Journal of Economics, Finance and Management Studies

ISSN (print): 2644-0490, ISSN (online): 2644-0504

Volume 4 Issue 09 September 2021

Article DOI: 10.47191/jefms/v4-i9-03, Impact Factor: 6.228

Page No.1603-1611

Skill Mismatch Assessment: Example of Software Industry in Bosnia and Herzegovina

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ABSTRACT: Concept of skill mismatch is very broad and can be measured using a variety of indicators. It is used to describe so-called vertical mismatches (over-education, under-education, excessive or insufficient training), skills gaps, skills shortages, enrolment policy or 'horizontal' mismatches and skills obsolescence. In this paper we are analyzing skill mismatch gaps and skills shortages in software industry in Bosnia and Herzegovina using firm level assessment.

The research results provide clear evidence for severe skill shortages facing IT companies in Bosnia and Herzegovina. Inadequate tertiary education enrolment policy results in numerous vacancies in software industry, especially for developer's positions. The evidence of skills gaps are also found. Primarily as a result of inadequate curricula in higher education institutions. The problem of skill gaps is most prominent referring professional (technical) skills, but also some 'soft' skills, such as the ability to work with clients, communication skills, problem detection and solving, etc. In a broad group of professional (technical) skills the biggest gaps are found in a sub-group related to fundamental knowledge of programming languages and IT systems, and sub-group related to experience in working with complementary tools and project management. In a way this was expected having in mind the stage of development of software industry in Bosnia and Herzegovina. Identified skill gaps and skill shortages are somewhat lower for non-IT employees. Based on the research findings several policy options are discussed.

KEYWORDS: Skill shortage, skill gaps, software industry

INTRODUCTION

The concept of skill mismatch is very broad. It is used to describe so-called vertical mismatch (overeducation or undereducation, overskilling or underskilling), skill gaps, skill shortages, horizontal or type of study mismatch and skill obsolescence. All of these differ significantly in terms of manifestation, measurement, determinants, etc. (McGuinness et al., 2017).

Some skill mismatches are measured on individual and others on firm level. The first group is related to the degree to which workers' skills or education level meet those required within their current job (Cedefop, 2010; Quintini 2011, Cedefop, 2015a). The waste majority of studies in this field is realted to overeducation as a measure of human capital surplus. Human capital deficits, measured by undereducation and underskilling, receive much less attention. The evidence suggests that overeducation imposes costs on workers in terms of lower wages and job satisfaction. However, overeducated workers are found to earn a premium relative to matched workers doing the same job (McGuinness, 2006, Quintini 2011 and Cedefop, 2015a). Higher rates of turnover among overeducated, overskilled or horizontally mismatched workers may also incur additional hiring and training costs to the firms.

Firm level assessment of skill mismatch are usually restricted to the study of skill gaps and skill shortages. Skill gaps describe the situation when the employer believes that workers do not possess the adequate competencies to successfully discharge their current role. If employees are asked similar questions this is usually refereed as underskilling. Surprisingly not so high correlation of employer-reported skill gaps and employee perceptions of underskilling is identified (McGuinness & Ortiz, 2016). The correlation was higher for technical or IT skills, management or communication and lower for literacy, numeracy and language skills. General incidence was higher in the case of underskilling. Skill shortages relate to a situation in which employers are unable to fill key vacant posts due to a lack of suitably qualified candidates. Of course, recruitment difficulties attributed to skill shortages may be related to inability of company to offer the necessary salary or working conditions to attract the relevant skills (Cedefop, 2015b), as well as other factors such as location.

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McGuinness and Ortiz (2016) find that sectoral-level collective bargaining and a well-developed human resource function are important for identifying skill gaps in firms. The same research found that skill gaps are a key determinant of training expenditures and labor costs. Jackson and Chapman (2012) find that business graduates in Australia are deficient in vital elements of the managerial skill set. Using UK data, Tether et al. (2005) find that over one fifth of firms believe that skill gaps delay the introduction of new products and one third of firms believe that skill gaps are a barrier to the introduction of new work practices. As pointed out by McGuinness and Ortiz (2016), the literature on firm-level skill gaps remains relatively underdeveloped compared to other measures of mismatch.

