IT industry (5.122 persons in FBiH and 1.144 in RS). Relative to 2012 (2.020 employees), there was a growth by 210 percent. For comparison purposes, in the same period, the total number of employees at the level of BiH was 19 percent only. Therefore, employment in the IT industry grew 10 times faster than the rest of the economy. The IT industry employment growth was prominently higher in FBiH than in RS. In late 2019, the IT sector employment ratio in the total employment in FBiH was almost 0, 8 percent, or close to 1 percent in FBiH and close to 0, 5 percent in RS. The information on women employment ratio in the IT sector is available for FBiH. In late 2019, it was almost 30 percent and it was not changed significantly in the period relative to this analysis.

The data presented in the table also show that IT sector employees had considerably higher income than the rest of the economy. In late 2019, an average net salary in IT sector was BAM 1.582 KM and it was by 71, 77 percent higher than the average net salary of BAM 921 at the BiH level. It is also worth mentioning that on average IT sector salaries saw a considerable growth in the analysed period (2012-2019) in relation to the average salary at the BiH level (46,9% in relation to 11,5%).

A considerably higher income in the IT sector also means higher contributions and taxes and the impact on the rest of the economy, as there are more employee demands in this sector in relation to an average employee in BiH. In other words, 6.266 employees in the IT sector are equivalent to 10.763 employees with an average salary in FBiH.

The employment multiplier⁴, expressed as a full-time equivalent for IT sector in BiH equals 2, 57. It means that for example 100 new vacant posts in IT sector result in additional new 157 workplaces in the rest of the economy (consolidated as 257 or $100 \times 2,57$)⁵.

The earlier research studies related to the software industry identified an insufficient number of software programmers and limited capacities of educational institutions as an important constraining factor on the future development of IT sector. In that regard, this study clearly draws the attention of all relevant stakeholders (education ministries at all levels, other line ministries, chambers of commerce, expert associations etc.) to the essential importance of education reforms. Furthermore, the study gives recommendations of measures and activities that need to be undertaken for the sake of better harmonisation (quantitative and qualitative) between the supply and demands for the workforce in order to overcome the gap in the short term, mid-term and long term.

The 2017 Study of information technology development in Sarajevo Canton, formally adopted by the Sarajevo Canton Government, states that the existing IT companies have an extraordinary capacity for new employments in thousands of new workplaces, as a result of available new business opportunities. The study also warns that their future growth and even their survival in the long run, is questionable due to trained employee shortages. Given the workforce shortage, these companies have refused some fruitful projects. The existing educational institutions simply lack the capacity, flexibility and technological competence to produce necessary number of IT graduates ready for the industry.

In view of all the aforementioned, it is crucial to: (1) recognise qualifications and skills required by the software industry, (2) estimate the gap between the skills of available workforce and the skills demanded by the industry, (3) analyse capacities and curricula of existing educational institutions and based on that (4) define mid-term and long-term mitigation strategies and recommendations to overcome the identified challenges and gaps between the skills demand and supply.

4 As a ratio of direct, indirect (through effects on suppliers of the first, second and every other round) and induced (through effects on the growth in demands due to the growth in income), as a result of change of work in relation to a direct change of work in some industry or sector.

5 Earlier research by Economic Institute of Sarajevo.

1.1. Description of the methodology

One of the tasks defined in the terms of reference (task 1.3. and task 1.4.) included the research amongst employers (IT companies) and employees of IT companies to assess the skills needs of the software industry employees and to possibly determine a gap. The said research needed a tailored tool: tailoring the measuring instrument – questionnaire, selection of a sample, defining the data collection method and analysis of collected data.

Since the research covered 2 target groups: IT companies managers/directors and IT companies employees (IT experts and other profiles or non-IT experts), two questionnaires were tailored:

1. Questionnaire for employers: Software industry employers skills needs assessment
2. Questionnaire for employees: Software industry employees skills needs assessment

Both questionnaires were tailored to obtain answers to questions defined in the terms of reference.

The questionnaire for employers contained the following sections:

1. GENERAL DATA ON THE COMPANY (name of the company, year of establishment, seat of the company, business model, foreign markets to which the company sells its products /solutions);
2. HUMAN RESOURCES (number of employees and gender structure per IT and NON-IT profiles);
3. EVALUATION OF IT EMPLOYEES IN THE COMPANY included: (1) self-assessment of soft skills and technical skills of IT employees. Self-assessment of skills was based on IMPORTANCE - PERFORMANCE framework, employers evaluated the importance of certain skills and their satisfaction with employees' skills. IMPORTANCE – PERFORMANCE framework provided for the identification of needs gap in certain skills (2) IT staff recruitment process; (3) evaluation of education system in the sphere of IT; and (4) practice of continuous training of IT staff;
4. EVALUATION OF OTHER NON-IT EMPLOYEES IN THE COMPANY included self-assessment of soft skills and technical skills of NON-IT employees; (2) NON-IT staff recruitment process; and (3) practice of continuous training of NON-IT staff.

The questionnaire for employees contained the following sections: general data, self-assessment of competences and skills, evaluation of education system, evaluation of skills acquired during formal and informal education and evaluation of the practice of continuous training for employees.

After the measuring tool- questionnaire was tailored, there were two meetings held with the Ordering party (UNDP) to verify if the tailored questionnaire meets the requirements of the task. The suggestions about the presentation of certain sets of questions and the wording of questions were accepted and after that, the Ordering party approved the final draft of questionnaire.

Research design – sample. Target population of this study includes general managers / chief executives of software industry companies with the seat in Bosnia and Herzegovina. On designing the sample, an arbitrary decision was made not to include companies, which employ less than five persons. The sample framework was defined in cooperation with BIT Alliance and it included 166 software industry companies, providing the employment to more than five employees. Considering the fact that the sample framework did not include all units from the target population, a probability sampling method was not applicable. Therefore, a non-probability sampling method was applied and a call for proposal sent to e-mail addresses of all companies that were included in sampling (166 companies). Thereby it became more probable that after the data collection is finalised, the target sample size of as defined in the terms of reference would be met (40 employers and 80 employees, with at least 1:1 ratio of IT and NON-IT staff).

Research design – data collection method. The data collection proceeded after the research tool had been carefully defined, and after the population, sample and data collection method have been established. The data collection phase is usually preceded by a pilot research or a pretest, with the main purpose of verifying legibility of the measuring tool – questionnaire. In this specific case, a pretest was done in a form of a debriefing with six persons from the target population – general managers and/or chief executives of IT companies (three persons) and IT companies' employees (three persons). Participants of the debriefing were asked to read the questionnaire out loud and to fill in the questionnaire pointing to those questions that they found unclear or pointing to some other difficulties they faced along the way. All participants of the pretest pointed to the length of questionnaire that is, the time they need to fill it out. The pilot testing has shown that it takes 35 to 50 minutes to fill in the questionnaire. Aware that the duration of the questionnaire might be a discouraging factor, we were unable to reduce the number of questions because of a complex research subject matter. Furthermore, participants of the debriefing stated that the meaning of translated B/C/S professional profiles was not completely clear and suggested that the English terms be used. The pretest confirmed that questions were defined in a clear and legible way, and that there was no ambiguity or inconclusiveness. After the pretest, the main research was conducted, the data collection method selected, and sampling defined.

The subject matter research opted for the method of survey, that is, the method of collecting the primary data by way of questionnaire. The said survey method (questionnaire) is most frequently used method in primary data collection when it comes to social research studies, especially those ones in the sphere of business economy. Primary advantages of the method include possibility to collect the data from the past, present, future, relatively simple and fast process data collection, and cost effectiveness. The survey method techniques include structural interview (direct communication with the respondent), respondent filling out the questionnaire on their own (»distribute and then collect«), phone survey, postal survey and internet survey. Having evaluated the advantages and shortcomings of these techniques, we decided to use online survey for the purposes of this study. The following advantages weighed in the selection of online survey:

- ✗ Extremely low costs that can be classified as questionnaire preparation costs and administrative costs;
- ✗ Possible collection of a large sample covering the geographical disparity;
- ✗ Respondents can fill in the questionnaire at the time most suitable for them thereby maximum focus of respondents is ensured;
- ✗ Automatic entry and logical data control which provides for an easy digital data processing;
- ✗ Possible defining of conditional activation of different sets of questions, that is, respondents can be redirected to a certain set of questions depending of the criteria met by the answers they provide;
- ✗ Possible usage of drop-down menus, predefined response formats, and additional online instructions for specific question or sets of questions.

A relatively large number of tools is available nowadays, which can help a researcher to design and conduct an online survey. The said tools can be classified into two groups: free software solutions or open code online tools (e.g. Lime Survey, Google Spreadsheets) and commercial tools (e.g. Qualtrics, Survey Gizmo, Question Pro). Having compared possibilities of online survey tools, we determined that Lime Survey is the most suitable tool for the research within this Project (unlimited number of respondents, different types of questions, possibility to transfer the data in SPSS format). The draft questionnaire was adapted to online form in LimeSurvey, and so the first call for participation was sent on 18 November 2019 to the companies (n= 166). A survey turnout was monitored on a daily basis given a relatively low turnout two reminders were sent. In cooperation with the ordering party (UNDP), we decided to finalise the data collection process on 12 March 2020. Conclusive with 12 March 2020, 35 valid questionnaires were collected from employers and 107 from employees. Therefore 87, 5% of the employers' target sample size was reached while the employees' sample was larger by 33, 8%.

Data analysis. The collected data were analysed in statistical processing software set - SPSS, and univariate and multivariate statistical analyses were applied.

2 ASSESSMENT OF RELEVANT DOCUMENTS AND STRATEGIES RELATED TO THE BIH SOFTWARE INDUSTRY

Information Communication Technology has a vast development potential, which was recognised in the course of last fifteen years by development policies at the state, entity, cantonal and municipal levels in Bosnia and Herzegovina. The first documents were generated at the state level in 2004, when the then Council of Ministers of Bosnia and Herzegovina adopted the **Policy for Development of the Information Society of Bosnia and Herzegovina** as the fundamental and guideline document for the process of development and establishment of information society, which would be used as the basis for new laws, regulations and other enactments and as the basis in deciding about the course of development, action plans and priorities at the level of Bosnia and Herzegovina and its entities⁶.

This Policy's vision is focused on the establishment of modern economy and society with citizens who are capacitated to accept new jobs and technologies, and state authorities equipped and capacitated to render services through the application of modern technologies in a transparent, cost-effective and efficient manner thus enhancing education, health, economy, administration and social standard of all citizens of Bosnia and Herzegovina.

The Policy defined 10 goals that pertain to building capacities of citizens and economy for the work and life in information society, software industry development, raising the living standard, increasing of gross national income, equal development of information society etc. The Policy identified eight development spheres, ICT infrastructure, ICT industry, eBusiness, eEducation, eHealth, eGovernance, legal infrastructure of information society and sustainable development.

Section 4 refers to the implementation and defines the obligation to enact the Strategy of Development of Information Society by the end of 2004, and to define development programmes and projects by way of adoption of action plans, different commissions and groups the so-called policy implementation action holders, and to establish the Agency for Information Society at the state level to play a critical role in the implementation of the Policy for Development of Information Society and the Strategy of Development of Information Society. The Agency for Information Society has never been established at the level of BiH and so the implementation of the Policy for development of information society was significantly reduced. The Agency for Information Society was established in Republika Srpska and it carried out the activities and projects related to the information society development in Republika Srpska. In 2018, it was integrated into the Ministry for Scientific Development, Higher Education and Information Society of Republika Srpska.

There was no such agency ever established in the Federation of Bosnia and Herzegovina.

The Strategy of Development of Information Society of Bosnia and Herzegovina is a document that provides strategic guidelines and plans of action for development of information society in Bosnia and Herzegovina for the period 2004-2010. The Strategy was based on the visions and goals defined in the Policy for Development of Information Society in Bosnia and Herzegovina. The Council of Ministers of BiH adopted the document in 2004. The document was prepared in cooperation with the United Nations Development Programme for Bosnia and Herzegovina.

⁶ Policy for Development of the Information Society of Bosnia and Herzegovina, page 5.

The Strategy contains five development pillars: eLegislation, eEducation, eGovernance, ICT Infrastructure and ICT industry, and for each of them a review of current status, development vision, basic strategies and guidelines for the achievement of the vision and the specific description of actions to be taken according to strategic guidelines.

Annexed to the document is an overview of actions while there is a separate document – Action Plan that provides a more detailed description of actions and success indicators⁷.

With no intention to disregard the importance of other Strategy pillars, it is worth noting the vision of the new status in the pillar / sphere of education and ICT industry. In that regard, education is understood as the service for information society with a specific emphasis on the need to increase the digital knowledge by way of including ICT education in the joint curricula for primary and secondary schools. It is also seen in terms of promoting lifelong education keeping abreast with continuous technological development, continuous harmonisation of curricula at all levels of education necessary to use ICT in the teaching process, and the utilisation of digital contents, etc.

The vision of current situation in the ICT industry is about the product and services quality improvement, liaison with developed worldwide companies, development of IT entrepreneurship through construction of technological parks and business incubators. According to the Strategy, future development of the ICT industry should be developed primarily through the maximum use of human resources with specialist knowledge.

The strategy foresees the state level incentive measures to ICT industry. One of the general measures focuses on the need for aggressive investment in human resources through enhancement of education system, setting high education standards, special tax benefits, and support to the ICT companies to develop knowledge and skills. Other general measures include support to science and technology development, easier development of clusters etc.

Special measures under the Strategy foresee customs and tax policy measures in terms of special regimes directed at the ICT sector development (tax exemptions etc.), and measures that imply reliefs for ICT financing through the establishment of Agency for Partial Credit Insurance, establishment of State fund for interest subsidizing, etc.

The Policy and the Strategy for Information Society Development for 2004 – 2010 were implemented to some degree, that is why the expected economic development effects are lacking.

The BiH Council of Ministers under the Decision on adoption No. 89/17 adopted the Policy for Development of the Information Society in Bosnia and Herzegovina for the period of 2017-2021 on 4 May 2017. As stated in its introduction, the main purpose of the Policy for Development of the Information Society is to plan activities that will fully use social and economic potential of ICT, especially Internet as an important tool of economic and social activities.

A special section of the Policy for Development of the Information Society in Bosnia and Herzegovina is about stimulating the development of domestic software industry as part of the ICT sector, which showed a huge potential for growth in the past 15 years, and became a highly respectable potential of Bosnia and Herzegovina⁸.

The vision of the information society development as defined by this Policy sees Bosnia and Herzegovina as a digital society, which recognises the social and economic potential of ICT and broadband access to Internet. The Policy goals and tasks pertain to defining the direction of further and accelerated growth of the ICT sector and broadband access, ensuring investments into the

7 Strategy of Information Society Development in BiH 2004-2010

8 Policy for Development of the Information Society in BiH for the 2017 - 2021 period.

ICT sector and broadband access, stimulating competition at the electronic communication market, providing Internet access, stimulating the use of ICT and build capacities of the BiH software industry.

Goals of the Policy clearly show the need for the development of a broadband net for high speed Internet as a requirement for the utilisation of ICT services in Bosnia and Herzegovina.

The ICT sector is recognised as a very important sector for economic development, social benefit and competitive position of the state in the region and Europe, wherefore the Policy implementation is the task for all levels of authority and stakeholders.

The Policy for Development of the Information Society in Bosnia and Herzegovina is harmonised with the EU Strategy Europe 2020 and Digital Agenda for Europe. Seven strategic pillars were taken over for the development of ICT, as follows:

I pillar	Establishing a digital single market
II pillar	Setting of frameworks of interoperability and standards
III pillar	Promoting trust and security,
IV pillar	Establishing fast and ultra-fast internet access
V pillar	Stimulating of development of the software industry, as well as an investment in research and innovation
VI pillar	Strengthening of digital literacy, skills and inclusion
VII pillar	Applying of ICT in solving key challenges of BH society

Considering the subject of this study, we will mention some activities planned within the strategic pillars V – Stimulating of development of the software industry and VI - Strengthening of digital literacy, skills and inclusion.

Strategic pillar V – Stimulating of development of the software industry, as well as an investment in research and innovation first refers to the promotion of software engineer job as the job of tomorrow for BiH young generations, followed by support to start-ups in the software industry and development of IT entrepreneurship, stimulating tax policy for the software industry companies aimed at reaching a higher employment and reduction of brain drain, etc.

Strategic pillar VI - Strengthening of digital literacy, skills and inclusion defines the activities of setting the guidelines for the enhancement of digital literacy and ICT skills of BiH citizens, setting the framework for recognition of ICT skills, adaptation of curricula in primary, secondary and higher education, so that informatics can, instead of being just one subject, be an integral part of all units, as well as the activities in development of retraining and additional training programmes aimed at higher employment rate and reduction of unemployment etc.

The Policy foresees the development of the Strategy for the Development of BiH Information Society, which will define activities per programmes /pillars of the Policy and represent the main strategical document - guideline for ICT development in Bosnia and Herzegovina. Drafting of action plans, development programmes and projects is also envisaged. BiH Ministry of Communication and Traffic is in charge of implementation and establishment of sectoral expert groups for all spheres recognised in the Policy. Those groups should be consisted of representatives from all levels of authority, academia, and ICT industry and user base per programmes. These activities of the Policy implementation were not realised at the state level.

Federation of Bosnia and Herzegovina has not developed strategic development documents for the development of information society and software industry.

Republika Srpska established the Agency for Information Society in 2007, which carried out the activities towards the information society development. In 2018, this Agency was integrated into the Ministry of Scientific and Technological Development, Higher Education and Information Society

of Republika Srpska. Within its competences, the Ministry rendered a set of draft strategies and accompanying action plans, such as the Strategy for Scientific and Technological development of Republika Srpska 2017-2021 "Znanje za razvoj" (Knowledge for development), and the Action Plan for Strategy for Scientific and Technological development of Republika Srpska 2017-2021 "Znanje za razvoj" (Knowledge for development).

