Project:	Boosting the telecommunications engineer profile to meet modern society and industry needs [BENEFIT]
Project ID:	585716-EPP-1-2017-1-AT-EPPKA2-CBHE-JP
Work Package 5:	Quality Control and Monitoring
Title:	D5.4 Reports on graduates profile improvements and correspondence to industry needs
Lead Organization:	ENT
Participating Organization:	ENT, UNI-KLU, UNI, UL, UB, UNSA, UNTZ, UNS, UBL
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Disclaimer:

Deliverable data	Work Package and Outcome ref.nr	WP5 D5.4
	Title	Reports on graduates profile improvements and correspondence to industry needs
	Type	☐ Teaching material ☐ Event ☐ Learning material ☒ Report ☐ Training material ☐ Service / Product
	Description	In this report, the QB will assess the impact of project actions on increased employability of the graduates and correspondence of the acquired skills with the job market requirements.
	Date	14.10.2020
	Language	English and Bosnian/Croatian/Serbian
Target groups	☒ Teaching staff ☒ Students ☒ Trainees ☒ Administrative staff ☐ Technical staff ☐ Librarians ☒ Industry partners, WB Higher education authorities	
Dissemination level	☐ Department / Faculty ☐ Local ☐ National ☐ Institution ☐ Regional ☒ International	
Lead Organization	ENT	
Participating Organization	ENT	
Task	T5.4 Monitor graduates profile, improvements in the skills, correspondence to industry needs. (Task leader: ENT).	

Revision History				
Version	Date	Author(s)	Organization(s)	Brief description of change
1	17.4.2020.	I. Stupar, D. Huljenić	ENT	Super draft
2	5.6.2020.	D. Huljenić, I. Stupar	ENT	Added information about assessment surveys
3	9.6.2020.	D. Huljenić, I. Stupar	ENT	Added implementation status
4	28.9.2020.	D. Huljenić, I. Stupar	ENT	Added results of collected polls
5	28.10.2020.	D. Huljenić, I. Stupar	ENT	Added survey results graphs and comments

Table of Contents

1. Introduction

This deliverable "D5.4 Reports on graduates profile improvements and correspondence to industry needs" reports the results of the activities carried out in:

T5.4. Monitor graduates' profile, improvements in the skills, correspondence to industry needs. (**Task leader: ENT**)

2. Proposed monitoring framework

To monitor project results in term of advancements made related to the graduates' profile and skills, as well as adherence to industry needs, we define a process used for the implementation of improvements monitoring. The process is illustrated in Figure 1. The monitoring process includes several phases: initial industry needs assessment, proposal of updates, implementation of updates, and monitoring of updates.
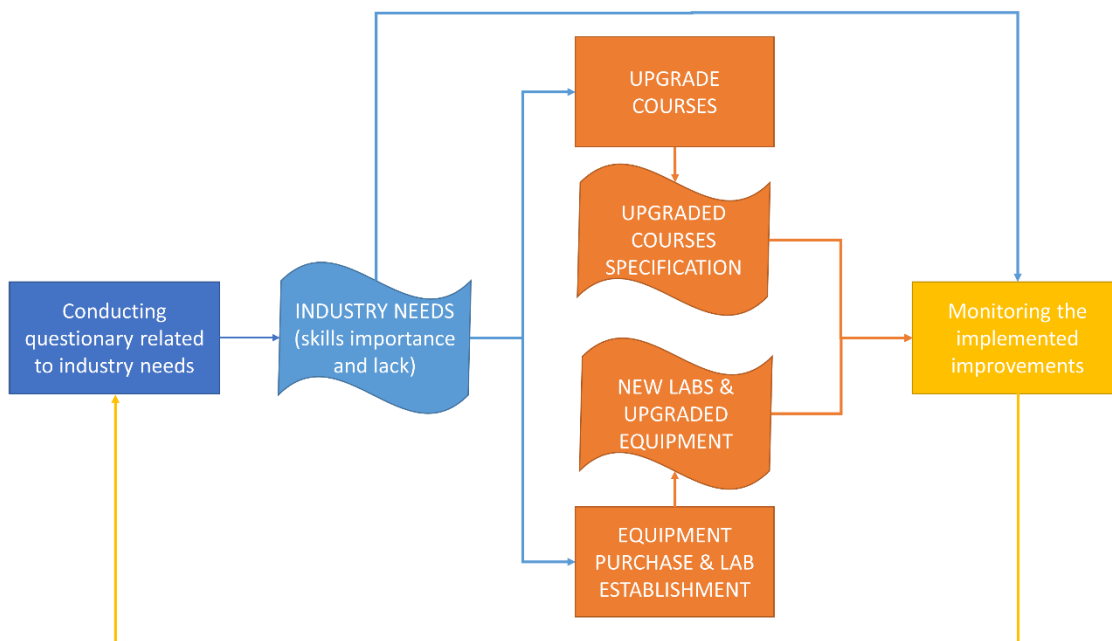

Figure 1. Improvements monitoring framework

One of the inputs to improvements monitoring are results of the questioner related to industry needs. The results indicate the skills that participants of the industry survey perceive as important for graduates to have as they enter the work market, as well as the skills that the survey participants have noticed are lacking among most of their current employees working as ICT specialists. The results of the survey indicating this information are of crucial importance for assessing the adherence of implemented changes to industry needs. The industry survey conducted within WP1 at the beginning of the project is documented in D1.1. The document contains information about the questions in the survey, and the results based on the seven participating companies. The results described in the D1.1 are used for the implementation of the first iteration of the implemented improvements monitoring. However, a good practice would also incorporate future iterations of acquiring industry feedback, and as such the monitoring process can result in the additional industry surveys.