Using firm level assessment in this paper we are analysing skill gaps and skill shortages facing software industry in Bosnia and Herzegovina (BiH). This is the fastest growing industry in the country with significant potential for new youth employment. The paper is organized as follows. After a brief introductory notes on the concept of skills mismatches, second part gives a short overview of Bosnia and Herzegovina's software industry trends. Third part explains applied methodology and presents main sample characteristics. Part fourth discusses the results. The last part concludes.

IT INDUSTRY IN BOSNIA AND HERZEGOVINA

The world is currently at the brink of the fourth industrial revolution. Speed at which the technology is developed is fundamentally changing the way we study, work and relate to one another. Automation is expected to have more or less impact on majority of workplaces globally. This means that some kind of retraining will be needed for persons currently occupying these places. 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 (WEF, 2016). This is the case primarily for developed, but also for developing countries. At the same time, on the supply side, enrolment policies, curricula and teaching methods mainly remain unchanged and so don't reflect the future jobs needs for knowledge and skills.

For some time software industry presents a significant potential for the new job creation around the world. In order to be fully utilized, that potential needs to be supported by the appropriately tailored education system. If adequately supported by the government and public educational institutions, software industry in developing countries has the potential of producing a sufficient number of workplaces, reducing unemployment of youth, emigration and brain drain, and contributing to the economic development in general.

The key indicators on software industry in Bosnia and Herzegovina are presented in the table below.

Table 1 – Software industry vs. rest of the country, BiH

	2012	2013	2014	2015	2016	2017	2018	2019	Growth 2019/12
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 (Euros)	539	523	587	588	669	665	725	791	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 (Euros)	413	414	415	415	419	426	440	461	11.5%
Share of IT in FBiH employment	0.30	0.33	0.39	0.45	0.47	0.59	0.67	0.78	
Ratio of IT to the average salary	130.39	126.48	141 45	141.69	159.55	156.29	164.85	171.77	

Source: Statistical offices data

The data shows that in 2019 more than 6 thousands workers (0.78% of total employment) were employed in software industry in BiH. The number of employees in the industry more than tripled in just seven years. Average salary in software industry in 2019 was 70 percent higher compared to the average salary in the country. Also, the industry's employment and salary growth was much higher comparing to the rest of the economy.

These results were accomplished despite the absence of any systematic support from the government. Indeed, several strategic development documents have been passed in recent years. Unfortunately, years after its implementation is still missing.

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As a result of increasing labor market demand, several private universities developed computer programming study programmes. Still, the number of graduates together in public and private universities (672 in 2019) is far from sufficient. Because of that, many private companies are organizing their own programming schools in order to mitigate labor shortages.

METHODOLOGY USED AND SAMPLE CHARACTERISTICS

To fill in identified gaps in the literature, the issue of skills mismatches in this paper was analyzed from the firm's level perspective. As previously explained, in this case the analysis is focusing on skill shortages and skill gaps. Specific questionnaire was developed to cover the main target group: IT companies general managers / chief executives / head of human resources departments.

The questionnaire contained the following sections: (1) general data on the company; (2) human resources; (3) skill assessment of employees (non-IT and IT staff) based on importance – performance framework. In order to verify the questionnaire, the data collection was preceded by a pilot testing.

The final version of questionnaire was adapted to online form in LimeSurvey. An invitation to fill in the questionnaire was then sent to e-mail addresses of all companies that were included in sampling. The sample framework included 166 software companies with more than five employees. A non-probability sampling method was applied.

A total of 35 valid questionnaires were collected. Micro enterprises make 27,3%, small and medium enterprises 48,4% and large enterprises 24,2% of the sample. These companies employ more than 2 thousands workers or around one third of total number of workers in software industry in BiH. 46% of companies generated income in 2019 over 0,5 million Euros.

More than half of surveyed companies, besides outsourcing, are also developing their own software. All companies are export oriented. They operate mostly in the European market (72.7%) and North America (36.4%) markets. 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.

Educational profile of employees 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, ie non-IT staff, administration, HR, etc. The gender structure of IT specialists is male dominated, given that men make almost ¾ and women only ¼ employees. The gender structure of other specialists or non-IT staff (sales, marketing, HR, administration, etc.) is almost completely balanced, given that men make up 46% and women 54% of these employees in companies from the analyzed representative sample.

SURVEY RESULTS

Survey results shows that at the time of the survey (end of 2019 and beginning of 2020), the total number of open positions in surveyed companies was 170 (156 IT specialists and 14 non-IT specialists). That is almost 10 percent of total number of employees in these companies. This clearly indicate a significant mismatch between supply and demand for IT specialists in the labor market.