The Strategy for Scientific and Technological Development of Republika Srpska 2017-2021 "Znanje za razvoj" (Knowledge for development), section 2.6.1. Information and Communication Technology, reads that the development of ICT sector in Republika Srpska requires a stimulating environment so that various ICT experts can easily start companies and plan their future in Republika Srpska. A special emphasis is placed on efforts in the development of the so-called software environments (cities) which will be able in two to three years to develop their products recognisable at the global market which will then increase the overall export of products and stimulate the development of other spheres such as education, starting of specialised companies that support the development of bigger companies, services and help branding of Republika Srpska in its entirety. Furthermore, a special attention is called for the development of ICT experts through formal and informal schooling and for the increase of contributions for the ICT sector per capita.

The goal 6.2. Significant increase of the scope of research in the fields that offer comparative advantage to Republika Srpska and measure 6.2.1. - set up the institutional framework for the development of smart specialisation, both refer to information and communication technology as the first area of smart specialisation.

The Ministry developed the draft Strategy for the Development of electronic governance of Republika Srpska 2019 – 2022 that defined the roadmap for eGovernance development in Republika Srpska particularly in the field of strategic development of ICT infrastructure, eServices and human resources (government employees and public sector).

Sarajevo Canton adopted 2017 **Development study of IT sector in Sarajevo Canton** analysing the current situation and making proposals for accelerated development of IT sector and its positioning as one of the leaders in the overall economic growth for Sarajevo Canton. An insufficient number of software developers/programmers has been identified as a basic obstacle for a faster growth and development of the IT industry. In that regard, the study reads that an absolute constraining factor for the future development of the IT sector lies with the existing educational institutions which produce the workforce for IT sector with regard to their structure, enrolment quota, education curricula, teaching staff and capacities along with the fact that there is not a single IT specialised educational institution. This calls for systematic and comprehensive structural changes, both in terms of quality and quantity.

In terms of quality, the Study clearly defines the need to considerably increase the level of knowledge and skills of the teaching staff, the need to update the existing curricula, that is, to establish a mechanism of flexible adaptation of curricula to dynamic development and technological trends. Furthermore, it calls for a direct and systemic cooperation between IT industry/companies and educational institutions so that the future graduates acquire practical knowledge needed for the work in the IT industry.

In terms of quantity, the Study calls for an urgent increase of enrolment quotas at the existing IT profile faculties and suggests the establishment (or restructuring of the existing) of at least two vocational secondary schools, establishment of IT Faculty within Sarajevo University, incorporation and attraction of private education institutions into IT education by providing subsidies to employment of their graduates in the real IT sector.

The Study reads that the existing legislation framework does not include adequate laws, which would prescribe specific characteristics of IT sector (customs laws, business codes, occupational profiles) and does not prescribe any reliefs or subsidy measures whilst maintaining competitiveness at the

international level in the long term depends on such measures. Most of the developing countries and the countries in the region employ a wide range of subsidy measures to intensively support their own IT sectors.

Institutional investments in research and development are so low in BiH, including Sarajevo Canton, that they dramatically lag behind the neighbouring countries which is why the Study reads that any serious development of IT sector, and even an overall economic development will remain just a wishful thinking if structural changes are not introduced into this sphere and if the conditions are not improved and investment increased.

In line with the initiatives, expressed interest and serious preliminary actions already taken by IT companies gathered around Znanje (Knowledge) Foundation and with a view of gathering resources, better connecting IT capacities and integrating education and development capacities at one site, construction of a technological park is required at the reserved site in Sarajevo Canton. The Study briefly describes some of the existing technological parks in the region and their results and impact on the economic growth, only confirming that it is unacceptable that Sarajevo Canton lags behind in the implementation of this project.

Based on the total situation analysis, the Study proposes short-term and long-term goals and briefly defines operational goals elements that can be used by the Sarajevo Canton Government in creation of its own action plan in line with other activities and available budget. Multiple economic effects of short-term and long-term goals that can be reached by the implementation of measures and through education of sufficient number of workforces are illustrated by a provisional calculation of possible budgetary revenue increase as a result of increased number of employees, increased total revenues of IT industry and especially improvement of trade balance due to increased exportation.

Elements of operational goals are integrated into three strategic goals:

- ✖ Restructuring of educational system along with a consistent implementation of proposed operational goals, opening of IT faculty and two secondary school, implementing the life-long education programme and retraining programme, opening a possibility to achieve the strategic goal - 12.000 IT engineers and specialist by the end of 2025.
- ✖ Establishment and construction of a technological park that would include flexible and functional areas for the needs of IT companies, the building of IT Faculty and IT research-development centre that can integrate the function of a modern innovative IT accelerator.
- ✖ Enhancement of business environment supporting the development of IT sector by the establishment of IT development council, legislative amendments, establishment of funds and finding ways to implement a wide range of tax reliefs or subsidizing certain activities.

The Study briefly presents a possible model of public private partnership based on the existing law in Sarajevo Canton, but this also points to the complexity and operational inconclusiveness of the existing legal framework. The legislation would need to be amended in case of the construction of technological park. Therefore, the Study suggest the Sarajevo Canton Government to find a more adequate solution, such as a private investor who would show the interest to construct a technological park with own funds and so the construction would be more certain and by far faster⁹.

The implementation momentum of strategic goals and recommendations of the Development Study for IT sector in Sarajevo Canton is not the one that would ensure an accelerated growth of IT industry. Instead of the establishment of a separate IT Faculty in 2019, enrolment of 100 students was allowed at short two-year IT education programmes at the Faculty of Electrical Engineering and Faculty of Natural Sciences and Mathematics. Instead of the establishment of two IT vocational secondary

⁹ Development Study for IT sector in Sarajevo Canton, 2017.

schools, the Sarajevo Canton Government introduced one class of IT profile in each grammar school in the school year 2019/20. The annual number of IT graduates is still significantly far from the target number of 1.250. The said target number is required to reach the strategic goal of 12.000 IT experts in Sarajevo Canton by 2025.

The **Development Strategy of Sarajevo Canton by 2020** recognises the ICT industry as the industry with significant economic and development potential, the activities towards the realisation of priority goal 2. support to higher competitiveness and attractiveness of Sarajevo Canton for investments into the ICT industry, are intended to increase the number of business subjects and number of employees in the ICT industry. The measures foreseen in these priority goals relate to support to information literacy and capacity building in support of ICT industry.

The measure of support to information literacy includes the projects of free access to internet and free e-mail addressed for all primary and secondary schools and university in Sarajevo Canton, introduction of ICT subject in curricula of all state faculties in accordance with the best global practices, primary and secondary school information clubs at cantonal level, establishment of the open fund for ICT scholarships with online portal for a transparent fund management, free training for persons who want to have a retraining in IT industry, merger and automation of information support in primary and secondary schools.

The measure of capacity building in the ICT industry includes the establishment of managing authority for the ICT industry in Sarajevo Canton and establishment of the ICT technological park (construction of new or reconstruction of the existing capacities).

Sarajevo Canton conducted the activities and projects that are envisaged by the Strategy to some degree. It is safe to say that the 2019 Project for financing of small and medium enterprises and entrepreneurship is a positive step forwards as it recognised the ICT industry and provided a grant line for the ICT companies and entrepreneurs.

IT MANIFESTO - Strategic plan of IT industry development in Bosnia and Herzegovina drafted by BIT Alijansa, leading association of the most significant IT companies in Bosnia and Herzegovina. This document is the list of strategic priorities of Bit Alliance for the period 2019-2022. IT Manifesto defined three basic elements: education, legislation and economy. Manifesto defined the strategy of the BIH IT industry development and it is compatible with the 2020 European Union Development Strategy.

The section related to education defines nine strategic goals which correspond to the needs of IT modernisation and include all levels of education, the need to constantly innovate curricula and programmes in cooperation with IT companies so that students are prepared in the best possible way for the work in IT industry. The strategic goals in the field of education are stated below:

STRATEGIC GOAL 1 - To connect educational system with IT industry for the purpose of synchronisation of theoretical knowledge and necessary knowledge in practice

STRATEGIC GOAL 2 – To strengthen the teaching staff in IT field of educational system

STRATEGIC GOAL 3 - To adjust IT education programmes with the needs of labour market

STRATEGIC GOAL 4 - To improve IT education at elementary school level

STRATEGIC GOAL 5 - To improve IT education at secondary school level

STRATEGIC GOAL 6 - To improve IT education at university level

STRATEGIC GOAL 7 – To strengthen the formal IT education with informal education

STRATEGIC GOAL 8 – To model lifelong education and additional trainings/retraining in IT field

STRATEGIC GOAL 9 – To permanently and statistically monitor changes in IT sector in education field

The section related to legislation is focused on defining the strategic goals and measures that would provide for a more favourable legislation framework for IT industry and for digital transformation

of society and economy. Three strategic goals are defined in the legislation section, targeting legal solutions for more efficient regulation of IT industry, initiating new legal solutions to support business and education digitalisation, and initiating tax policy reforms in the field of IT industry.

The section related to economy is focused on the establishment of more favourable business environment for the IT industry and infrastructure for small and medium companies, strengthening of domestic, regional and international liaisons between the IT sector companies with view of strengthening competitiveness in the domestic and foreign markets. To that regard, nine strategic goals were defined in the field of economy as follows:

STRATEGIC GOAL 1 to create better business opportunities in the IT industry for domestic businessmen and investors

STRATEGIC GOAL 2 to support start-up ecosystem with an accent on supporting start-up companies and projects

STRATEGIC GOAL 3 to reduce unemployment rate by establishing mechanisms of employment in the IT industry through creating new jobs and occupations

STRATEGIC GOAL 4 to strengthen connections between domestic IT companies by initiating joint projects and events

STRATEGIC GOAL 5 to develop the IT industry through regional cooperation and connecting with other IT clusters

STRATEGIC GOAL 6 to strengthen the capacities to use the EU resources and other funds for development of IT industry

STRATEGIC GOAL 7 to attract foreign investors through promoting BiH as an attractive country for IT investments

STRATEGIC GOAL 8 to put an emphasis on scientific-research work and technologic development in IT sector

STRATEGIC GOAL 9 to support an application of information technologies in the modernization of business operations in all branches of industry

IT Manifesto defines the strategic development of IT sector the way it is seen by the BiH IT industry. The document as such represents a platform for action of BIT Alijanse towards all the actors in Bosnia and Herzegovina, which are competent to conduct activities for the improvement and accelerated development of education, legislation and economic framework.

3 MAPPING THE PRESENT FORMAL AND INFORMAL EDUCATIONAL INSTITUTIONS RELEVANT TO INFORMATION INDUSTRY

3.1. Formal education assessment

This analysis covered public and private educational institutions in BiH, which offer formal and informal higher education in information technology. The study primarily focused on the review and analysis of educational curricula and secondarily on comparison of those curricula. The assessment was made of 21 formal educational institutions that offer 34 programmes of information and computer science and nine additional informal educational institutions that offer various courses in the field of information technology.

The study covered the following formal education institutions: Sarajevo University, Travnik International University, "Džemal Bijedić" University in Mostar, International Burch University, Apeiron PanEuropean University, Sarajevo University, International University in Sarajevo, High business technical school in Doboj, Sinergija University in Bijeljina, University in Istočno Sarajevo, High computer and business communication school eMPIRICA, University in Banja Luka, University "VITEZ", ITEP High information technology economy and entrepreneurship school and University in Mostar.

Some of the aforementioned institutions operate with two or more independent faculties that offer similar courses, for example University of Sarajevo, where the informatics programmes are offered at the Faculty of Traffic and Communication, Faculty of Electrical Engineering and Faculty of Natural Sciences and Mathematics.

A complete list of public and private formal institutions is given in the table below. Educational institutions offer programmes with different names. However, a deeper analysis has shown that the curricula have similarities; the table below presents a total overview and grouping of similar programmes.

Table 2 - Overview of formal institutions and programmes

Name of the institution:	Degree name:
Sarajevo School of Science and Technology	Computer Science, Information Systems
Faculty of Engineering and Natural Sciences – International Burch University	Information technologies
Faculty of Information Technology University „Vitez“	Information technologies, Business informatics
Computer science and information technologies - ITEP high school for information technology, economy and entrepreneurship	Computer science and information technologies
Faculty of Information Technology – International University in Travnik	Information technologies Computer systems and networks, Software programming
Faculty of Natural Sciences, Mathematics and Education – University in Mostar	Information technologies
Fakultet prirodoslovno-matematičkih i odgojnih znanosti - Sveučilište u Mostaru	Informatics Mathematics and informatics
Faculty of Information Technology – PanEuropean University Apeiron	Information technology engineering (Programming and software engineering), Computer security and information protection, Business informatics, Computer Multimedia and Graphics, Teacher Informatics (Informatics and Polytechnics)
High school of computer science and business communication eMPIRICA	Engineering informatics, Business informatics
Faculty of Traffic and Communication University of Sarajevo	Computer and information technologies
Faculty of Mechanical Engineering – University "Džemal Bijedić" Mostar	Computer engineering
Faculty of Economy - University of Sarajevo	Information technology management, Development of business information systems
Faculty of Mechanical Engineering, Computer Science and Electrical engineering -University of Mostar	Undergraduate study of computer science
Faculty of Natural and Technical Sciences - International University of Sarajevo	Computer science and engineering Software engineering
Faculty of Electrical Engineering - University of Sarajevo	Computer science and informatics
Faculty of Electrical Engineering - University of Istočno Sarajevo	Computer science and informatics
High business technical school	Computer science and informatics
Faculty of Electrical Engineering – University of Banjaluka	Computing and informatics, Software engineering
Faculty of Information technology - University "Džemal Bijedić", Mostar	Software engineering
Faculty of Polytechnics – University of Zenica	Software engineering
Faculty of Natural Sciences and Mathematics - University of Sarajevo	Theory of computer science

The table below shows the number of enrolled students and the number of graduates per programmes on an annual basis. It shows that in the school year 2018/19, 5.616 were enrolled while the total number of graduates was 672.

Table 3 - overview of the enrolled students and graduates per programmes

Name of educational institution:	Study Program:	Number of participants in the year 2018/19	Number of graduates in the year 2018/19
Sarajevo School of Science and Technology	Computer Science, Information Systems	32 128	25 19
Faculty of Engineering and Natural Sciences – International Burch University	Information technologies	113	23
Faculty of Information Technology University „Vitez“	Information technologies, Business informatics	136 12	30 -
Computer science and information technologies - ITEP high school for information technology, economy and entrepreneurship	Computer science and information technologies	172	0
Faculty of Information Technology – International University in Travnik	Information technologies Computer systems and networks, Software programming	41 11 46	8 1 2
Faculty of Natural Sciences, Mathematics and Education – University in Mostar	Information technologies		
Fakultet prirodoslovno-matematičkih i odgojnih znanosti - Sveučilište u Mostaru	Informatics Mathematics and informatics	224 79	54 21
Faculty of Information Technology – PanEuropean University Apeiron	Information technology engineering (Programming and software engineering), Computer security and information protection, Business informatics, Computer Multimedia and Graphics, Teacher Informatics (Informatics and Polytechnics)	80 10 444 72 20	0 0 80 0 4
High school of computer science and business communication eMPIRICA	Engineering informatics, Business informatics	n/a	n/a
Faculty of Traffic and Communication University of Sarajevo	Computer and information technologies	356	53
Faculty of Mechanical Engineering – University "Džemal Bijedić" Mostar	Computer engineering	84	23
Faculty of Economy - University of Sarajevo	Information technology management, Development of business information systems	n/a	n/a
Faculty of Mechanical Engineering, Computer Science and Electrical engineering -University of Mostar	Undergraduate study of computer science	386	38
Faculty of Natural and Technical Sciences - International University of Sarajevo	Computer science and engineering Software engineering	128 105	
Faculty of Electrical Engineering - University of Sarajevo	Computer science and informatics	738	19 -
Faculty of Electrical Engineering - University of Istočno Sarajevo	Computer science and informatics		
High business technical school	Computer science and informatics		1097
Faculty of Electrical Engineering – University of Banjaluka	Computing and informatics, Software engineering		66
Faculty of Information technology - University "Džemal Bijedić", Mostar	Software engineering	940	97
Faculty of Polytechnics – University of Zenica	Software engineering	81	-
Faculty of Natural Sciences and Mathematics - University of Sarajevo	Theory of computer science	81	-
	TOTAL:	5616	672

Source: FBiH Statistics Bureau and RS Statistics Institute

The table gives an overview of all programmes and the contents of all study profiles. The numbers mark the semester in which the subject is learned, and are colour coded from yellow (starting semesters) to blue (final semesters). "elec." stands for elective subjects that are offered during the study programme.