The results of the industry needs survey were also used for the implementation of courses update and establishment of new laboratories at universities participating in the project. We

use the specification of the implemented updates of the courses to analyze if the updates will contribute to bridging the skills gap perceived by the industry. Another useful input for monitoring of the potential improvements in the skills and adherence to identified industry needs is to analyze the established labs, which is a good indicator of the skills and knowledge which will be enabled for acquiring to the students of the ICT study programmes. As such, we use the stated information about courses updates (WP2) and improved teaching methodologies and established laboratories (WP3) for the process of matching the identified lacking skills and those that will be enabled by course upgrades and new lab equipment. In case of further information needed for assessment of the course upgrades, a survey will be conducted among academic partners for analyzing the changes done to the upgraded courses and how they relate to the identified lacking skills in the industry.

The evaluation of the implemented improvements is performed on several levels, including the assessment related to the student perception of gained knowledge and skills through upgraded courses, as well as the way the upgraded course materials were presented and delivered to the students, the expectations of industry participants related to the needed skills, and feedback of university professors applying the improved course programme and teaching methods.

One additional important measure will also be the dynamic of the change acceptance. The reason for such measure is very a dynamic business and work environment that requires fast adaptation to the labor market. Due to the dynamic developments in our business environment, universities must be adaptive to the rapid changes on the labor market if we want to create a sustainable system for our regional community. In the long-term evaluation process, satisfaction of industry with the updates implemented through the project might be measured via job interviews and the survey of trainees to acquire data on their experience with jobs gained after graduation in terms of knowledge and skills they gained using the updated curricula. However, this would require tracking of graduates and would have to be performed up to several years after certain course was taken, and it is therefore out of scope of the BENEFIT project.

To summarize the information on the monitoring process, an overview of available inputs needed for implementing the presented process and their status is provided in Table 1.

Table 1. The list of deliverables and tasks containing inputs for the monitoring process

Deliverable/Action	Title	Status	Expected readiness	Importance	Comment
D1.1.	Ex-ante analysis	delivered		Industry survey	
D2.1.	Modernized and accred. Study programmes	delivered	Oct/2020	Overview of changes	Changes discussed with labor market?
D2.2.	Delivered study programmes and overviev of changes	delivered	Oct/2020	Crucial to understand included changes	Labor market accept changes?
T2.4.	Web catalogue of industry capacities	delivered	Oct/2020	Overview of interested industry – labor	

				market fo tracking changes	
D3.1.	Adopting new teaching methodologies	delivered	Apr/2020	New skills creation	
D3.2.	Joint university-industry labs	delivered	Apr/2020	New skills building	How perceive labor market – other companies?

Considering the provided overview of the needed inputs and the deadlines for their completion, the time plan for the monitoring process implementation is tailored accordingly, with the focus on gaining the results from the WP2 and WP3. Preparation of additional surveys needed for the monitoring process took place in the meantime.

3. Implemented surveys

Industry needs survey

As mentioned previously, a survey was implemented to assess the industry needs. The obtained results indicate the skills that seven participants of the industry survey perceive as important for graduates to have as they enter the work market, as well as the skills that the survey participants have noticed are lacking among most of their current employees working as ICT specialists. The industry survey conducted within WP1 at the beginning of the project is documented in D1.1. The document contains information about the questions in the survey, and the results based on the participating companies. The results described in the D1.1 are used for the implementation of the first iteration of the implemented improvements monitoring. In addition to the survey results obtained at the beginning of the project and described in D1.1, an additional survey was conducted via online form among companies nearing the end of the project (September 2020) to evaluate the perception of implemented curricula changes by the industry (results described in Chapter 5).

Survey for student evaluation of course material

Within WP5 activities, a survey was developed for the purpose of evaluation of the quality of the upgraded course material. The survey is consisted of the questions related to the course identification (*Which University did the course take place in? Which semester are you attending? Write down the title of the course and name of the teacher(s) involved in teaching it.*) The following set of questions is asked to perform the evaluation of the upgraded course quality, in which the survey participants rate the level of agreement with the statements, ranging from 'strongly agree' to 'strongly disagree':

- *Teaching methods (lectures, exercises, practice, seminars, projects...) correspond to the content of the course*

- *Class was interactive and included timely case studies*

- *The content of the course provides the expected knowledge and practical skills*

- *The material of the course is clear, complete and technically sound*

- *The teaching staff applied the literature provided in the course specification*

- *The teaching staff taught efficiently and professionally*

- *The student workload is in accordance with the proposed amount of ECTS*

- *Student evaluation (during course and exam) is done professionally and in accordance with defined criteria*

- *Laboratory equipment and e-tools used in the teaching process adequately support the content of the course*

The details of the conducted survey and report on the tools for monitoring student's enrollment and employability are reported in the D5.5 deliverable within the WP5.