Enrollment policies do not follow labor market trends, resulting in small enrollment quotas (and thus faculty graduates) at higher education institutions that can't meet current and future needs of software industry for IT professionals. For example, out of a total of 6,357 enrollment places at Sarajevo University (the biggest university in the country) in academic 2019/2020, only 150 or 2.35% are for IT specialists. The situation is similar at other universities in BiH. For example, out of a total of 6,357 enrollment places at Sarajevo University (the biggest university in the country) in academic 2019/2020, only 150 or 2.35% are for IT specialists. The situation is similar at other universities in BiH. Therefore, software industry companies are forced to apply alternative strategies in overcoming the problem of staff shortages.

Two-thirds of the surveyed software companies stated that they had problems with filling vacancies for IT specialists during the previous and/or current year. The main reasons for the problems in filling vacancies for IT specialists in 81.8% of cases are the lack of candidates with appropriate knowledge and skills, and in 54.5% the lack of candidates with the necessary work experience. In 22.7% of cases, no one applied for the announced open call. In 22.7% of cases, the candidates were not satisfied with the offered conditions, such as salary, etc.

Table 2 – Reasons for not filling open vacancies for IT specialists

		N	Responses Percent	Percent of Cases
Reason	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%

Source: *Survey data*

Based on the survey data, the most deficient IT specialists are developers. Almost 60 percent of vacancies are developer's positions. Next one is project manager (10.26% positions), followed by test specialists (7.05% positions), enterprise architects (6.41%) and scrum masters (6.41%). As opposed to IT positions, the number of open positions for non-IT specialist was much smaller, mostly in marketing and sales.

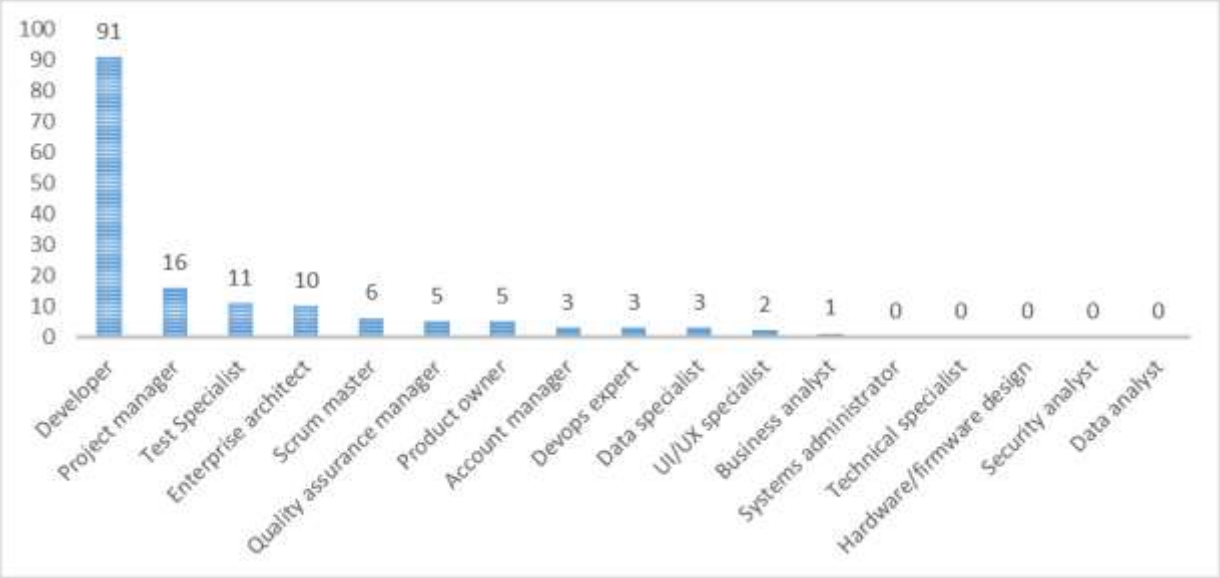

Figure 1 – **Open position for IT specialists**

The measures taken by software companies in Bosnia and Herzegovina to solve the problem of vacancies for IT specialists are different. They are aimed at providing the minimum required number of IT specialists for the smooth running of the company's business process. Labor market imbalance for IT specialists is so great that ⅔ software companies are forced to hire people who don't have the appropriate qualifications and then train them for the job they are looking for. Almost all surveyed companies subcontract external companies or individuals to perform jobs for which they don't have enough of their own capacities or IT specialists, nor can they be recruited on the labor market in the short term. 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 in terms of bootcamp as a measure of filling vacancies for IT specialists.