		Name of the institution:	Program name:	Core subjects studied in semester no. #:		Broj institucije / Institution no.#	Broj programa / Program no.#
		Ime obrazovne institucije/Name of the educational institution:		Skraćeno ime nastavnih predmeta i kurseva koji se rade u na obrazovnim institudijama/Course abbreviation:			
1	1	Sarajevo SST	Computer Science	1 2 3 4 5 6 7 8 7 8			
2	3	Int. Burch Uni. Sarajevo	Information Systems	1 2 3 4 5 6 7 6 6 7			
3	4	Uni. Vitez	Information Technology	1 2 3 4 5 6 5 3 6 7			
4	6	ITEP v. Škola Banja Luka	Business informatics	1 2 3 4 5 6 7 8 6 8			
5	7	Int. Uni. Travnik	Computing and Information Technology	1 2 3 4 5 8 4 7 8 7			
8		Int. Uni. Travnik	Information Technology	1 2 3 4 5 8 4 2 8 6			
9		Int. Uni. Travnik	Computing systems and networks	1 2 3 3 4 4 4 2 8 6			
6	10	Uni.Sinergija Bijeljina	Software programming	1 2 3 5 4 4 6 7 4 2 8 5			
7	11	FPMOZ Uni. Mostar	Information Technology	1 2 3 3 4 5 7 3 3 5			
12		FPMOZ Uni. Mostar	Mathematics and Informatics	1 2 3 4 5 6 6 6 5			
8	13	FIT Pan. Uni. Aperion Banja Luka	Information Technology Engineering (Programming and software engineering)	1 2 3 3 5 7 2 2 2 2 4 3 4 8 7 7 8 6 5			
14		FIT Pan. Uni. Aperion Banja Luka	Computer safety and information protection	1 2 3 3 5 2 2 2 2 4 3 4 8 7 7 8 6 5			
15		FIT Pan. Uni. Aperion Banja Luka	Business Informatics	1 3 7 7 4 4 4 4 3 4 7 4 3 4 7 7 5 5			
16		FIT Pan. Uni. Aperion Banja Luka	Computing multimedia and graphics	1 3 7 4 4 4 4 2 4 3 6 6 5 6 6 5 5			
17		FIT Pan. Uni. Aperion Banja Luka	Teacher Informatics, (Informatics and Polytechnics)	1 3 7 4 4 4 2 4 3 4 7 8 7 8 6 5			
9	18	VŠRIPK EMPIRICA Tuzla	Engineering Informatics	1 2 6 2 2 6 4 3 4 3 5 5 5 5 5 5 5			
19		VŠRIPK EMPIRICA Tuzla	Business informatics	1 3 6 2 2 6 3 4 3 4 7 3 5 5 5 5 5			
10	20	FZSIK - Uni. Sarajevo	Computing and Information Technology	1 5 6 3 5 5 4 6 6 4 5 5 4 6 6 4 5			
11	21	Maš. F - Uni. Mostar	Computer Engineering	1 5 6 3 5 5 4 6 6 4 5 5 4 6 6 4 5			
12	22	Ekonomija - Uni. Sarajevo	Information Technology/Management	1 6 3 5 5 4 6 6 4 5 5 4 6 6 4 5			
23		Ekonomija - Uni. Sarajevo	Business information systems development	1 4 5 4 4 5 5 4 5 5 4 5 5 4 5 5 4			
13	24	FSRE - Sremski Mostar	Undergraduate study of computing	1 2 3 4 5 5 5 6 6 6 6 6 6 6 6 6 6			
14	25	Int. Uni. Sarajevo	Computing Science and Engineering	1 2 3 5 5 5 6 6 6 6 6 6 6 6 6 6 6			
26		Int. Uni. Sarajevo	Software Engineering	1 2 3 5 5 5 6 6 6 6 6 6 6 6 6 6 6			
15	27	ETF - Uni. Sarajevo	Computing and informatics	1 2 3 5 5 5 6 6 6 6 6 6 6 6 6 6 6			
16	28	ETF- Uni. ist. Sarajevo	Computing and informatics	1 2 3 5 5 5 6 6 6 6 6 6 6 6 6 6 6			
17	29	VPTŠ - Doboj	Computing and informatics	1 2 3 5 5 5 6 6 6 6 6 6 6 6 6 6 6			
18	30	ETF - Uni. Banja Luka	Computing and informatics	1 2 3 5 5 5 6 6 6 6 6 6 6 6 6 6 6			
31		ETF - Uni. Banja Luka	Software Engineering	1 2 3 5 5 5 6 6 6 6 6 6 6 6 6 6 6			
19	32	FII - Uni. DŽB. Mostar	Software Engineering	1 2 3 5 5 5 6 6 6 6 6 6 6 6 6 6 6			
20	33	PF - Uni. Zenica	Software Engineering	1 2 3 5 5 5 6 6 6 6 6 6 6 6 6 6 6			
21	34	PMF - Uni. Sarajevo	Theory of computer science	1 2 3 5 5 5 6 6 6 6 6 6 6 6 6 6 6			

Table 4 - An Overview of all programs with relevant subjects for the IT industry

Table 5 - List of abbreviations for all relevant subjects

Abbreviation	Course/subject	Translation
Programming -1	Programming -1	Programiranje 1
-2	Programming -2	Programiranje 2
-3	Programming -3	Programiranje 3/Programski jezici
OOP	Object Oriented Programming	Objektno-orientirano programiranje
Data Struct. & Algorith.	Data Structures and Algorithms	Stukture podataka i algoritmi
Analysis & SW design	Analysis and software design	Analiza i dizajn softvera
SW Dev.	Software development	Razvoj softvera (Programski jezici/ Korisnička sučelja)
SW Testing	Software quality and testing	Testiranje softvera
SW Arch.	Software architecture	Softverska/računarska arhitektura
DB	Databases	Baze podataka
OS	Operating Systems	Operativni sistemi
Web prog.	Web programming	Web programiranje
Mobile dev.	Mobile development	Mobilno programiranje/.Net tehnologije
SW Eng.	Software engineering	Softverski inžinjerstvo/Programsko inžinjerstvo
SW PM	Software Project Management	Upravljanje softverskim projektima
AI	Artificial Intelligence	Umjetna/vještačka inteligencija
ML	Machine Learning	Mašinsko/Strojno učenje
Data Mining	Data Mining	Dubinska analiza podataka/rudarenje
Applied Prog.	Applied Programming	Primijenjeno programiranje
Net prog.	Network Programming	Mrežno programiranje
Parallel prog.	Parallel Programming	Paralelno programiranje
Script prog.	Script programming	Skriptovno programiranje
ERP	Enterprise Resource Planning	Planiranje resursa u korporacijama
BI	Business Intelligence	Poslovna inteligencija
IoT	Internet of Things	Internet uređaja
elec.	elective subject	Izborni predmet

The methodology used in this evaluation has a focus on two aspects: analysis of the compulsory vocational subjects and availability of relevant elective subjects. The contents of each vocational subject were analysed along with the recommended literature list. The subjects that were taught in line with the authors such as Bjarne Stroustrup for object programming, Robert Sedgewick for algorithms, Paul and Harvey Deitel for C++/Java programming, Erich Gamma for pattern design and other computer science experts obviously used best practices and transferred expert knowledge to students, as is the case with the best IT universities in the world (MIT, Stanford, Carnegie Mellon, Berkley, Cambridge, etc.) Those Universities that offered elective subjects in the field such as: Artificial intelligence, Machine Learning, Data Mining, mobile development, network or parallel programming and project management provided very useful education to their students and those students were capable to work in IT industry immediately after their graduation. Availability of such elective subjects added scores in the ranking process and thus affected the overall ranking list.

It is worth mentioning that some educational institutions followed rather unusual practice of not publishing their curricula, which made our analysis difficult, and so the scores of these institutions in the ranking list should be taken with reserves. Those three institutions are marked with an asterisk in the table.

The results of evaluation certainly do not represent an absolute ranking of companies or their programmes. It is worth mentioning that it was our intention to evaluate the degree to which the teaching programmes are adapted to current needs of IT industry. The table is below and a detailed Excel overview is at the end of the report.

Table 6 - Ranking of study programmes per relevant subjects

The presented table and the analysis thereof give an insight into the contents of study programmes. The ranking of compulsory vocational subjects was the basis for the analysis, as these subjects are necessary for acquiring the software industry related technical and vocational knowledge. Each relevant subject that was given points is mentioned in Table 6. Compulsory subjects were given point 1 while elective subjects were given half a point.

The results are categorised into three groups according to the number of points. The group number one includes the study programmes that were given scores from 18 to 12. The group number two includes those with scores between 9 and 11.5. The third group covers all programmes that were given score 8 or less.

According to the quantitative analysis, two programmes with identical number of points are at the very top of the list: Software engineering from the International University in Sarajevo and Faculty of Information Technology (FIT) of the University „Džemal Bijedić“ in Mostar. These programmes covered almost all relevant subjects as compulsory subjects and at the same time offered elective subjects to their students.

The interviews with IT industry representatives provided us with opinions and comments based on which we were able to make a qualitative analysis as well. According to the IT industry representatives' recommendations, the top programmes are Computer science and informatics at the Faculty of Electrical Engineering (ETF) in Sarajevo and Software Engineering at FIT, University of Mostar. These two programmes are the leaders in providing trained young generations for the work in IT industry in BiH.

3.2. Assessment of informal education

As for the informal educational institutions, the following were analysed and assessed: Akademija 387, Akademika, Centar za poslovnu edukaciju – CPE (Centre for business education), InfoARS - Banja Luka, JS Guru - Kliker, Lanaco, Regional development agency Centralna BiH, SPARK and ITAcademy.

Availability and business activities of these institutions considerably contribute to popularity of IT profession in BiH, as they often a first step to many individuals who want to change their occupation and re-train for IT positions.

Comments and opinions of IT industry representatives, however, suggest that informal education in BiH market does not serve well as a stepping-stone for work in the field of information technology. The informal educational institutions usually just provide their students a sense of direction through the maze of IT technologies helping them to continue their schooling at some of globally available and mainly free internet educational platforms such as: Coursera, edEx, Udemy, etc.

IT industry representatives also mentioned that specialised programmes of some of the leading companies in BiH information industry such as: Authority Partners - API Lab, Mistral - Gigi škola kodiranja, Lanaco - Edukacioni Centar, NSoft - Devhive, offer a good starting point in IT career and provide a useful technical knowledge to its students. The best students often have an opportunity to join the company that provided the education while the rest of them have more chances of getting a job in smaller IT companies at the market.

4 ASSESSMENT OF HUMAN RESOURCES AND SKILLS NEEDS ON THE DEMAND SIDE (EMPLOYERS) OF THE BIH SOFTWARE INDUSTRY

The needs of the software industry when it comes to skills and human resources are primarily defined by the technology applied by the software industry companies in their business models. IT specialists of different areas of specialisation, with skills and knowledge needed for the development of custom-made software or other IT services, are the main force of the growth and development of BiH/global software industry. Accelerated application of software in all areas of life and economy makes a constant need for IT specialist grow both in the BiH market and globally, causing an imbalance in which many IT specialist posts remain unfilled. The labour market does not have a sufficient number of IT specialists to fill the newly opened posts.

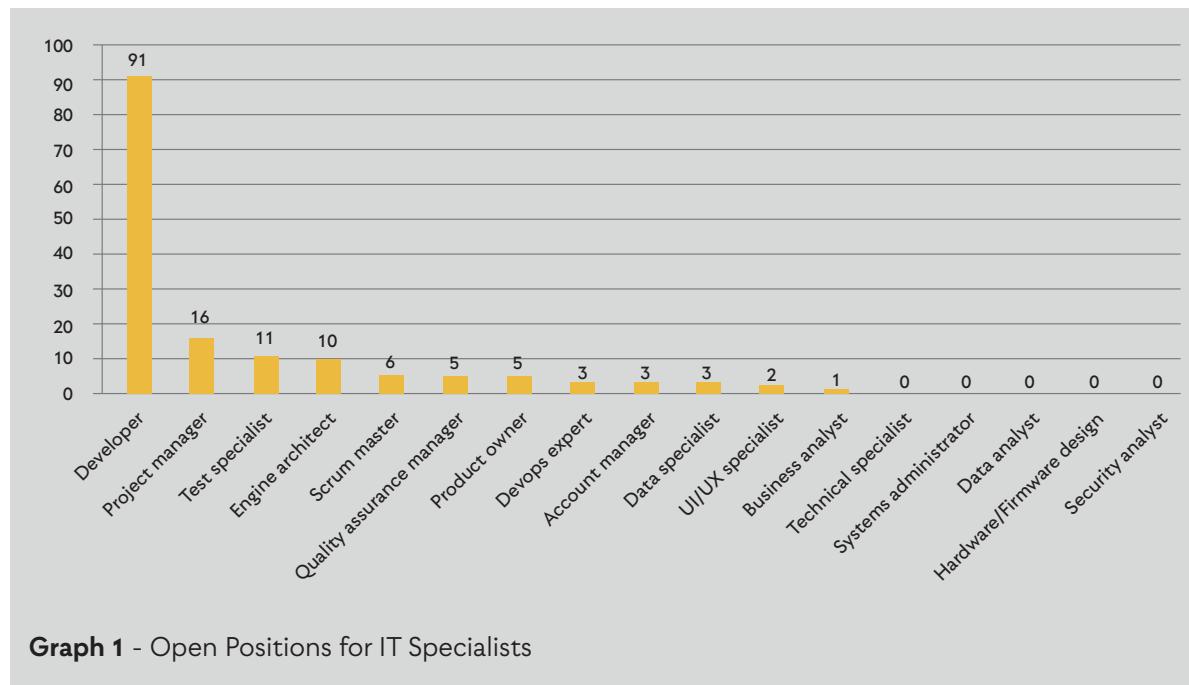
This section of the report is drafted based on the answers provided in the questionnaire on the sample of 35 companies in the BiH IT industry. Annex 1 gives a table with companies' basic demographic characteristics. The presented data show that micro companies make 24, 2%, small and medium enterprises 66, 7%, while large companies make 9, 1% of the companies that were subject to this survey.¹⁰ 54% of companies generated income less than BAM 1 million, while 46% of companies with an annual income of over BAM 1 million. The largest number of companies are from Sarajevo (62.5%), followed by Banja Luka (15.6%) and Mostar (12.5%). About three-quarters of the sample companies (76.5%) develop custom software for client - outsource. However, it should be noted that about half of the surveyed companies (55.9%) also develop their own software for sale on the market. The companies in the sample operate mostly in the European market (72.7% of them listed Europe among the offered options), in the second place is BiH (63.6%), followed by North America (36.4%), other countries (21.2%) and Asia (6.1 %). The structure of participation in each market for individual companies is given in the last table in Annex 1. Data on the ownership structure is also given, from which it can be seen that about 2/3 of the companies in the sample are fully domestically owned.

4.1. Educational and occupational profile of all present employees

The educational profile of employees in the software industry in BiH is mostly composed of young highly educated staff (85.3%), who in 90% of cases acquired their formal education at public educational institutions in BiH. Three quarters of employees are IT specialists, engineers and other technical persons, while one quarter are other specialists, i.e. non-IT staff, administration, HR, etc. The gender structure of IT specialists is male dominated, given that men make up almost three quarters and women only one quarter of employees. The gender structure of other specialists or non-IT staff (sales, marketing, HR, administration, etc.) is almost completely balanced, given that men make 46% and women 54% of these employees in companies from the analysed representative sample. (Detailed information is given in the tables in the annexes to the document.)

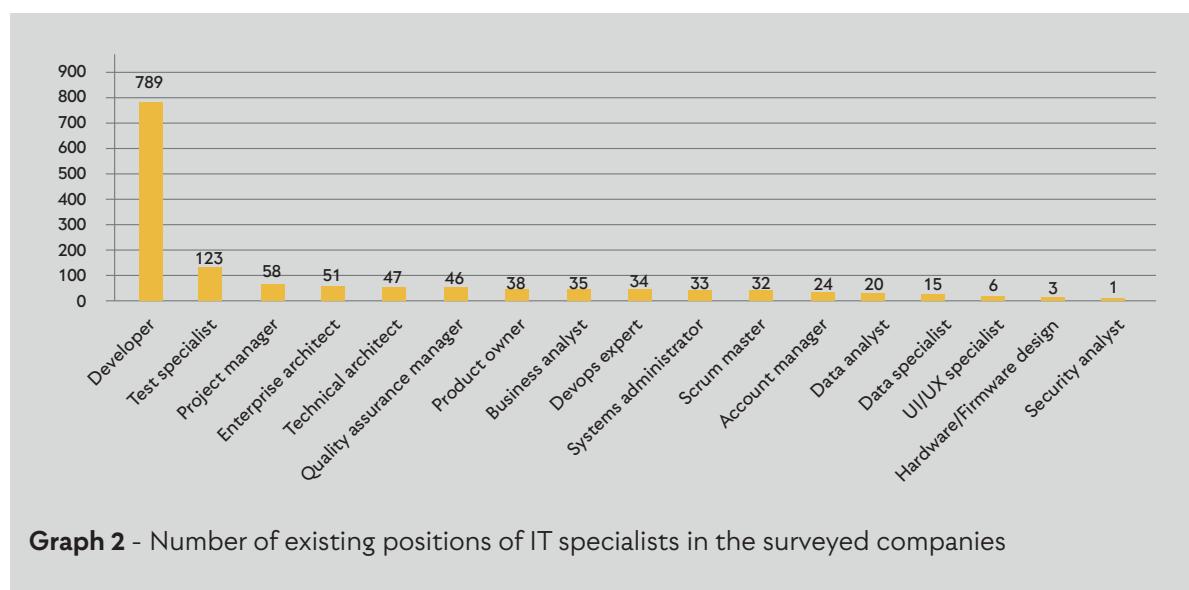
10 Out of those who answered to this question.

In Bosnia and Herzegovina, the most deficient IT specialists are developers who are, according to the results of the survey, in the highest demand. Out of 156 open positions for the employment of IT specialists, 91 or 58.33% of them are for the position of developers, more than a half. In terms of the number of open positions for the employment of IT specialists, the second position is for project managers, where 16 positions or 10.26% have been opened. This is followed by the positions of test specialists with 11 positions or 7.05%, enterprise architects with 10 positions or 6.41%, scrum masters with 6 positions or 6.41%, etc.