Survey for universities and industry about the implemented curricula changes

To assess the changes in curricula implemented within the scope of the project from both perspective of universities implementing the changes, and industry in terms of correspondence of changes to industry needs, three separate surveys were implemented.

The analysis of the survey results related to the implemented changes in curricula form perspective of universities (Appendix A.1) and industry (Appendix A.2) are presented in Chapter 5 of this document. The third survey (Appendix A.3) is a more detailed questioner for assessing the changes perceived by the employers about the graduating students who took classes according to the updated curricula, which should be conducted in a period of one to several years after the curricula changes were implemented in order to be able to see their full effect. This is the period that is needed for the students who took the updated and/or new classes to reach the companies in terms of internships or as an employee once they graduate.

4. Implementation status

In this chapter, the upgrades of the courses and development of new courses, as well as creation of new laboratories and acquiring of new equipment is evaluated in the context of planned upgrades and industry needs, which gives an overview of the context for the conducted surveys (described in Chapter 3) and results (Chapter 5).

Upgraded and new courses

In the scope of the project there were 43 courses selected for the modernization, and 19 novel courses developed, the changes made to the courses are documented within WP2. In order to estimate the correspondence of modernized and novel courses, an analysis was performed based on the results of the industry survey conducted at the beginning of the project and presented in D1.1. The survey estimated an industry perspective on important and lacking skills of the ICT specialists on the current job market. Highest grades in terms of skills lacking by ICT specialists were given to the Software and Applications category, as well as the Middleware category. The most important professional skills shown from the survey result are "software applications for software specialists", and "software applications for quality, test and certification specialists". Also "middleware for software specialists" is one of the most important highlighted skills (details related to the survey results can be found in D1.1). The survey also asked to grade the importance of the macro knowledge areas covered by study programmes in telecommunication engineering. The most important macro knowledge areas are "software engineering", "computer engineering" and "information and data management". We analyze the areas of upgrade in modified and new courses in accordance to the identified macro knowledge areas that the industry perceived as the areas with skills most relevant or lacking. The results (Table 2) are based on the 61 modernized and new courses descriptions reported within the WP2.

Table 2. Number of modernized and novel courses according to the knowledge areas identified as important in the industry survey

Knowledge area	Number of modernized courses	Number of novel courses	Total courses
Software engineering	39	18	57
Computer engineering	39	15	54
Information and Data Management	4	6	10

The description of novel or modified courses content was mapped on the three most important knowledge areas from the industry survey analysis (available in D1.1). Table 2 contains the number of novel and modernized courses that fall into one or more of the categories of knowledge area identified as important by the industry. As the observed courses are in the field of telecommunications and radiocommunications, most of them combine the knowledge areas of software engineering and computer engineering, hence most courses falls into both software engineering and computer engineering areas. However, there is a significant number of novel courses in the Information and Data Management area – 60% of the developed courses related to this area is new (compared to software engineering and computer engineering knowledge areas with approximately on third of novel courses), which also demonstrates the correspondence and adaptation of the curricula to the situation in industrial knowledge needs (e.g., the increasing usage of artificial intelligence and big data in commercial production systems).

Laboratory equipment

Six new joint labs were created within the scope of the project as novel thematic joint university-industry labs that would increase HEI-Industry cooperation through the

implementation of new trainings and internships. Like the analysis related to the knowledge areas of the novel and modernized courses, the developed labs provide the opportunity to develop knowledge and skills in software engineering, computer engineering, and information and data management. Specific joint HEI-Industry activities with students are negotiated through the agreement related to the joint labs. More details on the developed labs and the equipment acquired through the project is available within WP3 (deliverable D3.2), here we briefly present the labs and the thematic focus of each of them:

- University of Banja Luka: "Signal Processing in Telecommunications Lab" in collaboration with Bicom and AlfaNum;
- University of Sarajevo: "Telecommunications Lab" in collaboration with BIT Centar;
- University of Tuzla: "VoIP Services Lab" in collaboration with Bicom and BIT Centar;
- University of Belgrade: "IoT Networks Lab" in collaboration with CISCO;
- University of Nis: "Machine-to-Machine Communication Lab" in collaboration with NiCAT;
- University of Novi Sad: "Wireless Communications and Information Processing Lab" in collaboration with RT-RK and Saga.

5. Results and conclusions

With the provided on-line surveys we collected responses from the Universities professors about preparation and execution of the curricula changes, according to the changed and new knowledge units and in parallel collect expectations of the companies related to the changes executed in the process of curricula modernization and new potential employees. In total 38 responses were collected from the university professors and 24 responses from the industrial partners in the areas where the changes are executed (Novi Sad, Belgrade, Nis, Sarajevo, Tuzla, Banja Luka). The poll was conducted during September 2020.

Overall results are presented below. The Table 3 presents the overall result (38 responses) from the Universities and the Table 4 presents results from the Companies (24 responses).