Table 3 presents the results of the assessment of the importance of skills for IT specialists (average value and standard deviation) versus satisfaction with the given skills by the company's management (average value and standard deviation). In the 'gap' column, there is a difference between importance (how important respondents consider an individual skill to be) and satisfaction (how satisfied respondents are with what they currently have).

Table 3 – **Importance vs. satisfaction with general skills of IT specialists**

Skill	Importance		Satisfaction			
	Avg.	SD	Avg.	SD	Gap	*t*
Professional (technical) skills	4.71	.760	4.17	.707	-.529	3.11 ***
Knowledge of a foreign language	4.51	.562	4.26	.701	-.257	1.78 *

Communication skills	4.24	.606	4.00	.696	-.235	2.09 **
Organization skills	4.15	.667	3.76	.741	-.394	2.62 **
Ability to learn fast	4.47	.567	4.12	.640	-.344	2.61 **
Ability to work in a team	4.51	.887	4.37	.598	-.143	.72 ns
Ability to work individually	4.27	.801	4.09	.742	-.242	1.54 ns
Ability to train other employees	3.79	.641	3.91	.793	+.121	-.70 ns
Analytical thinking and problem solving	4.34	.787	4.09	.723	-.250	1.35 ns
Openness and adaptability	4.33	.890	4.03	.822	-.303	1.47 ns

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

Source: *Survey data*

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 necessary condition for working on software development and providing IT services, they still make up only a part of the total required skills of IT specialists. The process of producing custom software or providing IT services involves intensive communication with clients and service users, as well as colleagues, team members within which employees perform their activities. Therefore, other, non-technical skills are also considered important as they average grade (4.51) is approximately the same as for professional (technical) skills. These primarily relate to ability to work in a team, knowledge of a foreign language, the ability to learn quickly, analytical thinking, problem solving and finally communication skills.

The level of satisfaction with a given skill is in principle lower than the importance indicating skill gaps. For example, satisfaction with the professional (technical) skills of employees is rated at 4.17, so the gap in the case of this skill is -0.529 points. Practically, for all skills with a statistically significant difference, the satisfaction rating is lower than the importance rating. This implies that educational institutions through the changes of curricula should work to improve these skills for the graduates in order to bring satisfaction closer to the importance that companies attach to these skills.

These findings are confirmed with managers' answers to the question on priority skills that need to be improved in future period (Table 4).

Table 4 – IT specialists' skills that need to be improved

		Responses		Percent of Cases
		N	Percent	
The most needed skills for improvement	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%

Source: *Survey data*

Results of a deeper assessment of importance vs. satisfaction for professional IT technical skills is presented in the table below. For the analytical purposes technical skills are grouped in three categories. Those 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.

Table 5 – Importance vs. 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	ns
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	ns
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	ns
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	ns
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	ns
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	ns
Average	4.16		3.89				
3. category - knowledge of advanced technologies							
Microsoft Technologies (.NET framework, ASP.NET, Entitiy...)	3.87	1.088	4.07	0.828	0.133	-0.66	ns
Java Ecosystem and Tools (JEE, Spring, Hibernate...)	3.47	1.106	3.81	0.786	0.04	-0.22	ns
Mobile Development (Java, Kotlin, Swift, GoLang...)	3.68	1.056	3.71	0.854	0	0	ns
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 ns
Embedded Software Development	3.03	1.217	3.35	0.832	0.13	-0.77 ns
Average	3.55		3.62			

Source: *Survey data*

From the software industry needs perspective of, the first category - fundamental knowledge of programming languages and IT systems - represent the minimum competencies and skills required to enter the IT industry and was rated as extremely important (average rating of 4.1 on a scale of 1-5). Almost the same importance score (4.16) was attributed to the second category of professional technical skills - that includes tools for the application of fundamental programming languages and systems. Advanced technologies represent the third category of professional technical skills used by software companies in their business process. 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.