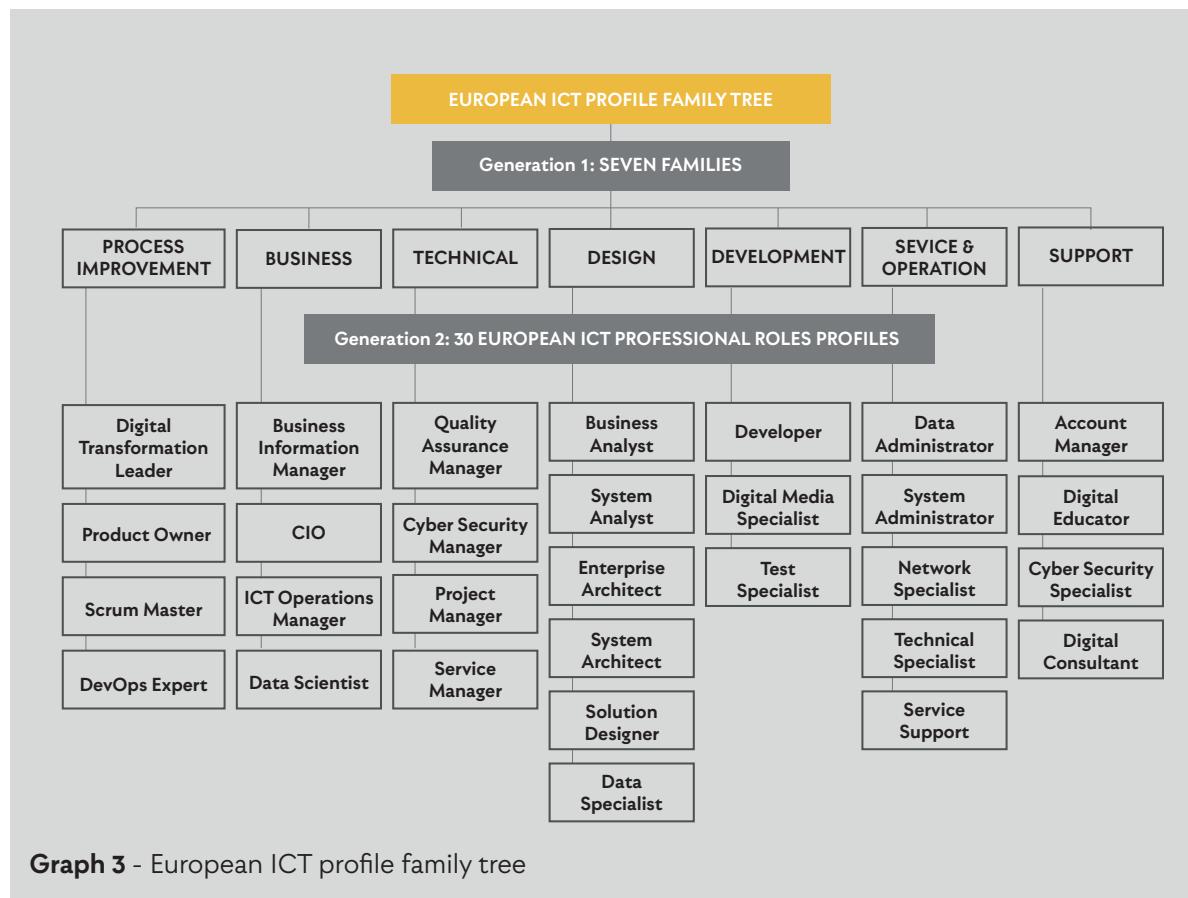
Graph 1 - Open Positions for IT Specialists

The analysis of the relationship between the total number of employees in the software industry and the number of employees in the surveyed companies determined a multiplication factor of 3 (approx. $6000/2000 = 3$), according to which it was calculated, at the time this research was conducted, that the software industry has 468 open positions for IT specialists, of which 271 positions are for developers.



Graph 2 - Number of existing positions of IT specialists in the surveyed companies

The review of the total number of active positions of IT specialists shows almost identical ratios as for the positions for which a call for employment was opened. Namely, out of 1,355 active positions of IT specialists, 789 or 58.23% are developers. They are followed by „Test Specialists“ with 9.08% or 123 positions, „Project Managers“ with 4.28% or 58 positions, and „Enterprise Architects“, „Technical Specialists“ and „Quality Assurance Managers“ with an individual share of over 3% in the total number of active positions.



According to the European ICT profile tree, created by the European Committee for Standardization - CEN, 2/3 of the positions of IT specialists are in the family of development, while 1/3 is distributed mainly to the families of technical and design ICT profiles. This distribution of positions reflects the business model in which most of the surveyed companies develop custom software for clients -outsource (76.5%), while 55.9% carry out activities to develop their own ICT solutions. In practice, 41.2% of software companies combine business activities that include outsourcing (development of custom software) and development of their own software / products. The extent to which one of the business models prevails is a matter of individual choice and business policy of the company.

The development family profiles, such as „Developer“ and „Test Specialist“ can be considered as entry profiles into the software industry since most IT specialists start their careers in these positions.

4.2. Forecasted skills and human resource-based needs

Professional (technical) skills are the most important skills of employees in the software industry. On a scale of 1-5, they were rated with an average score of 4.71. Although they represent the minimum requirement for working in software development and providing IT services, they still make only a portion of all needed IT specialists skills. The process of producing custom software or providing IT services involves intensive communication with clients and service users, as well as with colleagues and teammates. Therefore, other non-technical skills are also considered important, as their average score of 4.51 is approximately the same as the score for professional (technical) skills. These skills are primarily the teamwork ability, foreign languages, and the ability to learn quickly, analytical thinking, problem solving and communication skills.

On the other hand, viewed from the perspective of satisfaction of the software industry with the existing skills of employees, on a scale of 1-5 the highest average score of 4.37 was achieved by the teamwork ability. This is followed by foreign languages with an average grade of 4.26, professional technical skills with 4.17, analytical thinking and problem solving, and the ability to work individually with a grade of 4.09, etc.

The difference between the importance and satisfaction with the skills of employees is most significant in professional (technical) skills, which clearly indicates the fact that software companies are not fully satisfied with the professional technical skills of employees, and that these skills need to be improved. A statistically significant difference was also noted for communication and organizational skills, ability to learn quickly and foreign languages. All the aforementioned skills are generally in need for improvement.

According to a two-thirds majority of respondents, professional (technical) skills are in the largest need for improvement. It is obvious that the software industry is facing constraints of underdeveloped professional technical skills of IT specialists, which slow down the growth and development of both individual companies and the entire software industry.

The needs for improving the skills of IT specialists are clearly articulated for the ability to work with clients, communication skills, the ability to identify and solve problems, and to translate the needs of clients into action plans. More than a half of the respondents / management of the surveyed companies believe that there is room and need for their improvement. This set of non-IT skills is primarily related to the basics of business correspondence, creating up-to-date project documentation, understanding the broader business context of projects and their use value for the client.

The above indicates the need to improve the educational process in the segment of professional technical skills as well as in the segment of general business practice, administration and correspondence.

Table 7 - IT specialist skills in the highest need to improve, according to respondents

		N	Responses Percent	Percent of Cases
The Most Needed Skills	Professional (Technical) Skills	23	16.9%	69.7%
	The Ability to Work with Clients	18	13.2%	54.5%
	Communication Skills	17	12.5%	51.5%
	Problem Detection and Solving Abilities	17	12.5%	51.5%
	Transforming the Needs of Clients into Action Plans	17	12.5%	51.5%
	Organizational and Team Management Skills	16	11.8%	48.5%
	Mentorship/Coaching Abilities	13	9.6%	39.4%
	Knowledge of Foreign Languages	9	6.6%	27.3%
	Knowledge of Work Ethics	6	4.4%	18.2%
Total		136	100.0%	412.1%

The assessment of importance in relation to satisfaction with professional IT technical skills presented below shows the categories and subcategories of different IT technologies and methods used by software companies in BiH, to determine the gap between importance and satisfaction with IT skills at the level of applied IT technologies. In this regard, the assessment of IT technical skills was done according to the following categories, and they include:

1. Fundamental knowledge of programming languages and IT systems,
2. Experience in working with complementary tools and project management,
3. Knowledge of advanced technologies

In view of the software industry needs, the first category - fundamental knowledge of programming languages and IT systems, represents the minimum competencies and skills required to enter the IT industry. These include general programming (4.42), software development (4.37), databases (database administration) (4.38), system administration (3.73), application architecture (4.13), backup systems 3.63). They are the basis for employees to be able to develop the other two categories of professional technical skills. They were rated as extremely important by the surveyed companies and achieved an average score of 4.1 on a scale of 1-5.

The second category of professional technical skills includes knowledge of technologies and methods for process creation and automation (4.09), server-client programming (4.32), management systems (4.41), project / product management (4.18 / 3, 87), information systems security (3.91) and web development (4.52), and web design (3.97). From the aspect of importance for the business process of software industry companies, this category was rated with an average score of 4.16, which is very important. The category includes tools for the application of fundamental programming languages and systems such as. Java, C ++, Node.js, PHP, ASP.NET, web API, WCF services.

Advanced technologies represent the third category of professional technical skills used by software industry companies in their business process. This category consists of Microsoft .NET technologies (3.87), Java ecosystems (JEE, Spring) (3.47), Mobile development (Android / iOS) (3.68), Cloud computing (AWS, Azure) (3.97)), Data Science (ML, Big Data) (3.58), Internet of things (3.24), Embedded

software development (3.03). They represent a kind of upgrade to the existing two categories and are therefore used for the application and development of software solutions for end users. The average importance score for software industry enterprises for the third category on a scale of 1-5 is 3.55, which is the lowest average importance score.

From the perspective of satisfaction with professional technical skills within the category of fundamental knowledge of programming languages and IT systems, the highest satisfaction rating was achieved by technical software development skills (4.17) which includes Application development, Component integration, Testing, Solution deployment, Documentation and Production. This is followed by general programming (4.12) and database administration (4.10). Satisfaction with existing professional technical skills in the second category was rated highest for server-client programming (4.11) and management systems (4.06). Within the third category of professional technical skills, the highest average satisfaction scores were achieved by web development technologies (4.09) and Microsoft .Net technologies (4.07).

A statistically significant difference between the importance and satisfaction with the professional technical skills of employees was expressed for database administration, general programming and application architecture. This is a clear message that they need to be improved.

Management systems and information systems security are the second category of technologies where the most significant statistical gap between importance and satisfaction with skills has been registered. In addition, a significant statistical difference was registered in the sphere of project management and process and automation technologies. It is evident that there is a need to raise the competencies, knowledge and skills of employees in this field, both through interventions in the educational process and activities of continuous training of employees by the software industry companies.

When it comes to advanced tools, significant statistical differences between importance and satisfaction with professional technical skills have been noted in the sphere of Web development, cloud computing and data science technologies.

The differences identified in this way between the skills importance and satisfaction indicate the need to improve these skills of employees and are a guideline for planning the improvement of IT education in both Faculties and companies. If the skills identified in this way are improved, they open up opportunities for software industry companies in BiH to expand the offer of services in the field of IT services in which no significant business activities have been carried out in the past period.

Table 8 - Importance in relation to satisfaction with IT technical skills

Skill / Ability	Importance		Satisfaction		gap	t
	Avg.	SD	Avg.	SD		
1. category - fundamental knowledge of programming languages and IT systems						
General programming (C, C++, C#, Java, Python...)	4.42	0.708	4.12	0.74	-0.303	1.83
Software Development (Application development, Component integration, Testing, Solution deployment, Documentation Production...)	4.37	0.615	4.17	0.711	-0.207	1.29
Database Administration (MS SQL, Oracle, MySQL...)	4.38	0.707	4.1	0.759	-0.333	3.01
System Administration (MS Windows Server, Exchange server, Linux Systems...)	3.73	1.015	3.7	0.993	-0.074	0.37
Application Architecture (Arch. design, Arch. patterns, App design...)	4.13	0.776	3.79	1.048	-0.357	1.91
Backup systems (Backup and storage admin related skills)	3.63	0.964	3.85	0.818	0.154	-1.28
Average	4.11		3.96			
2. category - experience in working with complementary tools and project management						
Server-client Programming (Java, C++, Node.js, PHP, ASP.NET, web API, WCF services...)	4.32	0.653	4.11	0.567	-0.259	1.66
Processes and Automation (Jira, Confluence, Polarion, DevOps, Agile methodologies...)	4.09	0.879	3.81	0.98	-0.355	1.83
Management Systems (Git, SVN, TFS, ClearCase...)	4.41	0.665	4.06	0.772	-0.323	2.4
Information System Security (Intrusion detection, Risk analysis, Security analysis...)	3.91	0.893	3.69	0.788	-0.385	2.08
Project Management (Agile, Scrum...)	4.18	0.716	3.83	0.889	-0.31	1.61
Product Management	3.87	0.942	3.62	0.82	-0.345	1.78
Web Development (HTML, CSS, JavaScript, JQuery, Angular...)	4.52	0.619	4.09	0.689	-0.438	3.99
Web Design (Photo editing, UX design, Graphic design...)	3.97	1.048	3.88	0.909	-0.192	1.15
Average	4.16		3.89			
3. category - knowledge of advanced technologies						
Microsoft Technologies (.NET framework, ASP.NET, Entity...)	3.87	1.088	4.07	0.828	0.133	-0.66
Java Ecosystem and Tools (JEE, Spring, Hibernate...)	3.47	1.106	3.81	0.786	0.04	-0.22
Mobile Development (Java, Kotlin, Swift, GoLang...)	3.68	1.056	3.71	0.854	0	0
Cloud Computing (Cloud Migration, Serverless architecture, Cloud security...)	3.97	0.999	3.68	1.069	-0.44	2.11
Data Science (Data warehouses, Machine learning, Big Data, Data pipeline...)	3.58	0.969	3.36	0.907	-0.4	2.31
Internet of Things (IBM Watson, API, Arduino, Raspberry Pi...)	3.24	1.123	3.38	0.77	-0.083	0.57
Embedded Software Development	3.03	1.217	3.35	0.832	0.13	-0.77
Average	3.55		3.62			

4.3 Identification of major obstacles related to job vacancies and occupational gaps

Two-thirds of the surveyed software industry companies (23 companies or 66%) stated that they had problems filling vacancies for IT specialists in the past and / or current year. 81.8% of cases stated that the main reason for the problems in filling vacancies for IT specialists is the shortage in candidates with appropriate knowledge and skills, and 54.5% of them stated the shortage in candidates with the necessary work experience. 22.7% of cases stated that no one applied for the announced open call. 22.7% of cases stated that the candidates were not satisfied with the offered conditions, the amount of salary, etc., and 31.8% of cases stated that the employer did not find the candidates suitable. Based on the aforementioned, it is clear that there is a significant mismatch between supply and demand for IT specialists in the labour market of Bosnia and Herzegovina. It is evident that enrolment policies do not follow market trends, resulting in small enrolment quotas at higher education institutions that cannot meet the current and future needs of the software industry for IT professionals. For example, at the open call in Sarajevo Canton for enrolment of students in the first year of the first cycle of integrated studies at the University of Sarajevo in the academic year 2019/2020, only 150 places out of a total of 6,357 enrolment places, are for IT specialists, which makes 2.35%. The situation is similar or the same at other universities in BiH. The number of students and thus the number of graduates at the faculties that educate IT specialists is insufficient to meet the demand of the software industry. Therefore, the software industry companies are forced to apply alternative strategies in overcoming the problem of staff shortages.

Table 9 - Main reasons for which the companies have problems in filling the vacant IT specialist posts

Reason		Responses		Percentge of cases
		N	Percentage	
	Candidates did not have the appropriate knowledge and skills	18	36.7%	81.8%
	Candidates did not have adequate work experience	12	24.5%	54.5%
	Candidates did not express positive attitudes towards learning, dedicated work and career development	7	14.3%	31.8%
	The working conditions did not suit the candidates	1	2.0%	4.5%
	Candidates were not satisfied with the salary	5	10.2%	22.7%
	Candidates wanted a safer job	1	2.0%	4.5%
	Nobody applied for the announced call	5	10.2%	22.7%
Total		49	100.0%	222.7%

4.4. Recruitment strategy(ies) and sourcing of new employees

The most important or most common source of recruitment is through personal contacts and recommendations. This method of recruiting IT specialists is used by 91.2% of surveyed companies and is universal for all companies regardless of the size and development of the organization. Posting open positions for IT specialists on the company's website is used by 76.5% of companies, and it is combined with other sources of recruitment, such as social networks and private employment agencies. Recruitment through cooperation with faculties / universities is carried out by 44.1% of surveyed companies. This source of recruitment is related to scholarship programmes for gifted students, organizing joint projects and providing support in the teaching process. It is characteristic for larger software companies, which, in addition to cooperation with faculties, in 14.7% of cases also cooperate with secondary vocational schools. Recruitment of IT specialists from other companies as a source of recruitment is carried out by one third of the surveyed companies. The turnover of IT specialists between software companies is continuous, and employees of other companies are offered better conditions and positions than those they have in their current companies. The organization of boot camps, short courses, which employ the best participants as a source of recruitment, is characteristic of medium and large companies in the software industry. Smaller companies in the software industry employ boot camp participants who are not employed by the company that organized the boot camp, as a rule. It is interesting that only 5.9% of software industry companies used candidate selection services through the Employment Institute. Employment Institutes are obviously the least used source of recruitment of IT experts, given that in the past period, the Employment Institutes primarily dealt with the records of unemployed persons, and less with employment mediation. However, the Employment Institutes manage significant funds for the implementation of employment, retraining and additional training programmes. If tailored to the needs of the BiH software industry, they can potentially become a significant source of recruitment of IT professionals. This primarily refers to retraining and additional training of the unemployed for IT occupations, co-financed training for IT occupations and the like.