Table 3. Overview of responses from the university professors on introduced curricula changes

Question No.	Question/Statement	Response		
		Fully Agree	*Partially Agree*	*Disagree*
1.a	I agree with improved knowledge areas	**34**	**2**	**2**
1.b	I agree with new introduced knowledge areas and knowledge units	**34**	**2**	**2**
2.	Are you well prepared to carry out teaching according to the newly proposed knowledge units?	**31**	**6**	**1**

| 3.	Are you well prepared for the newly proposed teaching methodologies?	**29**	**8**	**1**	
4.	Do you believe that students will accept the new knowledge areas?	**33**	**5**	**0**	
5.	Do you believe that the newly developed knowledge areas will increase potential for the employability of the students?	**25**	**13**	**0**	
6.	Do you believe that modified curricula will be beneficial for employers when students will start working at their companies?	**25**	**13**	**0**	
		Well prepared with good potential	*Well prepared with some potential*	*No opinion*	*Do not support such concept*
7.	What is your opinion about the joint labs with the companies?	**19**	**15**	**4**	**0**
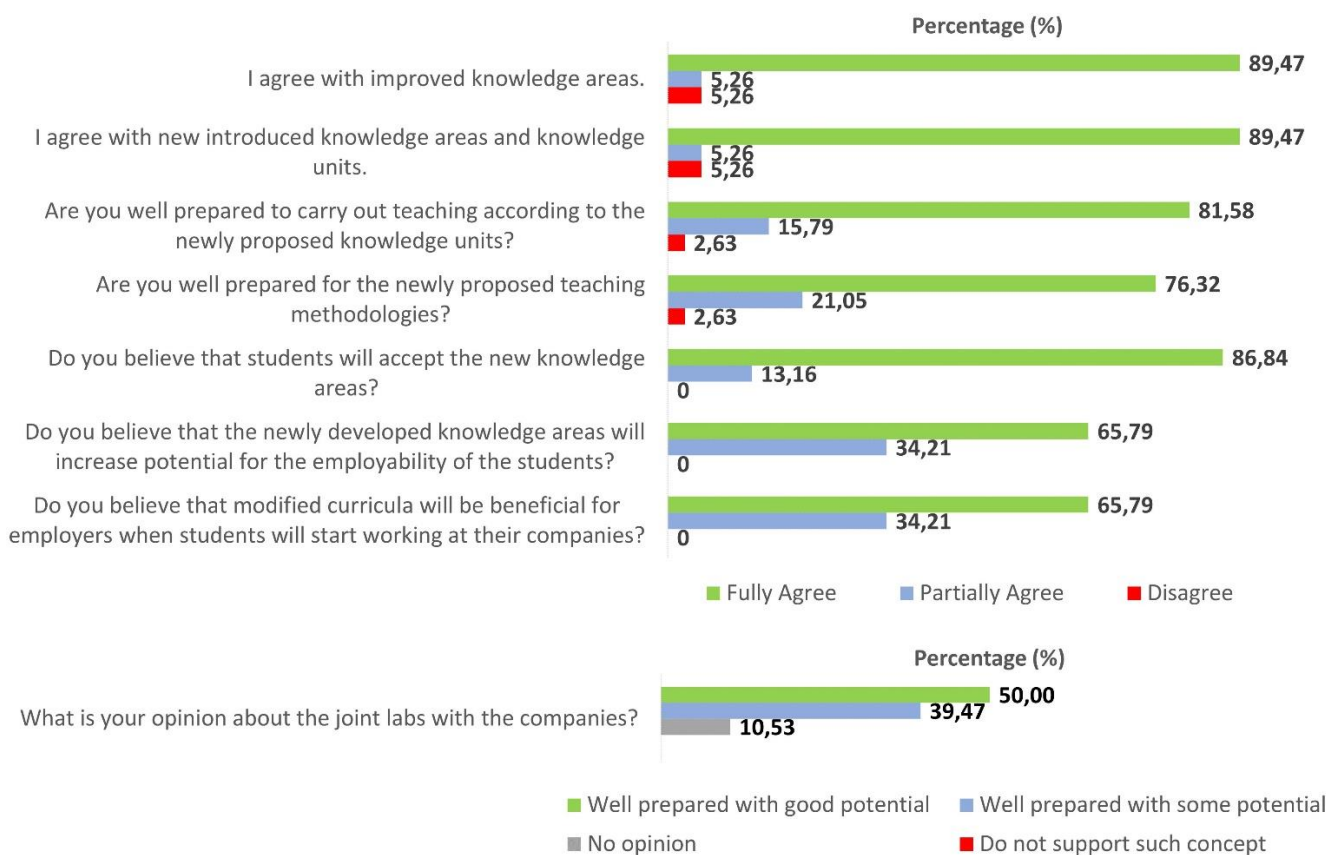
Figure 2. Results of the university survey in percentages

From the collected results (Table 3 and Figure 2) it is visible that professors accept made changes and expect a positive step in the teaching process change. The positive acceptance

reaches 89,47% of respondents. The slightly lower agreement is achieved with the new methodologies of teaching – 76,32%. Introduced changes are expected to make a change in employability potential for the graduates and here the results show that fewer professors think that it will happen – 65,79 % is positive towards provided changes and employability potential. The most doubts are visible in the introduced joint labs between universities and the industry –50% of professors think that labs are well prepared with the good potential and 39,47% have an opinion it will gain some potential but are positive towards such a way of working. The lowest score on the opinion for the joint labs could be due to the fact that both industry and universities have to be involved in their operation. A small number of comments related to the given grade on this question expressed scepticism of the level of industry involvement in the work of joint labs (e.g. "*The companies need to embrace the concept as well.*"). Additionally, comments in the survey related to the readiness for teaching according to the newly proposed knowledge units and new teaching methodologies were mentioning delays in procurement of equipment due to complicated procedures at national level. Another reason for evaluating their level of readiness as "partially prepared" was due to the preparation of teachers for new methodologies (e.g. "*I must learn how to do it well.*"). Another comment emphasized that the online teaching (which was ongoing and prevalent at the universities at the moment of conducting the survey and writing this deliverable due to the COVID-19 pandemic) may limit other methodologies which were planned to be conducted in teaching prior to the pandemic when students were mostly physically present at the university facilities. The general comment is that changes are well accepted and provide a good base for further development.