The largest gap between importance and satisfaction was identified in the case of the first and especially the second skill category. These are the primary areas for improving the educational process in higher education institutions given the current level of development and requirements of the software industry in Bosnia and Herzegovina.

Research results for non-IT employees are somewhat different (Table 6). As presented before, number of vacancies for non-IT specialists is much smaller. However, even for this group of employees the gaps between satisfaction and importance regarding several skills are identified.

Table 6 – **Importance vs. satisfaction with non-IT specialists' skills**

Skill	Importance		Satisfaction			
	Avg.	SD	Avg.	SD	Gap	*t*
Professional (technical) skills	4.46	.922	4.16	.624	-.250	1.19 ns
Knowledge of a foreign language	4.39	.629	4.15	.613	-.160	1.00 ns
Communication skills	4.52	.893	4.12	.516	-.333	1.88 *
Organization skills	4.57	.573	3.92	.744	-.640	5.02 ***
Ability to learn fast	4.24	.636	3.92	.744	-.280	1.66 ns
Ability to work in a team	4.43	.879	4.23	.587	-.160	.72 ns
Ability to work individually	4.17	.889	3.88	.781	-.280	1.57 ns
Ability to train other employees	3.74	.903	3.83	.868	+.042	-.24 ns
Analytical thinking and problem solving	4.11	.892	4.08	.688	-.000	.00 ns
Openness and adaptability	4.50	.839	4.00	.748	-.480	2.39 **

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

Source: *Survey data*

Statistically significant are the communication skills, organization skills and openness and adaptability. Priority non-IT staff skills that need to be improved are presented in the table below.

Table 7 – Non-IT specialists' skills that need to be improved

		Responses		Percent of
		N	Percent	Cases
The most needed skills for improvement	Professional (Technical) Skills	14	14.9%	50.0%
	The Ability to Work with Clients	7	7.4%	25.0%
	Communication Skills	6	6.4%	21.4%
	Problem Detection and Solving Abilities	12	12.8%	42.9%

	Transforming the Needs of Clients into Action Plans	12	12.8%	42.9%
	Organizational and Team Management Skills	12	12.8%	42.9%
	Mentorship/Coaching Abilities	8	8.5%	28.6%
	Knowledge of Foreign Languages	13	13.8%	46.4%
	Knowledge of Work Ethics	10	10.6%	35.7%
Total		94	100.0%	335.7%

Source: *Survey data*

Priority non-IT specialists skills that need to be improved, according to employers' opinion, are professional (technical) skills, according to the job description (50%), followed by customer service skills (46%), communication skills (43%), team management skills (43%) and problem detection and solving abilities (43%).

As a part of the questionnaire the business were also asked about the measures they are taking in order to mitigate identified skill gaps. Based on the answers collected we can see that the vast majority of companies (97%) carry out additional employee training within the company. These are on-the-job training and various mentoring models. 27% of companies hired private educational institutions or training institutions for additional employee training.

Surveyed companies are reporting that on average newly employed faculty graduated need six months of internal training to be prepared for the work in company.

CONCLUSIONS

Software programing is the fastest growing industry and the industry with significant new employment potential in Bosnia and Herzegovina. This potential, unfortunately, hasn't been fully exploited. According to the firm owners/managers and the industry's business association statements, the key reason for that are skill shortages and skill gaps the business are dealing with. These kind of statements are clearly confirmed with our research results.

It is fair to say that software industry in Bosnia and Herzegovina is directed to self-reproduction of its own professional staff (IT specialists), ie filling the gap between supply and demand for IT specialists, which the existing capacities and performance of the education system in Bosnia and Herzegovina are not able to fill. In that sense, the companies partially take on the role of the education system, which additionally occupies the already limited human resources and makes it difficult to perform commercial tasks and projects. This situation points to the need to improve IT education in Bosnia and Herzegovina, in order to make greater use of the economic and development potential the software industry if offering. These improvements apply to all levels of education.

In the case of tertiary education it is first necessary to redesign enrolment policy to secure more places for IT specialists. Survey data shows that it is necessary to increase the number of positions on IT faculties for more than seventy five percent in order to satisfy expected needs of software industry in next three years.

Significant curricula changes are also necessary in a case of majority of faculties offering IT specialists' education. 82.9% of employers 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. 78.1% of surveyed employers believe that professional IT education should be modernized, and that it should be more open for new teaching methods such as the 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 employers 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.

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