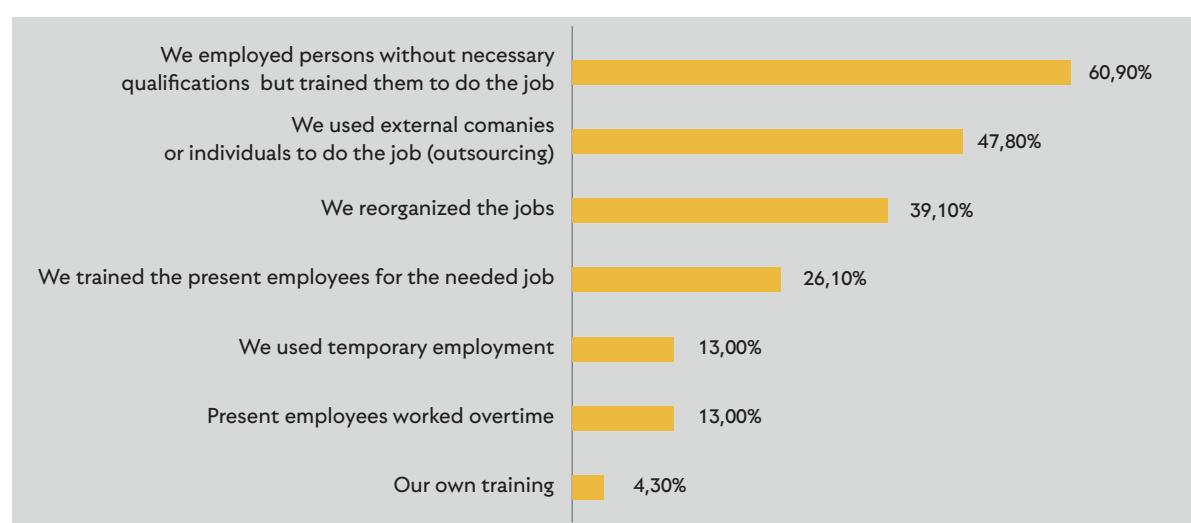
The aforementioned findings of the survey clearly show that software industry companies in BiH use several sources when it comes to recruitment. It is a strategy of securing the required number of employees by various sources of recruitment. The mix of recruitment sources depends on the size of the company. As a rule, larger software industry companies use more sources of recruitment, and in some cases, due to the insufficient number of available IT specialists in the BiH labour market, they are forced to recruit IT specialists in the international labour market. The human resources management department through the application of known methods of testing and profiling candidates usually carries out the recruitment process. On the other hand, smaller software companies have less formalized recruitment methods, and personal contacts and recommendations are the main source of new employees / IT specialists.

The measures taken by software companies in Bosnia and Herzegovina to solve the problem unfilled IT specialists' positions are different. They are aimed at providing the minimum required number of IT specialists for the smooth running of the company's business process. The imbalance in the labour market when it comes to IT specialists is so great that a half of software industry companies are forced to hire people who do not have the appropriate qualifications and then train them for the job they are looking for. Almost half of surveyed companies subcontract external companies or individuals to perform jobs for which they do not have enough of their own capacities or IT specialists, and cannot recruit them from the labour market on short notice. 39.1% of surveyed companies reorganize jobs in order to successfully service existing and new projects / jobs, and 26.1% of them conduct training of existing employees for these purposes. 13% of companies use temporary employment of IT specialists and overtime work of existing employees. 4.3% of surveyed companies use their own training, such as boot camps, as a measure of filling IT specialists' posts.

The measures taken by software industry companies to solve the problem unfilled IT specialist posts, or rather to provide the required number of IT specialists for servicing projects and clients, are in practice a mix of the above. The largest number of these measures, 3, includes education and training of both new and existing employees and boot camp participants. It is safe to say that the software industry in Bosnia and Herzegovina is directed to self-reproduction of its own professional staff (IT specialists), i.e. filling the gap between supply and demand for IT specialists, as the existing capacities and BiH education system are not able to do that. By doing that, the software industry companies so to say assume the role of the education system, which additionally occupies their already limited human resources and makes it difficult to perform commercial tasks and projects. This situation calls for the improvement of IT education in Bosnia and Herzegovina at all levels, in order to make greater use of the economic and development potential of the software industry. These improvements apply to higher, as well as to secondary and primary education.

Table 10 - Recruitment sources used by companies

		Responses		Percentage of cases
		N	Percentage	
Source of recruitment	Personal contacts and recommendations	31	23.1%	91.2%
	Posts on the company's website	26	19.4%	76.5%
	Social media	22	16.4%	64.7%
	Private employment agencies (eg. Posao.ba)	17	12.7%	50.0%
	Cooperation with faculties / universities	15	11.2%	44.1%
	Recruiting IT specialists from other companies	12	9.0%	35.3%
	Cooperation with secondary vocational schools	5	3.7%	14.7%
	Bootcamp	4	3.0%	11.8%
	Candidate selection services through the Employment Institute	2	1.5%	5.9%
Total		134	100.0%	394.1%



Graph 4 - measures taken in order to solve the problem of unfilled It specialist posts

4.5. Inflow and outflow of employees during the last 3 years

Software industry companies in BiH covered by this survey employ a total of 2,069 people, of which IT specialists make up 82% or 1,689, and non-IT specialists 18% or 380 (sales, marketing, HRM, administration, etc.) The sampled companies have an average of 38 male IT specialists and 15 female IT specialists. At the same time, they have an average of seven other non-IT male specialists and eight other non-IT female specialists.

In the last three years, companies from this sample have employed 809 IT specialists, 77% of which are men and 23% women. At the same time, the companies in the sample employ 209 specialists of other profiles (sales, marketing, HRM, administration, etc.), 47% of which are men and 53% women. On average, 22 male IT specialists, 8 female IT specialists, 5 other male specialists and 7 other female specialists were employed.

According to the data on the number of employees in the statistical code of activities of BiH 2010 - 62. Computer programming, consulting and related activities, in the last 3 years the net increase in the number of employees was 2,951. If the ratio of IT and non-IT specialists (82% / 18%) from the sample is applied this means that in that period 2,420 new IT specialists and 531 other specialists were employed.

The sample companies registered the outflow of 495 employees in the last three years, 402 of which are IT specialists and 93 others non-IT specialists. In the last three years, an average of 10 male IT specialists, 4 female IT specialists, 3 non-IT male specialists and 3 non-IT female specialists have left.

In the same period, the net inflow of labour amounted to 523 employees, of which 407 IT specialists and 116 non-IT specialists.

Table 11 - Expected number of employments in the next 3 years (n = 35)

	Sum	Median
IT specialists	926	28
Other specialists	134	6

Respondents stated that in the next three years, it will be necessary to employ 926 IT specialists and 134 non-IT specialists, which is an average of 28 newly-hired IT specialists and 6 other specialists per company. Applying the multiplication factor 3, the expected number of new employees in the next three years at the level of the entire software industry in BiH is 3,180, that is, 2,778 IT specialists and 402 other specialists.

According to data obtained from the entity statistical institutes, the number of graduates in IT majors in BiH in the 2018/2019 school year was 672. Assuming that the number of IT graduates remains the same in the next three years, and that all graduates are employed in the software industry and stay in Bosnia and Herzegovina, the difference between the number of IT graduates and the number of open positions for IT specialists is 762 or 27.4%, which means that the number of IT graduates in faculties in BiH should increase by 37.8% to meet the needs of the software industry for IT professionals. Given that all IT graduates at faculties in BiH are not only employed in the software industry, and that a certain number of them is leaving Bosnia and Herzegovina, the number of IT graduates potentially available to the software industry is significantly lower than the annual number of IT graduates at

faculties in Bosnia and Herzegovina. If we assume that 80% of the total number of IT graduates join the BiH software industry, the difference between the number of IT graduates and open IT positions in the next 3 years is much larger and amounts to 1,165 IT graduates or 41.9%.

Table 12 - Expected number of graduates in relation to the expected number of open positions

Expected number of IT graduates in the next 3 years (672x3)	Expected number of open positions / newly hired IT specialists in the next 3 years	The difference between IT graduates / open IT positions in the next 3 years
2.016	2.778	762 ili 27,4%
Expected number of IT graduates in the next 3 years (672x3) 80% available to the software industry in BiH	Expected number of open positions / newly hired IT specialists in the next 3 years	The difference between IT graduates / open IT positions in the next 3 years
1.613	2.778	1.165 or 41,9%

4.6. Other specialists – non-IT - Assessment of required skills for non-IT specialists

The business process of the company, in addition to the core activity, includes the implementation of all other regular jobs and tasks, such as sales, finance and accounting, marketing, administration, HRM, etc. Other activities require the necessary knowledge and competencies that are not necessarily related to the core activities of the company, but are necessary for companies to operate in accordance with domestic and international business legislation, and to conduct commercial activities such as sales, marketing and others. 59 or 22% of the total number of positions for other non-IT specialists are employees in the administration. If employees in finance and accounting (41 or 15%), support (16 or 6%) and other logistics positions (7 or 3%) are added to this number, the total number of employees in the administrative and accounting section is 119 or 46%. Sales and marketing together make 34% of the positions of other specialists whose specialty involves conducting commercial business activities aimed at existing and future clients. Human resource management as a separate function is characteristic of larger companies in the software industry, while this function in smaller companies is usually performed within the management of the company, consisting of the founders of the company. The human resources management function amounts to 13% of the positions of employees of other non - IT specialists. Women fill two thirds of the positions in human resources, finance and accounting, and they are majority in business administration and marketing positions.

With regard to vacant posts, most of them are open for sales, a total of 6. Human resources management, marketing and sales with 3 or 2 open positions follow this.

The importance and satisfaction with the skills of non - IT specialists on the Likert scale of 1-5 was rated with a high average score over 4. Statistically significant differences between importance and satisfaction with employee skills were expressed for organizational skills, openness and adaptability skills and communication skills. These skills require a certain amount of work experience in addition to the educational background. To that regard, the skills need to be improved, both by training

the employees within the company and by providing them with guidelines for the improvement of educational process in the non-IT professions, or strengthening the component of practical work, practice during the educational process.

According to the management of software industry companies in BiH, in case of non-IT specialists the most important skills are professional (technical) skills, in accordance with the job description (50%), followed by customer service skills (46%), communication skills (43%), team management skills (43%) and the ability to spot and solve problems (43%). The skills most needed for non-IT specialists are the same as for IT specialists. Professional technical skills for non-IT specialists include the application and use of modern tools, methods and technology in performing regular jobs and tasks defined by the job description of each non - IT position. In addition to the necessary technical skills, the need was expressed for the classic business skills of lower and middle management, and the example of the software industry clearly articulates the need to improve the education of non-IT specialists in management, business and administration - MBA (Management Business Administration).

Table 13 - Skills most needed for NON-IT specialists

Skill		Responses		Percentage of cases
		N	Percentage	
Skill	Professional (technical) skills, in accordance with the job description	14	14.9%	50.0%
	Knowledge of foreign languages	7	7.4%	25.0%
	Knowledge of business ethics	6	6.4%	21.4%
	Communication skills	12	12.8%	42.9%
	Team organization and management skills	12	12.8%	42.9%
	Ability to spot and solve problems	12	12.8%	42.9%
	Ability to mentor / coach other employees	8	8.5%	28.6%
	Ability to work with clients	13	13.8%	46.4%
	Translating customer needs into action plans	10	10.6%	35.7%
Total		94	100.0%	335.7%

4.7 Compliance of education with the labour market in BiH

The harmonization of education with the labour market implies continuous monitoring of the needs of the economy for labour force and harmonization of the education system in accordance with the needs of the economy. Ideally, the expressed needs of the economy for a certain profile of the workforce initiates changes in the enrolment policy and professional study programmes, in order to offer the economy a sufficient number of professional workforces. In the case of the software industry in BiH, this mechanism does not show the necessary functionality, given that the survey identified a gap between the number of graduates and the number of open positions for IT specialists¹¹. Non-compliance is also demonstrated at the level of training students with the necessary knowledge and skills to work in the software industry. From the perspective of educational institutions, the main question when creating study programmes is what students should learn. At the same time, the perspective of the software industry when creating educational study programmes starts from the question of what jobs and tasks students, future employees, should perform. Due to the above approach of educational institutions, study programmes, according to 55.9% of software companies in BiH, do not train IT employees with the necessary skills. 32.4% are indifferent, while only 12% believe that educational programmes at colleges train IT employees with the necessary work skills.

The inconsistency of educational programmes at the faculties with the jobs and tasks that the graduates will perform in software industry companies as future employees is also reflected in the average time required to train new IT employees. More than half of the surveyed companies (60%) need on average 4-6 months to train new IT employees, while 22.5% of them stated that it takes them from 1 to 3 months. Other surveyed companies state that on average it takes them 7 months or more to train new IT employees.

According to the software industry representatives, the following faculties are the best in preparation of IT professional profiles for labour markets: the Faculty of Electrical Engineering Sarajevo (76.2%), the Faculty of Information Technology Mostar (42.9%), FON Belgrade, the Faculty of Electrical Engineering Banja Luka and Burch Sarajevo (4.8%).

Table 14 - Which faculty or university are the best in preparation of IT professional profiles for the labour market

		Responses		Percentage of cases
		N	Percentage	
The best faculty / university	ETF, Sarajevo	16	57.1%	76.2%
	FIT, Mostar	9	32.1%	42.9%
	FON, Beograd	1	3.6%	4.8%
	ETF, Banja Luka	1	3.6%	4.8%
	Burch, Sarajevo	1	3.6%	4.8%
Total		28	100.0%	133.3%

Respondents are most satisfied with the aforementioned faculties because these faculties provide fundamental engineering knowledge to IT experts (80%).

11 Enrolment policy or the number of enrolments for IT specialists does not follow the growing need for IT specialist in BiH software industry BiH.

4.8 Additional training of employees after the formal schooling

The software industry is faced with a dynamic and speedy technology development, which calls for a constant training of employees. Training is a necessary imperative to maintain competitiveness and survival in the global market, which is why 94% of surveyed companies conduct constant training and development of IT specialists. Software companies in BiH use several methods to determine the gap between the required and existing IT skills of employees, in order to organize and conduct their professional development according to needs. The largest number of surveyed software industry companies in BiH, 60% of them, makes plans for a professional training of employees. Half of the companies determine the gap between the existing and required skills of IT specialists based on the market requirements or feedback from customers. Only one third of companies create a list of current skills of IT specialists and compare it with business requirements. In practice, companies use all the listed methods to identify the necessary skills of IT specialists, and the ratios of the use of individual methods are a matter of business policy of the company.

All companies that conduct constant training and development of IT specialists (94%) offer their employees a training in the field of improvement and development of professional technical skills. Two thirds of the companies also offer a training to employees in the field of non-technical / soft skills. Only two surveyed companies did not offer any training to employees due to suspicions as to the quality of the offered training programmes or a lack of information about the offered training programmes.

The vast majority of software industry companies, 97% of them, carry out additional employee trainings within their companies. These are on-the-job trainings and various mentoring models. 27% of companies hired private educational institutions or training institutions for additional employee trainings. In most cases, training in external educational institutions or training institutions is conducted in order to acquire skills and knowledge when the companies have no internal capacities, or when it is necessary to have professional certification (e.g. Microsoft, oracle certificates, etc.) of a certain number of employees with the aim of qualifying for the provision of specific types of services. In addition to the above, a small percentage of companies use the services of equipment manufacturers, online education and state educational institutions for the employee trainings. When it comes to informal education providers, the surveyed software companies believe that Academy387 (60%), ITAcademy (47%) and Spark Mostar (47%) offer IT courses and trainings that benefit their IT specialists the most. As non-formal and vocational programmes do not provide graduates with skills and competencies that could fully meet the requirements of software industry companies, the surveyed companies advocate the widest range of changes in educational institutions, of which the first four stand out, as stated by 61-70% of respondents (see table below). These are the willingness to revise curricula to be in line with technological change, openness to new teaching methodologies, focus on practical training, organization of internships, internships in companies, etc., and joint projects of IT companies and educational institutions. These changes are also the framework within which cooperation between software companies / industries and educational institutions should take place.

Table 15 - Changes necessary in vocational and higher education institutions so that graduates' skills and competencies can meet the requirements of companies

	Responses		Percentage of cases
	N	Percentage	
Willingness to revise curricula to keep pace with technological change	23	15.8%	69.7%
Openness to new teaching methodologies	20	13.7%	60.6%
Focus on practical training, organizing practical work, internships in the company, etc.	21	14.4%	63.6%
Joint projects of IT companies and educational institutions	20	13.7%	60.6%
Defining and updating educational profiles in accordance with the needs of the labour market	17	11.6%	51.5%
Involvement of stakeholders in the planning and development of educational profiles	12	8.2%	36.4%
Creating skills and competencies that can be applied in the company without investing additional time for additional training	16	11.0%	48.5%
Harmonisation of training programmes with international standards	17	11.6%	51.5%
Total	146	100.0%	442.4%

Although 18 or 51% of the surveyed companies stated that they cooperate with secondary vocational schools and universities, and 8 or 23% of them define this cooperation as joint activities in the development of curricula for the education of IT professional profiles through the organization of research (14%) or workshops (86 %), it is evident that this is an individual approach of individual educational institutions or proactive individuals who want to improve the quality of their teaching with information from the software industry. In order to have more significant effects in terms of harmonisation of skills and competencies of graduates from IT educational institutions, a systematic approach is needed, which would include representatives of the software industry, as well as the competent ministries of education, which have the mandate and resources to implement necessary changes of curricula, teaching methods and practices of education for IT occupations. Until then, the software industry in BiH will have to find alternative solutions to fill the gap between the required professional technical skills and the skills of graduates from IT educational institutions.

5 SUPPLY SIDE OF THE BIH SOFTWARE LABOR MARKET – EMPLOYEES TRAINING NEEDS AND SELF-ASSESSMENT OF SKILLS

The analysis of skills and needs for training on the supply side of the labour market in Bosnia and Herzegovina was made on the sample of 99 employees of the surveyed software industry companies in BiH. The majority of respondents, three quarters of them are IT specialists, and the rest, one quarter of them are non-IT specialists. The majority of IT specialists in the analysed sample are developers, 71%, followed by system administrators with 17.4%, project managers 15.9%, enterprise architects 14.5%, technical specialists 11.6%, etc. The surveyed population is of young age, considering that the sample is predominantly consisted of individuals aged 20 to 39, a total of 85%. Men make up 76% and women 24% of the analysed sample, which corresponds to the current gender structure of the software industry.