Table 4. Overview of responses from the industry regarding curricula changes

Question No.	Question	Response			
		Yes	*Partially*	*No*	
1.	Do modified curricula accept industrial requirements?	**16**	**6**	**2**	
		Yes	*Partially (just informed)*	*No*	No informed
2.	Do you partake in the creation of modified curricula?	**15**	**5**	**4**	**0**
		Good idea well executed	*Good idea but not well executed*	*Nothing inside for me*	
3.	What is your opinion about established joint academia-industry lab at University?	**21**	**0**	**3**	
		Yes	*No*	*No opinion*	

4.	Do you expect improved employees and faster start in the job execution with modified curricula?	19	1	4	
		Yes	*Partially*	*No*	
5.	Are you satisfied with the frequency with which curricula changes are carried out?	19	2	3	

The most important result of the updated curricula is to have people capable to execute the job provided to them and to ensure the employability of graduates with an earned profile degree. The response to that is twofold: the first one is filling of the graduate on the accepted job, and the second one are employers (companies) and their perception of graduates potential in an industrial environment and the time needed to accommodate their daily tasks. To have such an overview we need additional time after the project finishes to be able to collect such results. For that reason, the third poll is prepared and available in Appendix: Employer overview.
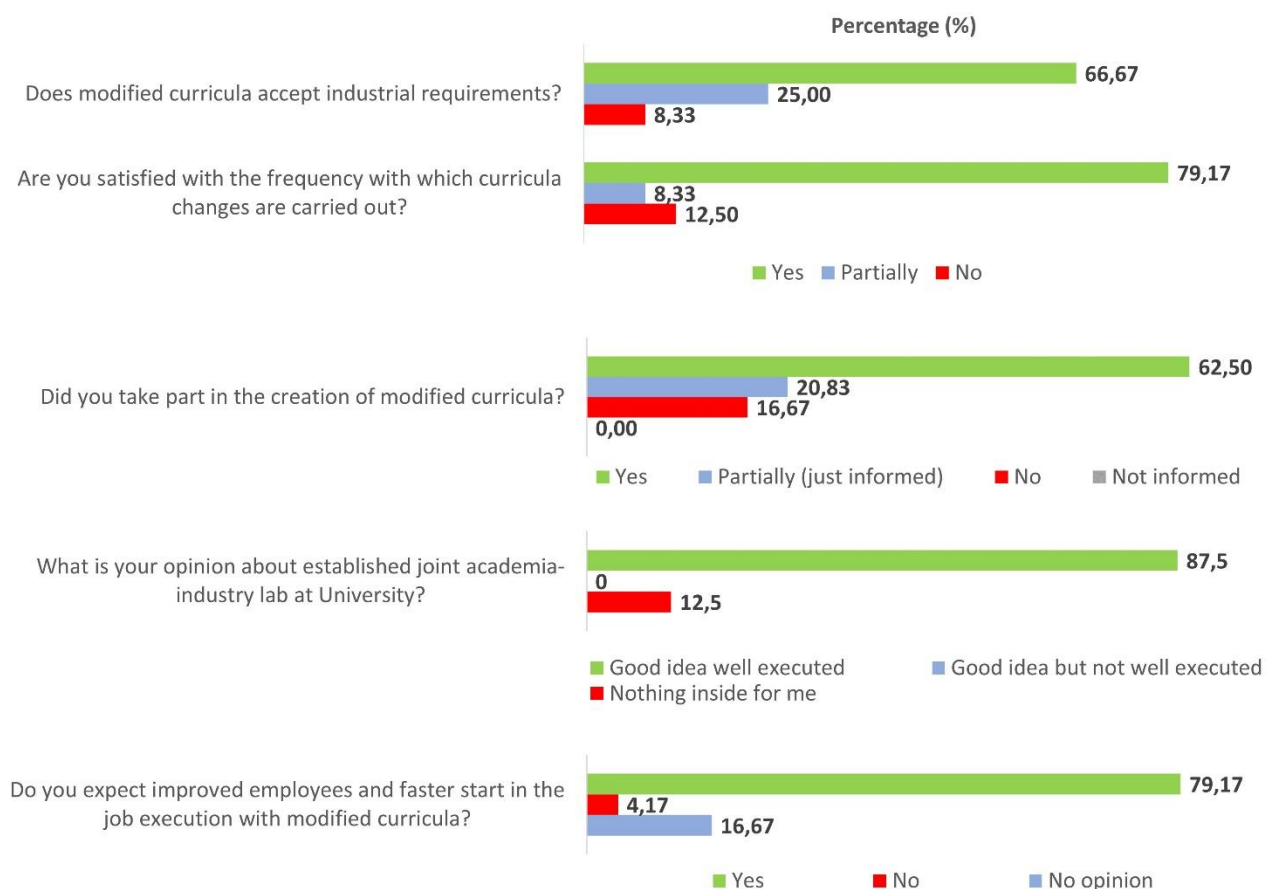