5.1. Supply side of the BIH software labour market – Employees training needs and self-assessment of skills

The highest percentage of employees consider it necessary to improve their professional technical skills (60%) in order to perform their tasks better. 50% of them believe that improving their organizational and team management skills would enhance their workplace performance, and 41.3% of them believe that this could be achieved by the improvement of communication skills or knowledge of a foreign language. It is evident that a productive and successful performance of jobs and tasks of software industry company employees requires a set of skills composed of professional technical skills and skills that involve interaction with team colleagues and clients.

Identification of differences between skills from the perspective of employees was made on the series of general business skills and technical professional IT skills. Respondents rated the importance and satisfaction of a particular skill on a Likert scale from 1 to 5, for which a gap and statistical variance were subsequently calculated. At the level of general business skills, which in addition to professional technical skills, include knowledge of a foreign language, communication and organizational skills, etc., from the perspective of their importance are rated high, 4.4 on average, which implies that employees consider them very important for regular work and tasks. On the other hand, from the perspective of the level of satisfaction with these skills by employees, a slightly lower, but still high average score of 4.1 was achieved. Statistically significant differences between importance and satisfaction regarding skills were expressed for 9 out of 10 analysed skills. A statistically insignificant difference was calculated only for the skill of individual work ability so the importance and satisfaction with this skill is almost completely harmonized, which means that there is no difference that would indicate the need to improve it.

Significant statistical differences were calculated for professional (technical) skills, foreign language skills, communication, organizational skills, ability to learn quickly and teamwork, ability to train other employees, analytical thinking and problem solving, and openness and adaptability. It is evident that employees feel that there is room and a need for further development of these skills.

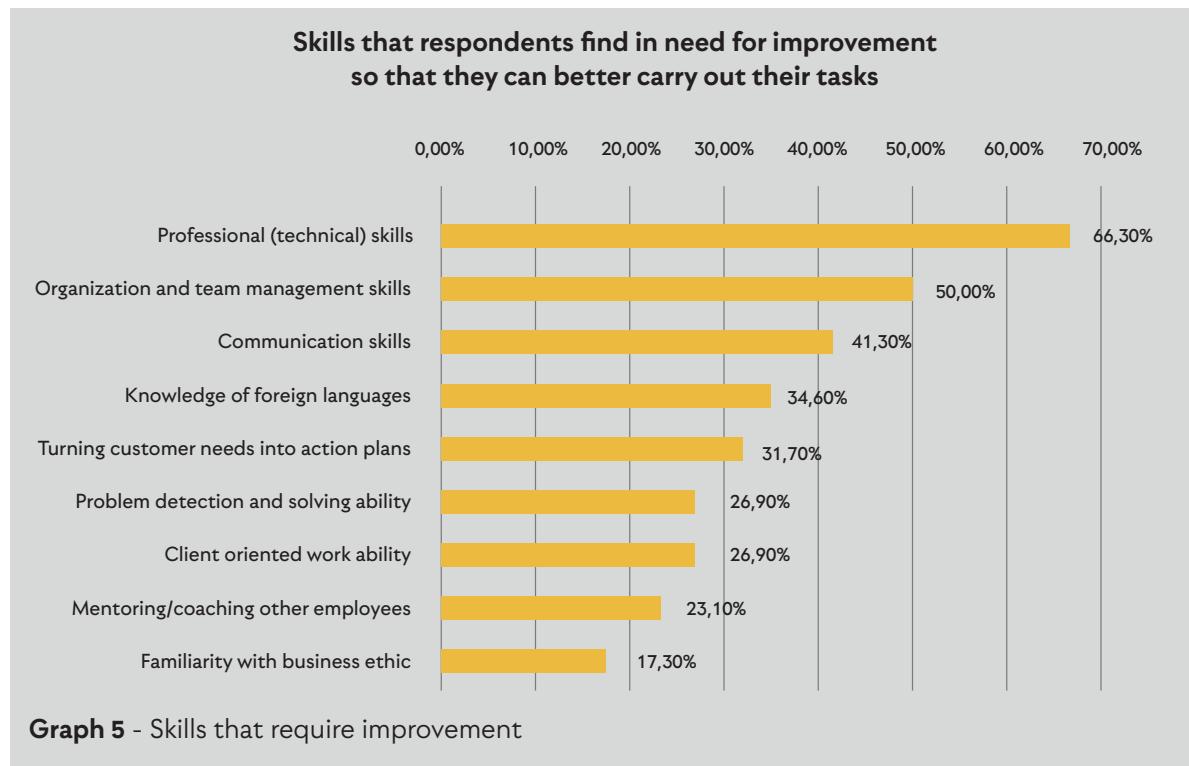


Table 16 - Importance in relation to satisfaction with general skills/abilities for the job

Skill / Ability	Importance		Satisfaction		gap	t	
	Avg.	SD	Avg.	SD			
Professional (technical) skill	4.63	.524	3.95	.635	-.686	8.58	***
Knowledge of foreign language	4.54	.664	4.12	.783	-.417	5.01	***
Communication skills	4.43	.717	3.97	.664	-.466	6.19	***
Organizational skills	4.43	.586	3.92	.710	-.515	5.98	***
Ability to learn fast	4.44	.570	4.12	.812	-.327	3.46	***
Teamwork ability	4.48	.573	4.32	.658	-.136	1.89	*
Individual work ability	4.46	.605	4.38	.676	-.079	1.05	ns
Ability to train other employees	4.01	.757	3.85	.809	-.162	1.79	*
Analytical thinking and problem solving	4.66	.475	4.22	.685	-.431	6.25	***
Openness and adaptability	4.48	.623	4.19	.768	-.294	3.40	***

Statistically significant*** p < 0.01; ** p < 0.05; * p < 0.1; ns = not significant

At the level of importance in relation to satisfaction with IT technical skills, observed from the perspective of applied technologies, in relation to the software industry companies, employees expressed slightly lower by 10 to 15 percent project ratings of importance and satisfaction with IT technical skills. At the same time, the statistically significant differences between the importance and satisfaction with individual IT technical skills were more prominent.

Within the category of fundamental knowledge of programming languages and IT systems, the highest average importance score on a scale of 1 to 5 was achieved by software development skill 4.05 followed by database administration 3.97, application architecture 3.89, and general programming 3.84. From the perspective of satisfaction with IT technical skills of this category, the highest average scores were achieved by the same technical skills listed here. A gap or statistically significant differences between the importance and satisfaction of IT skills of this category were achieved for general programming, software development, database administration, and application architecture.

Within the IT technical skills for technologies of the category of experience in working with complementary tools and project management, the highest average rating of importance was achieved by IT technical skills working on system management 4.24, then server-client programming 3.84, processes and automation 3.65, and project management 3.53. From the perspective of satisfaction with IT technical skills in this category, management systems achieved the highest average score of 3.84, followed by web development 3.35, server-client programming 3.31 and project management 3.28. The gap or statistically significant differences between the importance and satisfaction of IT technical skills in employees were recorded for server-client programming, processes and automation, management systems and information systems security.

The category of IT technical skills of knowledge of advanced technologies was rated the lowest for importance (2.65) and satisfaction (2.57), which implies that employees rarely use these technologies¹² in their jobs in software industry companies. From the perspective of importance, the highest rating was 3.24 for the skill of Cloud computing, followed by Microsoft technology 2.8, data science 2.79 and mobile development 2.66. On the other hand, the highest average rating of satisfaction with IT technical skills in this category was 2.88 for Microsoft technologies, followed by mobile development 2.67, cloud computing 2.64 and Internet of things 2.51. The gap or statistically significant difference was registered only for the technical skill of cloud computing.

9 or 42.8% out of 21 IT technologies, in relation to which employee skills were analysed, expressed a statistically significant difference between the importance of IT technology for jobs and tasks performed by employees in software companies and employee satisfaction with the level of knowledge and skills they possess within that technology. Most of the IT technical skills for which the gap between importance and satisfaction was calculated, 8 out of 9, fall into the first two categories, fundamental knowledge of programming languages and IT systems and experience in working with complementary tools and project management. For the advanced technology knowledge category, the gap between importance and satisfaction was calculated only for cloud computing knowledge and skills. The skills gap of employees within the identified technologies points to the need for continuous education of employees, but also the strengthening of IT education in these areas.

¹² Although BiH has some software, industry companies which base their services on some of these three technologies such as Microsoft

Table 17 - Importance in relation to satisfaction with IT technical skills

Skill / Ability	Importance		Satisfaction		gap	t
	Avg.	SD	Avg.	SD		
Category 1 - fundamental knowledge of programming languages and IT systems						
General programming (C, C ++, C #, Java, Python ...)	4.42	0.708	4.12	0.74	-0.303	1.83
Software development (Application development, Component integration, Testing, Solution deployment, Documentation Production ...)	4.37	0.615	4.17	0.711	-0.207	1.29
Database administration (MS SQL, Oracle, MySQL ...)	4.38	0.707	4.1	0.759	-0.333	3.01
System administration (MS Windows Server, Exchange server, Linux Systems ...)	3.73	1.015	3.7	0.993	-0.074	0.37
Application architecture (Arch. Design, Arch. Patterns, App design ...)	4.13	0.776	3.79	1.048	-0.357	1.91
Backup systems (Backup and storage admin related skills)	3.63	0.964	3.85	0.818	0.154	-1.28
Average	4.11		3.96			
Category 2 - experience in working with complementary tools and project management						
Server-client programming (Java, C ++, Node.js, PHP, ASP.NET, web API, WCF services ...)	4.32	0.653	4.11	0.567	-0.259	1.66
Processes and automation (Jira, Confluence, Polarion, DevOps, Agile methodologies ...)	4.09	0.879	3.81	0.98	-0.355	1.83
Management systems (Git, SVN, TFS, ClearCase)	4.41	0.665	4.06	0.772	-0.323	2.4
Information systems security (Intrusion detection, Risk analysis, Security analysis ...)	3.91	0.893	3.69	0.788	-0.385	2.08
Project management (Agile, Scrum...)	4.18	0.716	3.83	0.889	-0.31	1.61
Product management	3.87	0.942	3.62	0.82	-0.345	1.78
Web developmentj (HTML, CSS, JavaScript, JQuery, Angular...)	4.52	0.619	4.09	0.689	-0.438	3.99
Web design (Photo editing, UX design, Graphic design...)	3.97	1.048	3.88	0.909	-0.192	1.15
Average	4.13		3.85			
Category 3 - knowledge of advanced technologies						
Java ecosystem and tools (JEE, Spring, Hibernate...)	3.87	1.088	4.07	0.828	0.133	-0.66
Mobile development (Java, Kotlin, Swift, GoLang...)	3.47	1.106	3.81	0.786	0.04	-0.22
Cloud computing (Cloud Migration, Serverless architecture, Cloud security...)	3.68	1.056	3.71	0.854	0	0
Data Science (Data warehouses, Machine learning, Big Data, Data pipeline...)	3.97	0.999	3.68	1.069	-0.44	2.11
Internet of Things (IBM Watson, API, Arduino, Raspberry Pi...)	3.58	0.969	3.36	0.907	-0.4	2.31
Embedded Software Development	3.24	1.123	3.38	0.77	-0.083	0.57
Embedded Software Development	3.03	1.217	3.35	0.832	0.13	-0.77
Average	3.55		3.62			
Statistically significant*** p < 0.01; ** p < 0.05; * p < 0.1; ns = not significant						

5.2 Relevant data on educational background of employees (additional training and development skill programmes after graduation)

The analysed sample of employees consisted of 71% of persons with university degree and 29% of respondents with secondary school degree. As for employees with university degree, 74.8% of them attended vocational faculties of computer science and informatics, 2.8% of them attended other faculties of engineering and 21.3% other faculties such as faculties of social sciences, arts, etc. Within the group of employees of IT specialists included in this survey, out of 69, 52 or 75% graduated from the faculties of computer science and informatics. Most of the IT specialists completed their studies at the Faculty of Information Technologies - FIT Mostar, the Faculty of Mechanical Engineering and Computing Mostar and the Faculty of Electrical Engineering ETF in Sarajevo. Three quarters of the surveyed employees attended additional trainings after the completion of the study, two thirds of which are trainings in the field of professional technical skills, and one third of trainings for non-technical skills. The highest percentage of employees, who did not attend additional training after graduation, stated it was due to lack of time (29%), some of the stated that they have all the necessary skills (25%) or that the offered training programmes did not meet the business needs of employees (25). When it comes to non-formal education providers which offer courses in the field of IT and education that contribute to the acquisition of skills necessary for IT and non-IT specialists, the largest number of respondents mentioned Spark Mostar (53%), Academy 387 from Sarajevo (31%) and IT Academy from Sarajevo (29%).

5.3 Employees skills gap assessment (time needed to meet the IT industry job after graduation, appropriateness and applicability of skills and knowledge obtained during the formal education)

The gap between professional technical and other skills possessed by college graduates and the skills needed to work in the software industry is measured by the time it takes for graduates or new employees to fully meet the requirements of the job, or to fully start contributing to the business. The majority of surveyed employees, 41.8% of them, stated that it took them 4 to 6 months to meet the job requirements. For 16.3% of employees the required training time after the completion of formal education was longer than 9 months, and for 14.3% of them the period was 1 to 3 months, while for 12.2% of employees the period was from 7 to 9 months.

Table 18 - The time required to meet job requirements (in terms of skills) after completing formal education

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-3 months	14	13.1	14.3	14.3
	4-6 months	41	38.3	41.8	56.1
	7-9 months	12	11.2	12.2	68.4
	Longer than 9 months	16	15	16.3	84.7
	Unknown	15	14	15.3	100
	Total	98	91.6	100	
Missing	System	9	8.4		
Total		107	100		

Satisfaction with the skills and competencies acquired by the surveyed employees during formal education was measured on a scale from 1 to 5. The average scores for secondary and higher education are almost identical, 3.23 and 3.14 respectively. The surveyed employees are partially satisfied with the skills and competencies acquired during formal education.

These findings suggest that content and methods of the formal education process need to be harmonised with the needs of the software industry in order for graduates to acquire the knowledge, competencies and skills needed to work in the software industry during formal education. This would make the transition of graduates from the educational process to the software industry much easier, and the time to adapt to the ways of working and technology used by software industry companies will be significantly shorter.

5.4 Employees recommendations on changes in the formal education (e.g. focus on practical trainings, better cooperation with the private sector etc.)

According to the surveyed employees, multiple changes need to be introduced in the vocational schools and faculties so that the graduates acquire skills to meet the software industry demands.

82.9% of employees believe that formal education should be faster and more flexible in terms of revision and changes in curricula in order to be in line with technological changes. To that regard, the legal framework in the field of education requires amendments in as much as to allow the revision and changes in curricula to keep abreast of technological changes (for example, a joint expert body composed of representatives of the software industry and representatives of the education sector which would adjust the curriculum every 2 years.)

78.1% of surveyed employees believe that professional IT education should be modernized, and that it should be open for new teaching methodologies. Previous educational methods of theoretical lectures need to be replaced by learning through project implementation, using available electronic

educational content such as OER - open educational resources, MOOC - massive open online courses, and various video tutorials and the like, as methods that develop students' research ability or the skill of independent learning, problem solving and critical thinking.

78.1% of surveyed employees also believe that the share of practical training, organization of practical work and mandatory internships during studies should be significantly increased, so that students are acquainted with the work of software companies and best prepared for the transition from education to work in the software industry.

67.6% of surveyed employees believe that there should be a developed cooperation between the software industry companies and educational institutions through implementation of joint projects, with a view of connecting the education sector and the software industry.

57.1% of surveyed employees expressed the need for defining and updating the educational profiles in accordance with the needs of the labour market and for harmonizing the training programmes with international standards through an interaction between educational institutions and software industry representatives. They further emphasised the need for a quality coordination between education and the software industry. Whilst several initiatives were implemented at the level of faculties and high schools in the past, a systemic coordination is required, that is, a coordination at the level of competent education ministries and economy ministries.

Other suggestions regarding the improvement of education are listed in the table below along with the aforementioned suggestions.

Table 19 - Changes necessary in vocational and higher education institutions so that the skills and competencies of graduates can meet the requirements of the software industry

	Responses		Percentage of cases
	N	Percentage	
Willingness to revise and change curricula to keep pace with technological changes	87	16.30%	82.90%
Openness to new teaching methodologies	82	15.40%	78.10%
Focusing on practical training, organizing practical work, internships in companies, etc.	82	15.40%	78.10%
Joint projects of IT companies and educational institutions	71	13.30%	67.60%
Defining and updating educational profiles in accordance with the needs of the labour market	60	11.30%	57.10%
Harmonization of training programmes with international standards	60	11.30%	57.10%
Involvement of stakeholders in the planning and development of educational profiles	47	8.80%	44.80%
Creating skills and competencies that can be applied in the company without investing additional time for additional training	44	8.30%	41.90%
Total	533	100.00%	507.60%

5.5 Training needs, impact of on-the-job trainings

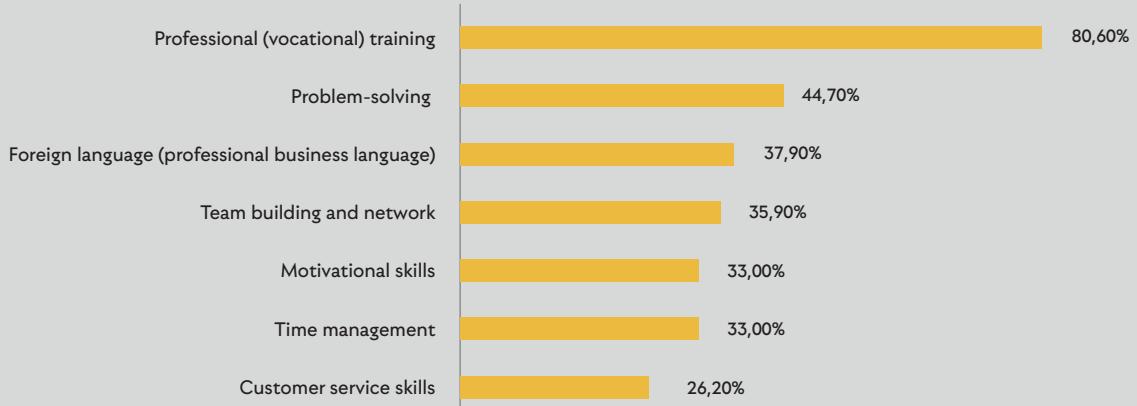
Surveyed employees clearly expressed their needs for training. In the first place, they are most prominent for professional technical IT skills, since they are crucial competencies of employees in the software industry. With regard to professional technical skills, trainings in the field of fundamental knowledge of programming languages and IT systems, and in the field of working with complementary tools and project management, are continuously needed both for training new IT specialists and for developing the capacities of present ones. When it comes to the field of fundamental knowledge of programming languages, it is about specialist trainings for general programming skills (C, C ++, C #, Java, Python ...), software development (Application development, Component integration, Testing, Solution deployment, Documentation Production ...), database administration (MS SQL, Oracle, MySQL ...), system administration (MS Windows Server, Exchange server, Linux Systems ...), application architecture (Arch. design, Arch. patterns, App design. ...), and backup systems (Backup and storage admin related skills). Within the field of working with complementary tools and project management, specialist trainings include trainings for server-client programming (Java, C ++, Node.js, PHP, ASP.NET, web API, WCF services ...), processes and automation (Jira, Confluence, Polarion, DevOps, Agile methodologies ...), management systems (Git, SVN, TFS, ClearCase ...), information systems security (Intrusion detection, Risk analysis, Security analysis ...), project management (Agile, Scrum ...), product management, web development (HTML, CSS, JavaScript, JQuery, Angular ...) and web design (Photo editing, UX design, Graphic design ...).

The needs for trainings are expressed for the aspect of non-IT skills, and they predominantly refer to communication skills and business correspondence for the purpose of communication with colleagues in the team and with employees of clients who are rendered with IT services. It transpires that business ethics and communication are insufficiently studied at the faculties of computer science and informatics, and yet they are highly necessary in the software industry business process. The need to improve foreign language skills is also expressed. The vast majority of clients of software industry companies are located outside BiH, and during the provision of services, correspondence is conducted in English, and occasionally in German. Unsatisfactory knowledge of foreign languages is a consequence of an inadequate model of education during primary and secondary education. Namely, every employee of a software industry company attended a foreign language, mostly English, for 12 years, 8 or 9 in primary school and 4 in secondary school, and yet a certain number did not acquire a level of foreign language knowledge sufficient for normal business correspondence.

Training needs are also expressed for organisational skills, planning, and teamwork, problem solving, etc., representing a set of general business skills.

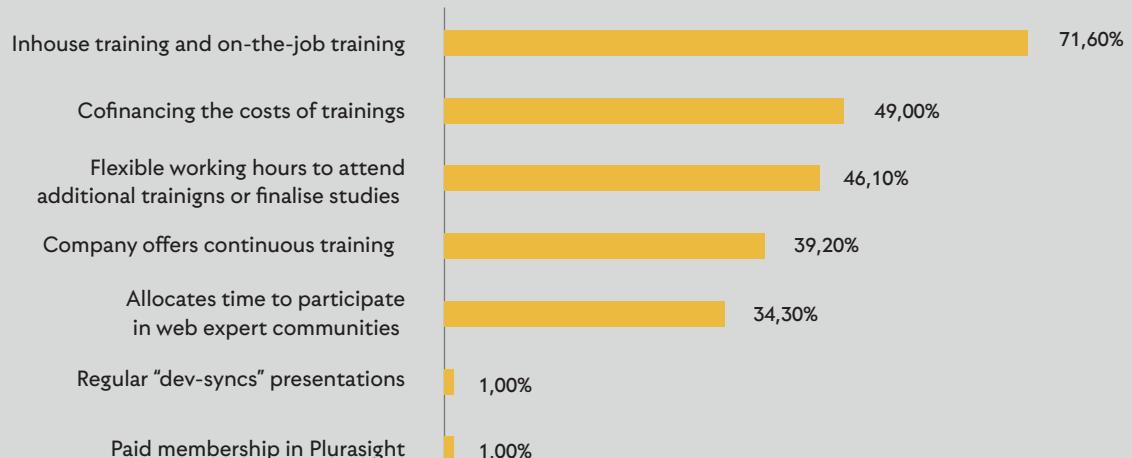
In order to improve the skills and business development of employees, software industry companies provide employees with opportunities for continuous education. In 83% of cases, companies have offered training in professional technical skills to employees in the last 12 months, while 39% have offered training in non-technical skills. 43.3% of the total number of surveyed employees participated in a continuous training in the past 12 months, and 56.7% of them did not take part in it. Almost half of the employees (47%) are satisfied with the current opportunities for a continuous training, 37.5% are indifferent, while 15.6% are dissatisfied. The largest percentage (71.6%) of software industry companies carry out continuous business development of employees through internal trainings and through on-the-job trainings, and by co-financing training costs (49%), providing flexible working hours for the purpose of further education or graduation, etc.

What types of training would you participate in if given the opportunity



Graph 6 - Types of training for which interest has been expressed

How the company improves the business development of the respondents/employees



Graph 7 - Modalities of professional development of employees

6 SKILL MISMATCH AS A CRUCIAL CONSTRAINT TO THE BIH SOFTWARE INDUSTRY GROWTH

Skill mismatch is a phrase often used in debates about situation and policies at the labour market. The concept of skill mismatch has a very wide range¹³ and it can be measured by various indicators. Skill mismatch is used to describe the so-called vertical mismatch¹⁴ (usually qualified as overeducated, undereducated,¹⁵ overskilled or underskilled¹⁶), skill gap¹⁷ (shortage in skills on the side of employees which are required for their current job), skill shortage¹⁸ (usually qualified as unfilled and difficulties in filling certain positions), lack of harmonisation in education (horizontal mismatch) and skill obsolescence¹⁹ (usually measured by employees whose certain physical skills are reduced in the process of aging, or the result of technological or economic changes which make the skills not needed).

The different concepts of skills mismatch mentioned above differ significantly in the context of their manifestation, measurement, determinants and the way in which their consequences are manifested. Some relate to inconsistencies felt by employees, while others relate to employers and difficulties at the enterprise level. Some concepts of skills mismatch are measured subjectively, while others are derived from available data.

In the context of our study research, the horizontal mismatch of the labour market is the most problematic (a result of an inadequate enrolment policy) which consequently affects shortages in IT sector employees, especially IT developers (as visible by the high number of currently unfilled positions). The skills gap follows, caused by and inadequate structure of study programmes at certain educational institutions. This problem is especially prominent in the field of advance IT skills.

Finally, a problem of overeducation has also been identified to some degree, where persons are overeducated for certain entry points in the software industry of BiH.



Graph 8 - The concept of skills mismatch

¹³ The phrase is merely used to refer to mismatch which affects employees or companies that are currently seeking employees. Although unemployment may be viewed as some sort of mismatch at the labour market, it has not been discussed in the literature to this topic.

¹⁴ Vertical mismatch

¹⁵ Overeducation and undereducation

¹⁶ Overskilling and underskilling

¹⁷ Skill gaps

¹⁸ Skill shortages

¹⁹ Skill Obsolescence

A horizontal mismatch in the labour market has been a constant issue at the BiH software industry. Inadequate enrolment policies, i.e. an insufficient number of enrolment places at the faculties of computer science and informatics, result in an insufficient number of graduates who could fill open positions in the software industry companies. On an annual basis, a horizontal mismatch in the labour market in the BiH software industry is 41.9%, which means that out of 926 open positions for IT specialists annually, 388 or 41.9% will not be able to be filled due to insufficient number of IT graduates at the faculties of computer science and informatics in Bosnia and Herzegovina (calculated as the annual number of IT graduates reduced by 20% / annual number of open positions for IT specialists). To overcome the horizontal mismatch in the software industry labour market, the annual number of graduates available to the software industry should increase from the current 537 for 72% so that all open positions for IT specialists can be filled annually. Possible measures to overcome this situation in the first place include revising enrolment policies and adapting them to the needs of the software industry, then establishing specialist high schools of computer science and informatics, further strengthening vocational education and retraining measures for IT occupations of employment offices, and improving IT education at primary school level in Bosnia and Herzegovina.

The skills mismatch/gap expressed as the difference between the skills of graduates from IT faculties and the skills needed to work in the software industry in Bosnia and Herzegovina, is demonstrated in practice by the time needed to train new IT employees to work in the software industry companies. According to the research findings, the majority of surveyed companies (60%) on average needs 4-6 months to train new IT employees, with that the required training time for a certain number of new IT employees may vary in both directions, it may be shorter (1-3 months) but also longer (7-9 and more months). Almost identical research findings were confirmed in the employee survey, where the majority of surveyed employees, 41.8% of them, stated that it took them 4 to 6 months to meet the job requirements. For 16.3% of employees the required training time after the completion of formal education was longer than 9 months, and for 14.3% of them that period was 1 to 3 months, while for 12.2% of employees that period was from 7 to 9 months. The identified skills gap points to the need to harmonize the content and methods of the formal education process with the needs of the software industry in order for graduates to acquire knowledge, competencies and skills needed to work in the software industry, i.e. to make the transition from education to work faster and easier. In this regard, the surveyed companies and employees in the largest percentage (61-70%) advocate a range of changes in educational institutions that include a willingness to revise curricula to comply with technological change, openness to new teaching methodologies, focus on practical training, organizing internships, internships in companies, etc., and joint projects of IT companies and educational institutions. These changes are also the framework within which cooperation between software companies/ industries and educational institutions should take place aimed at overcoming the identified skills gap, the cooperation being systemic and including the ministries of education and ministries of economy.

The gap or problem of overeducation is present for certain entry positions within the software industry, not requiring professional engineering knowledge, such as a wide range of computer, information and mathematical knowledge and skills. To perform jobs and tasks within the junior position of tester or developer, the necessary knowledge and skills can be acquired in shorter educational cycles, i.e. they do not require an engineering level of education. Therefore, it is safe to say that the engineers employed in these positions are overeducated, i.e. that their knowledge and competencies exceed the needs of these positions. The labour market overeducation gap for junior positions within the software industry in Bosnia and Herzegovina can be balanced by establishing semi-annual, one-year, or two-year studies specifically designed for junior developer and tester positions. Such study programmes would be ideal for people who do not have engineering ambitions or potentials, and want to join a propulsive and promising industry such as the software industry. These primarily include unemployed persons with higher and secondary education who would go through the process of vocational education and additional training through these programmes.

7 KEY ACTIONS THAT THE BIH SOFTWARE INDUSTRY SHOULD TAKE TO ADDRESS THE IDENTIFIED LABOUR-RELATED CHALLENGES

7.1. Action I: Introduction of Programming into primary education

Short description of the action

- ✗ Incorporate programming skills into the basic literacy courses at primary education level. Assign the same importance to learning programming as to learning to read and write, or learning basic math, mother tongue and foreign language. Introduce the subject “Programming” in primary education and assign the same importance as to the subjects of mother tongue, mathematics and foreign language.
- ✗ Use available programming learning platforms such as Scratch, Code.org, etc. in the lower grades. As for the upper grades, the 5th onward, start with Python and other programming languages. The mentioned platforms are localized in BCS languages and available on all devices. In addition, all platforms have a developed international community of teachers who exchange experiences, teaching materials and projects.
- ✗ Education content related to the use of word processing, image, data, internet search programmes such as Word, Excel, Power Point, and other skills should be developed as part of other subjects, e.g. mother tongue, mathematics, history, etc.

Short-term perspective (activities and tasks)

- ✗ The relevant education ministries at all levels should reach a decision to integrate Programming into primary education.
- ✗ In cooperation with the IT industry, determine the syllabus for the subject of Programming along with application of the aforementioned platforms, with a focus on practical work and play learning.
- ✗ Use the available and develop their own materials and contents.
- ✗ Conduct a training of teachers and teaching staff for this model of teaching. Provide for an expert support if additional expert staff is needed for the teaching process.
- ✗ In view of the computer equipment shortage in schools, students use their own smart phones, as the aforementioned applications are available for cell phones. Also, allow for the use of private laptops and other equipment in accordance with “bring / use your own device” policy.

■ *Mid-term perspective*

- ✖ Act towards the introduction of a constant regular training of Programming teachers and professors.
- ✖ Keep the programming syllabus up to date with the technology development.
- ✖ Act towards the enhancement of technology equipment in line with the one student-one computer policy.
- ✖ Make the action plan and provide for the budget for its implementation.
- ✖ Promote the programming skills as the key basic competencies for a successful participation in the digital economy of the fourth industrial revolution.

■ *Long-term perspective*

- ✖ Constantly invest into modernisation of teaching of Programming.
- ✖ Make plans for the introduction of robotics and similar subjects into primary schools.
- ✖ Provide for a systematic support and development of Programming competitions locally, and provide for a participation of BiH primary school pupils in globally recognised programming and robotics competitions.

Reasoning Reasoning Programming and machine language literacy skills are the key skills required at the BiH IT industry level, and globally and it is regarded as a job of tomorrow. Children attending primary schools should therefore learn programming and thus acquire the skills required for the work in the IT industry and jobs of tomorrow.

According to the World Economic Forum report on jobs and skills, all jobs and occupations that are paid above average would require programming skills to some degree. Furthermore, the report reads that 65% of children that are now starting primary schooling will have occupations that are not existent now. That is why the educational system must be adapted to the new needs of society and economy.

The study of the IT sector development in the Sarajevo Canton, as well as the IT manifesto of the BIT Alliance recognise the need to introduce programming in primary education. The IT manifesto within strategic goal 4 (Improve IT education at the primary school level) states the need to study Informatics from the first grade of primary school, since primary school age is crucial for the development of basic digital competencies and skills, ways of thinking and using computers in problem solving, which makes children ready for a better quality of life in the digital age. The study of the IT sector development in the Sarajevo Canton states the need to improve primary education by enhancements to the subject of Informatics, and do that in cooperation with the IT industry. Both documents recognise the need for training and professional development of teaching staff for the subject of Informatics in primary education, with the aim of increasing the quality of education for students.

7.2. Action II: Establishment of secondary vocational schools for information technology in BiH

Short description of the action

To establish secondary vocational information and communication technology throughout Bosnia and Herzegovina, with a view of increasing the number of secondary school students who are ready for the work in the IT industry (see into possibilities of changing the specialisation of certain vocational schools). Focus the curricula on programming, data science, data analysis and artificial intelligence. Organise the work in schools in as much as to teach specialised vocational subjects four days in a week, and leave one day for general subjects. Focus on the learning method through project implementation and practical work.

Short-term perspective (activities and tasks)

- ✗ The relevant education ministries at all levels should reach a decision on the establishment of secondary vocational schools of information technology.
- ✗ Develop the curriculum of secondary vocational schools of information technology in cooperation with the IT industry.
- ✗ Use all available online platforms for teaching programming in programming languages defined in the curriculum. Focus on practical work and play learning.
- ✗ Use the available and generate own education materials and contents, provide for an expert support if additional expert staff is need for the teaching process. (Key obstacle)
- ✗ Develop network infrastructure and internet access on secondary vocational schools of information technology.
- ✗ In view of the computer equipment shortage, allow the use of private laptops and other equipment in accordance with "bring / use your own device" policy. (Key obstacle – and proposed solution – children who do not have their own devices must be given access to school computers)
- ✗ Provide for a practical training in the IT industry companies. The communities without a sufficient number of IT companies, should organise online practical classes (see into a possibility to organise practical online teaching during workshops)

Mid-term perspective (activities and tasks)

- ✗ Act towards the introduction of a constant regular training of teachers in vocational subjects of information technology.
- ✗ Keep the programming syllabus up to date with the technology development.
- ✗ Develop cooperation and liaisons between secondary vocational schools of information technology and IT sector companies.

Act towards the enhancement of technology equipment in line with the one student-one computer policy.

Make the action plan and provide for the budget for its implementation.

Promote IT occupations as a perspective career choice for young generations.

Use technical capacities of secondary vocational schools of information technology to provide adults the possibility of reskilling towards IT occupation.

■ Long-term perspective

- ✖ Constantly invest into modernisation of teaching in secondary vocational schools of information technology.
- ✖ Increase the number of vocations at the secondary school level in the sphere of information technology.
- ✖ Systemically support and develop local level programming competitions and provide for BiH students to take part in internationally recognised competitions in programming and robotics.

Reasoning Reasoning A shortage in skills needed for the work in the BiH software industry is recognised as the main constraint to the accelerated growth of BiH software industry. As the Study of IT sector development in the Sarajevo Canton reads, IT companies are constantly missing the business opportunities because the labour market does not provide a sufficient number of IT experts, and so companies cannot grow in terms of employees and profit.

A ratio between the number of employees in the BiH software industry and the total number of employees in BiH barely reaches 1%. Sarajevo Canton is the largest software industry centre in BiH, but employees in the software industry make only 1, 5%, approximately 150 thousand employees, with regard to the overall number of employees.

The software industry will become a significant branch of industry in BiH once the ratio of IT industry in the overall number of employees in BiH reaches at least 10%. More precisely, it should grow from current 5 – 6 thousand to 30 – 40 thousand.

A statistical data analysis has shown that the number of graduates at the faculties which train programmers and other IT employees, in the school year 2018/2019 was 672, and this is far below the target number needed to achieve the planned growth of BiH software industry.

Higher educational institutions have limited capacities when it comes to educating the programmers and training the teaching staff, and it is not realistic to use the increase of higher educational institutions capacities as the basis for the strategy of increasing the number of IT experts and software industry experts.

As a university degree is not required to work in the IT industry, one of the realistic solutions is the establishment of secondary vocational schools of information technology. Secondary education in Bosnia and Herzegovina is compulsory and free. Given the fact that secondary education is free, an economic barrier would be removed from IT education at this level, which would allow children of all social groups to access this type of education. This is especially important for children of lower social status, possibly consisting of the greatest talents.