Figure 3. Results of the industry survey in percentages

Here we present an initial poll conducted during September 2020 where responses of 24 industrial entities from the Serbia and Bosnia and Herzegovina are presented (Table 4 and Figure 3). The achieved results demonstrate a positive acceptance of the change process and have positive expectations from the graduates finishing provided curricula. It is visible that communication with the industry was moderate because acceptance of the industry requirements is 66,67% in the changing curricula process and industrial participation during the University change process is on the 62,50% which means that is positive, however, the activities of the common interest require further discussion in terms of how they can be improved. The joint labs achieved the most positive effect in the industrial view and reached 87,5% of acceptance. The very positive view is also on the expectation with graduates according to new curricula – expected improvement had a score of 79,17%. The results of the poll indicate a good perspective of the started process (79,17% of respondents are satisfied with the frequency of changing curricula) which will require further monitoring and continuous improvements.

In the overall conclusion and the quality-wise review, it is visible that all interested parties in the curricula change process see a positive direction of the implemented changes. Most actors are satisfied with executed changes and expect a positive impact. One thing that for sure can be improved is communication – an involvement of industrial partners during the change creation. The most valuable results will come out from the employer surveys when graduates will start their work for a while and use their achieved knowledge and skills in the industrial environment.

Appendix A Prepared surveys

1 Questions for universities that implement changes in curricula

1) Satisfaction with changed courses (modified and new one)
   a. I agree with improved knowledge areas (please Vote)

Fully Agree	Partially Agree	Disagree
If partially agree or disagree make short comment why:		

   b. I agree with new introduced knowledge areas and knowledge units (please Vote)

Fully Agree	Partially Agree	Disagree
If partially agree or disagree make short comment why:		

2) Are you well prepared to carry out teaching according to the newly proposed knowledge units? (please Vote)

Fully Agree	Partially Agree	Disagree
If partially prepared or no make short comment why not:		

3) Are you well prepared for the newly proposed teaching methodologies? (please Vote)

Fully Agree		Partially Agree	Disagree
	If partially prepared or no make short comment why not:		

4) Do you believe that students will accept the new knowledge areas? (please Vote)

Fully Agree	Partially Agree	Disagree

5) Do you believe that the newly developed knowledge areas will increase potential for the employability of the students? (please Vote)

Fully Agree	Partially Agree	Disagree

6) Do you believe that modified curricula will be beneficial for employers when students will start working at their companies? (please Vote)

Fully Agree	Partially Agree	Disagree

7) What is your opinion about the joint labs with the companies? (please Vote)

Well prepared with good potential	Well prepared with some potential	No opinion	Not support such concept
If no opinion or not support, please write short comment:			

2 Preliminary question for the industry about changed curricula

In the Ex-ante analysis (deliverable D1.1.) industrial entities marked like most important knowledge areas: "software engineering", "computer engineering" and "information and data management". By looking into the changed curricula (link to the portal with changed curricula) what is your opinion:

1) Do modified curricula accept industrial requirements? (Vote)

Yes	Partially	No
If partially or no please make short comments why:		

2) Do you partake in the creation of modified curricula? (Vote)

Yes	Partially (just informed)	No	Not informed
If answer is not yes please write a short comment:			

3) What is your opinion about established joint academia-industry lab at University? (https://www.project-benefit.eu/wp-content/uploads/2019/03/List-of-joint-labs-BENEFIT-final.pdf) (Vote)

Good idea – well executed	Good idea but not well executed	Nothing inside for me
	Please write comment for improvements:	

4) Do you expect improved employees and faster start in the job execution with modified curricula? (Vote)

Yes	No	No opinion
Please write comment for improvements:		

5) Are you satisfied with the frequency with which curricula changes are carried out? (Vote)

Yes	Partially	No
If partially or no please make short comments why:		

3 Survey for employers

BENEFIT Boosting the telecommunications engineering profile to meet modern society and industry needs

BENEFIT is an ERASMUS+ KA2 project that focuses on three main pillars:

1) the cooperation between Higher Education Institutions (HEIs) and industry to modernize the study program in telecommunication engineering in the Western Balkans region;
2) the adoption of modern teaching methodologies and tools, the upgrade of the infrastructure, and the creation of several joint university-industry labs;
3) the training of both teachers and students.

   This survey has been prepared to collect information on job market/needs and to map skills and knowledge areas required from ICT engineers and specialists in the ICT sector so that study programs in telecommunications engineering can be modernized.

More information on the project can be found at: https://www.project-benefit.eu

Privacy and data consent

Information presented in this questionnaire is strictly confidential. Please check the boxes below, you do not have to tick all of them, we will protect your personal information according to your choices below, then sign and date the form where shown.

Checking the boxes, I confirm:

☐ I have been informed about the objective of the project and my role and involvement in it. I understand that my participation is voluntary.

☐ I agree to take part in the above research study.

☐ I understand that relevant sections of any of the information I am providing, may be looked at by responsible individuals and under the supervision of the principal investigator of this study or for contributing to the understanding of the matter.