If a sufficient number of secondary vocational schools for information technology were established, the number of persons trained to work in the software industry could increase significantly in the coming period and reach the number needed to achieve the goal of increasing the number of employees in the software industry and its share in total employment in BiH.

The information and communication technologies programmes were introduced in the gymnasium curricula in the past period. Due to the large number of subjects defined in the curriculum for gymnasiums, children who attend these programmes do not have a sufficient number of classes and practices in professional fields of IT, and as such, in most cases, are not ready to work in the software industry after graduation. Therefore, we think that this approach is not a solution, although the BIT Alliance in the IT Manifesto - Strategic Goal 5 (Improve IT education at the secondary level) recommends it.

7.3. Action III: Introducing distance learning in higher education in the field of IT

Short description of the action

Introduce distance learning course at the Information and communication technology faculties to increase the capacity of educational institutions and the number of students and graduates for IT occupation. It is wise to employ the existing practice of the Faculty of Information Technology of Mostar or other globally renowned universities²⁰.

Harmonise the online programmes and curricula with the results of this research survey.

Establish specialist faculties of information technology where possible.

Short-term perspective (activities and tasks)

- ✗ The relevant faculties and ministries should render the decision on the establishment of distance learning course.
- ✗ Use the EU standardisation of IT competencies and IT jobs when drafting the curricula.
- ✗ Develop annual, biannual and triannual academic programme in the IT sector.
- ✗ The relevant education ministries should provide additional finances for the preparation of a digital format teaching material (recording the lectures, digitalisation of teaching material), training of employees and establishment of a distance learning digital platform at faculties and universities.
- ✗ The distance learning programmes should be adapted to the results of the survey regarding the skills in need.
- ✗ Develop programmes in cooperation with the software industry.
- ✗ Promote massive open online courses - MOOCs (- OER -Open Educational Resources)
- ✗ Increase the enrolment quota for distance learning courses.
- ✗ Start a training programme for higher education teaching staff to be able to use available distance-learning technologies.

Mid-term perspective (activities and tasks)

- ✗ Constantly adapt IT distance-learning programmes to the technology development.
- ✗ Promote the distance learning courses (in general, special benefits to employees in terms of additional training, re-training).
- ✗ Promote IT occupation as a perspective career choice for young generations.
- ✗ Promote IT occupation as a perspective career choice for a retraining.
- ✗ Constantly work on the usage of the state-of-the-art technologies in distance learning university degree.
- ✗ Start the localisation process, translating the educational contents MOOC and OER in latest technologies, so that they become available to persons who do not speak English.
- ✗ Develop cooperation and liaison between information technology faculties and IT sector companies.
- ✗ Invest in increasing of technological equipment of IT faculties. To make the action plan and the budget for the implementation thereof.
- ✗ Use the technical capacities of the Information technology Faculty to provide training to adults in the IT retraining process.

20 see <https://www.distancelearningportal.com/search/#q=di-281|mh-blended,online|tc-EUR&order=tuition&start=120>.

■ Long-term perspective

- ✖ Continuously invest in the modernisation of teaching within the Faculty of Information Technology.
- ✖ Increase the number of programmes for professional occupations within higher education in the field of information and communication technologies.
- ✖ Systematically support and develop cooperation programmes between IT faculties and other specialist faculties within which, through IT and non-IT students mixed teams work on problem solving in specific areas with the application of IT technology, e.g. application of IT in solving challenges and problems in the field of medicine, mechanical engineering, social sciences, etc.

Reasoning According to available statistics, the number of IT graduates per year ranges from 600 to 700, which is far below the number needed for the dynamic growth and development of the software industry in Bosnia and Herzegovina. The reason for such a small number of graduates, persons trained to work in the software industry, is determined by the limited capacity of IT faculties, both in terms of teaching staff and in material and technical terms. Due to the attractiveness of the software industry, the pressure on these faculties is significant, which exhausts the capacities of these educational institutions to the maximum.

The introduction of distance learning is certainly a solution that enables a significant increase in the capacity of IT faculties in Bosnia and Herzegovina, and along with the application of available multimedia technologies and digitalisation of educational process, can make education available to all interested persons. Distance learning significantly reduces the pressure on teaching staff and increases their capacities. One teaching course\subject can be attended by hundreds of thousands of students at the same time, regardless of which part of BiH or the world they come.

There are online educational platforms in the world, such as edX or Coursera, where the most prestigious colleges in the world, such as Harvard, MIT, the Sorbonne, Oxford, etc., offer their programmes or courses. These programmes are attended by millions of students from around the world. The programmes are designed in a way that allows an unlimited number of students. In this direction and in that way, domestic Bosnian-Herzegovinian online programmes for studying software engineering and other IT areas should be developed.

The development of distance learning would significantly increase the capacity of software engineering educational institutions, and consequently the number of students / graduates, which would then meet the requirements of a faster growth and development of the domestic software industry.

7.4. Action IV: Additional training and retraining programmes in the sphere of IT in BiH

Short description of the action

With a view of providing for a needed workforce, the IT sector companies developed a couple of informal training programmes over a several years. The programmes were often developed in cooperation with international donors. Considering that these programmes require a significant IT companies' action, along with a support of the public sector, a focus in the forthcoming period should be placed on long-term sustainability of the said programmes capacity building and keeping abreast of the trends. In that regard, the relevant ministries, with their Measures Stimulating Programmes, and the BiH Employment Bureaus, with their programmes for employment and maintenance of a higher employment, should increase a focus on the software industry in terms of higher quotas and specially designed software industry programmes. The said would lead to the increase in the number of persons who would start software industry careers, through additional training and retraining programmes.

Retraining and additional training programmes should be developed based on the existing education and training models and innovative learning methods such as project-based learning, distance learning, vocational certification etc.

In addition to that, additional (alternative) sources of financing should be provided for the said programmes (loan and grant funds etc.).

Short-term perspective (activities and tasks)

- ✗ The relevant ministries and employment bureaus in BiH should define the programmes of support (or increase the quotas for the existing ones) to retraining and additional training programmes in order to see new employments in the software industry.
- ✗ Pilot a voucher scheme at employment bureaus which can be combined with other measures, such as job searching clubs and the like.
- ✗ Use the EU standardisation for IT competencies and IT jobs when developing the retraining and additional training programmes.
- ✗ The retraining and additional training programmes shall be developed in cooperation with the software industry.
- ✗ The programmes will refer to students, unemployed, and employed who want to retrain for the jobs in the software industry.
- ✗ Support the prioritisation of the retraining and additional training programmes that are adapted to the findings of the survey.

Mid-term perspective (activities and tasks)

- ✗ Develop financing/financing programmes of retraining and additional training of IT skills (special loan and grant fund etc.).
- ✗ Constantly adapt the software industry informal retraining and additional training programmes to the technology development.
- ✗ Through the improvement of the IT career portal, intensify the promotion of the IT profession as a promising career orientation in the process of up-skilling training for the unemployed.
- ✗ Promote IT occupations as a promising career orientation in the retraining process.
- ✗ Continuously work on the use of the most modern technologies in the field of learning in the processes of retraining and up-skilling, especially distance learning.

- ☒ Initiate the processes of localization, translation of MOOC and OER educational content for the latest technologies, so that they are available to the non-English speaking population.
- ☒ Use the technical capacities of the faculties for information technologies and the capacities of software industry companies in BiH for adult education in the processes of up –skilling and retraining for IT professions.

■ Long-term perspective

- ☒ Constantly invest in the modernisation of teaching within the up –skilling and re – skilling programmes for IT professions.
- ☒ Increase the number of up –skilling and re – skilling training programmes for professional occupations in the field of information and communication technologies.
- ☒ Systematically support the focus of Active Employment Policies on up-skilling and retraining programmes for the 21st century IT occupations and skills. Extend the focus from the needs of software industry companies to the needs of the unemployed.

Reasoning The effects of technological development and the application of technology in business processes automate an increasing number of jobs. Jobs are essentially taken over by machines. It is estimated that two thirds of jobs will be affected by these changes, which will lead to a great need for retraining and up-skilling of the workforce in general.

The software industry jobs are the least affected by this trend and therefore the most promising. In this regard, focusing on retraining and up-skilling programmes for IT occupations have full justification and effect on achieving long-term employment.

7.5. Action V: Declare the software industry as a strategic developmental industry in BiH at all levels of authority

■ Short description of the action

Software industry should be integrated into strategic developmental documents at all levels of authority in Bosnia and Herzegovina, with a view to having systemic plans and implementation of the BiH software industry development. This all includes the determination of goals and priority sector development, the plan of activities, the financial and institutional framework for the implementation, monitoring, evaluation and reporting.

■ Short-term perspective (activities and tasks)

- ☒ Software industry sector strategies should be developed at the state, entities and cantonal levels which shall define the goals and development priorities, the manner in which they will be achieved, the financial and institutional framework for the implementation, monitoring, evaluation and reporting.
- ☒ Software industry sector strategies should be developed within the framework of current legislation (Law on Developmental Planning and Management in the Federation of Bosnia and Herzegovina; Economic Development Guidelines of Republika Srpska) and Software Industry Development Strategy of the European Union.

- ✗ Software industry representatives must be engaged in the drafting process of software industry development strategies at all levels.
- ✗ Measures of support to the software industry development at all levels of authority should be planned based on the software industry sector strategies.
- ✗ Software industry sector strategies should be adopted by relevant authorities, BiH Parliament, Parliaments of Entities and cantonal assemblies at the proposal of the Council of Ministers, entity and cantonal governments, respectively.

■ *Mid-term perspective (activities and tasks)*

- ✗ Software industry sector strategies should be incorporated in the regular developmental documents at all levels the same way the traditional strategic sectors were incorporated (metal, woods, textile, agriculture, etc.)
- ✗ Permanently monitor the realisation of goals and developmental priorities defined by software industry sector strategies.
- ✗ Permanently monitor the implementation of the support measures that were drafted based on the software industry sector strategies.

■ *Long-term perspective*

- ✗ Permanently manage the development of software industry sector strategies with the active involvement of software industry representatives.
- ✗ Permanently develop the measures of support to the growth and development of software industry by strategy sector planning on a regular basis.

Reasoning The software industry is not adequately recognised in the developmental documents of Bosnia and Herzegovina. Hence, there is no sector development strategy, and no specific measures of support to the sector development.

The software industry is competitive on a global level and has a great potential for economic development. It should receive a systemic support so that BiH society and economy can use its full potential. The increase of the number of employees and revenues from the software industry has been above average in relation to the economy and traditional industries. This absolutely justifies the investment into the software industry development. Although it is referred to as a small industry in Bosnia and Herzegovina, its effects on the economy are significantly larger than the effects of traditional industries, since the salaries and the employment increase are far above the average at the state and entities levels.

Therefore, declaring the software industry as a strategic industry at all levels in BiH is completely justified.

LITERATURE

International Labour Organisation (2017): "How Useful is the Concept of Skills Mismatch?", available at: https://www.ilo.org/wcmsp5/groups/public/---ed_emp/---ifp_skills/documents/publication/wcms_552798.pdf

Strik Consulting (2017): "IT Sector Development Study in Sarajevo canton", available at: <https://docplayer.net/58139221-Studija-razvoja-it-sektora-u-kantonu-sarajevo.html>

Council of Ministers of BiH (2004): "Information society development policy in Bosnia and Herzegovina", available at: <http://www.mkt.gov.ba/bos/dokumenti/zakoni/default.aspx?id=1499&langTag=bs-BA>

Council of Ministers of BiH (2004): "Information society development strategy in Bosnia and Herzegovina", available at: <http://www.mkt.gov.ba/bos/dokumenti/zakoni/default.aspx?id=1500&langTag=bs-BA>

Council of Ministers of BiH (2017): "2017-2021 Information society development policy in Bosnia and Herzegovina": available at: <http://www.sluzbenilist.ba/page/akt/LhPPM81UcxE=>

Government of RS (2017): "2017-2021 Scientific and Technological Development Strategy of Republika Srpska, available at: <https://e-vijecenarodars.net/wp-content/uploads/2017/05/Prijedlog-strategije-naucnog-i-tehnoloskog-razvoja-RS-2017-2021-1.pdf>

World Economic Forum (2016): "The Future of Jobs – Employment, Skills and Workforce Strategy for Fourth Industrial Revolution", available at: http://www3.weforum.org/docs/WEF_Future_of_Jobs.pdf

ANNEX I: DEMOGRAPHIC CHARACTERISTICS OF COMPANIES FROM THE SAMPLE

One half of the sample (51.5%) is made of companies with up to 20 employees, and somewhat less than another half (46%) is made of companies with annual revenues between BAM 1 and 10 million.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	1-10 employees	9	25.7	27.3	27.3
	11-20 employees	8	22.9	24.2	51.5
	21-100 employees	8	22.9	24.2	75.8
	101 + employees	8	22.9	24.2	100.0
	Total	33	94.3	100.0	
Missing	System	2	5.7		
Total		35	100.0		

Table Ia - company size per number of employees

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Less than 50.000 KM	5	14.3	19.2	19.2
	50.000 - 500.000 KM	6	17.1	23.1	42.3
	500.000 - 1.000.000 KM	3	8.6	11.5	53.8
	1.000.000 - 5.000.000 KM	5	14.3	19.2	73.1
	5.000.000 - 10.000.000 KM	7	20.0	26.9	100.0
	Total	26	74.3	100.0	
Missing	System	9	25.7		
Total		35	100.0		

Table Ib - company size per annual revenue

Most of the companies are based in Sarajevo (62.5%), followed by Banja Luka (15.6%) and Mostar (12.5%).

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Sarajevo	20	57.1	62.5	62.5
	Banja Luka	5	14.3	15.6	78.1
	Mostar	4	11.4	12.5	90.6
	Tuzla	2	5.7	6.3	96.9
	Bihać	1	2.9	3.1	100.0
	Total	32	91.4	100.0	
Missing	System	3	8.6		
	Total	35	100.0		

Table Ic - number of companies per place of their base

Most of the companies a (76.5%) develop custom-made software and 55.9% of the develop their own software for the market sale.

		N	Responses Percent	Percent of Cases
Business model ^a	Own product development	19	39.6%	55.9%
	Software development for clients - outsource	26	54.2%	76.5%
	System integration	2	4.2%	5.9%
	Provision of services	1	2.1%	2.9%
Total		48	100.0%	141.2%

Table Id - companies business model

Most of the companies have busines operations in the European market (72.7%), followed by the BiH market (63.6%), and then the North America (36.4%), other countries (21.2%) and Asia (6.1%). The percentage in the last column is over 100% suggests that some companies have business operations at more than one market.

		N	Responses	Percent of Cases
Market	BiH	21	31.8%	63.6%
	Europe	24	36.4%	72.7%
	North America	12	18.2%	36.4%
	Asia	2	3.0%	6.1%
	Other countries	7	10.6%	21.2%
Total		66	100.0%	200.0%

Table Ie - markets at which the companies had business operations in the last three years

ANNEX II CONTACT INFORMATION FOR FORMAL EDUCATION INSTITUTIONS

Sarajevo School of Science and Technology
Hrasnička cesta 3A, 71210 Ilidža-Sarajevo
www.ssst.edu.ba
administration@ssst.edu.ba
+387 33 975 002

Internacionalni Burč univerzitet
Francuske revolucije bb, 71210 Ilidža-Sarajevo
<http://eng.ibu.edu.ba>
mirdin.zilic@ibu.edu.ba
+387 33 944 489

Sveučilište/Univerzitet "VITEZ"
Školska 23, 72270 Travnik
www.unvi.edu.ba
info@unvi.edu.ba
+387 30 509 763

ITEP Visoka škola Banja Luka
Jovana Dučića 14, 78000 Banja Luka
www.itep.edu.ba
info@itep.edu.ba
+387 51 303 527

Internacionalni univerzitet Travnik
Aleja Konzula-Meljanac bb, 72270 Travnik
www.iu-travnik.com
pravnasluzba@iu-travnik.com
+387 30 509 682

Univerzitet Sinergija Bijeljina
Raje Baničića bb, 76300 Bijeljina
www.sinergija.edu.ba
univerzitet@sinergija.edu.ba
+387 55 217 100

Sveučilište u Mostaru
Fakultet prirodoslovno-matematičkih i odgojnih znanosti
Matice hrvatske b.b., 88000 Mostar
<http://fpmoz.sum.ba>
informatika@fpmoz.sum.ba
+387 36 355 456

Panevropski univerzitet Apeiron
Ul.Vojvode Pere Krece 13, 78000 Banja Luka
www.apeiron-uni.eu
info@apeiron-uni.eu
+387 51 247 983

Visoka škola računarstva i poslovnih komunikacija eMPIRICA
Bulevar mira 8 Brčko, Fočanska 1, 75000 Tuzla
www.empirica.ba
empirica@empirica.ba
+387 35 312 350

Univerzitet u Sarajevu
Fakultet za saobraćaj i komunikacije
Zmaja od Bosne 8, 71000 Sarajevo
www.fsk.unsa.ba
info@fsk.unsa.ba
+387 33 565 200

Univerzitet "Džemal Bijedić" u Mostaru
Mašinski fakultet
Univerzitetski kampus Sjeverni logor b.b., 88000 Mostar
www.mf.unmo.ba
mf@unmo.ba
+387 36 571 258

Univerzitet u Sarajevu
Ekonomski fakultet, Trg oslobođenja -
Alija Izetbegović 1, 71000 Sarajevo
www.efsa.unsa.ba
efsa@efsa.unsa.ba
+387 33 275 900

Sveučilište u Mostaru
Fakultet strojarstva, računarstva i elektrotehnike
Matice hrvatske b.b., 88000 Mostar
<http://fsre.sum.ba>
fsre@sum.ba
+387 36 337 001

Internacionalni univerzitet u Sarajevu
Fakultet prirodnih i tehničkih nauka
Hrasnicka cesta 15, 71210 Ilidža
<http://fens.ius.edu.ba>
info@ius.edu.ba
+387 33 957 101