☐ I agree that my data gathered in this study may be shared by the partners of the Erasmus+ project 585716-EPP-1-2017-1-AT-EPPKA2-CBHE-JP and the European Commission.

☐ I agree that the name of the company can be mentioned in the acknowledgements of the project at the project website, in reports and in publications.

☐ I agree that I agree that my data gathered in this study may be stored (after they have been anonymized) in a specialist data centre and may be used for future research.

☐ I agree to the use of anonymized quotes in publications.

☐ I wish to be contacted again by the research team to be informed about the state of development of the project.

Region, municipality:_____

Business entity (Company):_____

Representative of the business entity: _____
(name, surname)

Function: Owner/Director/HR Manager/Other_____

Contact telephone/e-mail: _____

Signature: _____

Date: _____

A.1. Full name of the business entity	
A.2. Register code of the business entity	
A.3. Registration date	
A.4. Juridical address	
A.5. City and country	
A.6. Telephone/fax/e-mail	

A.7. Organizational type	☐ Limited liability company	☐ Stock company	☐ Other _____
A.8. Ownership	☐ Private	☐ Public	☐ Other _____

A.9. Origin of capital	☐ Domestic	☐ Foreign	☐ Mixed	☐ Other _____

A.10. Type of core business activity	**Market sector**	**Core business**
	☐ Energy	[please specify your core business]
	☐ Materials	
	☐ Industrials and manufacture	
	☐ Consumer	_____
	☐ Healthcare	
	☐ Financial	
	☐ Information technology	
	☐ Telecommunication services	
	☐ Utilities	
	☐ Real estate	

A.11. Business model	☐ Internal product/ service development	☐ Outsourcing	☐ Other _____

A.12. Size by number of employees	☐ Micro (up to 9 employees)	☐ Small (10-49)	☐ Medium (50-249)	☐ Large (250 plus)

B. Self-assessment of the skills of those currently employed

B.1. Does your company have problems with ensuring adequate skills of employees? [Mark appropriate selection with X]

Yes	No

B.2. Has your company experienced difficulties in filling vacancies in the last 12 months? [Mark appropriate selection with X]

Yes	No

B.3. According to your experience what are the obstacles which cause difficulties in filling vacancies for each of the following occupational groups? [Mark appropriate selection with X. Multiple answers are allowed]

Difficulties in filling vacancies	ICT specialists, developers, researchers	Managers	Marketing and sales	Other (please specify) _____
Insufficient supply of qualified candidates who poses adequate skills				
Candidates do not have work experience				
Candidates do not possess positive attitudes towards learning, working hard and career development				
Candidates do not favour occasional/short-term jobs				
Wages are not high enough to attract qualified candidates				
Do not know				
There are no difficulties in filling vacancies for this type of profession				

B.4. What are your expectations regarding the changes in the number of employees in the next 12 months? [Please mark with X only ONE answer for each occupational group]

Occupations	Increase	Remain unchanged	Reduce	Do not know
ICT specialists				
Managers				
Marketing and sales				
Other				

B.5. Which skills are the most important for your employees to fulfil their assignments but are currently insufficient? [Mark appropriate selection with X or write-in. Multiple answers are allowed]

Skills	ICT specialists, developers, researchers	Managers	Marketing and sales	Other
Professional (technical) skills, according to the job description				
Knowledge of foreign languages				
Possession of professional ethics				
Skills in organizing and managing a team				
Communication and team spirit				
Ability to work with clients				
Ability to identify and solve problems				
Passion for new knowledge, ambition to learn and excel				
Other specific technical skills _____				
There is no lack of skills				

B.6 Which professional skills are most important for your company in reference to the ICT specialists? [Mark appropriate selection with X or write-in. Multiple answers are allowed]

Skill\job title	Software specialist	Hardware specialist	System and security specialist	Quality, test and certification specialist	Operations and maintenance specialist	Project management
Hardware components						
Hardware integration						
Firmware						
Middleware						
Software and Applications						
Other specific technical skills _____						

B.7 Which professional skills does your company currently lack in reference to the ICT specialists?
[Mark appropriate selection with X or write-in. Multiple answers are allowed]

Skill\job title	Software specialist	Hardware specialist	System and security specialist	Quality, test and certification specialist	Operations and maintenance specialist	Project management
Hardware components						
Hardware integration						
Firmware						
Middleware						
Software and Applications						
Other specific technical skills _____						

B.8. The table below reports a list of macro knowledge areas covered by study programs in telecommunications engineering. Please grade the importance of each of them for the ICT specialists in your company. [Mark appropriate selection with X. 1 – Not important, 2 – Slightly important, 3 – Moderately important, 4 – Important, 5 – Very important. Write-in additional information.]

Knowledge areas [see below for descriptions]	1 Not important	2 Slightly important	3 Moderately important	4 Important	5 Very important
Mathematics					
Physics					
Fundamentals of electrical engineering					
Measuring and instrumentation					
Electronics engineering					
Radio communications					
Information theory					
Communication networks					
Communication systems					
Signal processing					
Software engineering					
Computer engineering					
Information and data management					
Other engineering courses					
Multimedia					
Communication and presentation skills, foreign languages					
Business economics, management and organization					
Applications of telecommunications (e.g., in energy, health, robotics, automotive, etc): [please specify] _____					
Other knowledge areas: [please specify] _____					

Description of Knowledge Areas

1. **Mathematics**: number systems, matrices, linear algebra, analysis of continuous functions, differential equations, probability, statistics, etc.
2. **Physics:** mechanics, thermodynamics, atomics, optics fluid statics and dynamics, thermodynamics, nuclear physics, etc.
3. **Fundamentals of electrical engineering:** circuit analysis, semiconductors, frequency and time domain, Maxwell equations, transmission lines.
4. **Measuring and instrumentation**: metrology, measuring accuracy and uncertainty, instrumentation, standards, etc.
5. **Electronics engineering**: microelectronics, operational amplifiers, integrated circuits, combinational and sequential circuits, etc.
6. **Radio communications**: radio-communication concepts, propagation of EM waves, radio systems design, antennas and propagation, etc.
7. **Information theory:** source coding, channel coding, statistical theory in telecommunications.
8. **Communication networks**: communication network technologies, OSI layers, TCP/IP, protocols, network management, network security, etc.
9. **Communication systems**: analog and digital data transmission, communication theory, channel modelling, multiple access schemes, etc.
10. **Signal processing**: signal analysis, s-domain, z-domain, digital signal processing, audio processing, transforms, Fourier analysis, filters.
11. **Software engineering**: programming principles, programming languages, object-oriented programming, operating systems.
12. **Computer engineering**: computer system architecture, microprocessor, memory, input-outputs, embedded systems.
13. **Information and data management**: information and knowledge, data storage, maintaining data, markup languages, etc.
14. **Other engineering courses**: courses from other departments not directly related to telecommunications.
15. **Multimedia:** Multimedia systems and services, image processing, audio and video technologies, multimedia production, etc.

B.9. In your opinion, what are the reasons that cause the lack of skills, observed by the occupational groups? [Mark appropriate selection with X or write-in. Multiple answers are allowed]

Reason	ICT specialists, developers, researchers	Managers	Marketing and sales	Other
High fluctuation of employees				
Market requirements				
Lack of newly employed				
Technological change				
No possibility to organize in-company training				
No financial resources for off-site training				
Lack of time due to project deadlines				
Other causes: [please specify] _____				
There are no problems				

B.10. Does your company collaborate with universities (in terms of hiring graduates, providing work experience, scholarships, internships, and so on)? [Mark appropriate selection with X]

	Universities/faculties
Yes	
No	
Do not know	

B.11. To what extent are you satisfied with the skills and competences acquired during the process of formal education? [Mark appropriate selection with X]

	Universities/faculties
Very satisfied	
Somewhat satisfied	
Neither satisfied nor dissatisfied	
Somewhat dissatisfied	
Very dissatisfied	

B.12. To which extent you are familiar with joint lab between industry and University?

We participate and support	We are familiar but not participate	We know but not support	We are not informed

If you are familiar please answer the next questions:

Ownership of the lab	Exclusively University	
	Joint ownership	
	Exclusively company	
Equipment in the lab	Exclusively University	
	Joint equipment	
	Exclusively company	
Lab experiments preparation and execution	Only University staff	
	Joint activity	
	Only company staff	

B.13. Do you know the qualifications offered by the national education and training system? [Mark appropriate selection with X]

Yes	No	Partly, depends on the profile

B.14. In your opinion, what changes are necessary in the higher education institutions in order for the skills and competences of the graduates to meet the job requirements of your company? [Mark appropriate selection with X or write-in. Multiple answers are allowed]

Readiness to review and change curricula in order to align them with technological change	
Openness to new methodologies of teaching	
Focus on practical training, organisation of practice, internships at the company, etc.	
Joint projects between companies and education institutions	
Define and update educational profiles in line with labour market needs	
Involve the representatives of the social partners (employers, trade unions, public employment service, other public and non-public relevant actors) in planning and developing the educational profiles	
Create the skills and competences that will be applicable in the company without more time being spent on additional trainings	
Introduce additional foreign language courses (professional language)	
Provide career guidance services to future graduates	
Harmonise the training programmed with international standards in order to improve the supply of ICT and other professionals	
Other [please specify] _____	
Do not know	
Nothing	

C. Education and business cooperation

C.1. Is information on needed skills communicated to the education trainings in the ICT sector? [Mark appropriate selection with X]

Yes	No	Do not know

C.2. If YES, through [Mark appropriate selection with X or write-in. Multiple answers are allowed]

Communication between the ICT companies and education/training institutions locally	
Communication between the ICT sector and the education/training authorities at local level	
Communication between the ICT sector and the education/training authorities at provincial level	
Communication between the sector and the education/training authorities at national level	
Other [please specify] _____	

C.3. If NO, why? [Mark appropriate selection with X or write-in. Multiple answers are allowed]

There is no mechanism that functions at present	
Other [please specify] _____	

C.4. Does your company provide student internship opportunities?
[Mark appropriate selection with X]

Yes	No
If not, please provide reason why (optional):	

C.5. In case your company provides student internship opportunities, what is your opinion on the following statements? [Mark appropriate selection with X]

	Agree	Neutral	Disagree
The skills developed by students during internship build upon and help extend the knowledge students acquire during the education at the university.			
I find that internships are a good way of introducing students to the company.			
Participating in the industry internships increases the employability of the students after they graduate.			