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ANALYSIS OF THE FASTEST-GROWING JOBS IN THE ICT SECTOR

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Summary

This report analyses economic and financial aspects of Serbia's ICT sector, focussing in particular on the ICT labour market characteristics, to gain understanding of the skills mismatch, i.e. the extent to which the current workforce supply of Serbia's educational system matches the demand in this sector. The workforce demand and supply are analysed individually, by interpreting data obtained from relevant state institutions, as well as data collected through a survey and interviews with representatives of major ICT companies in Serbia. On the basis of this analysis, guidelines and recommendations are provided with respect to planning the future education of the workforce, in accordance with ICT sector needs.

Key characteristics and role of Serbia's ICT sector in the country's economy

Information and Communications Technology (ICT) has been Serbia's fastest-growing sector in the past three years, providing a basis for driving the growth of the country's digital economy. The sustained increase in demand for ICT-related products and services (primarily in the domain of software development) seen across all sectors of the economy, including the individuals and households segment, resulted not only in the creation of new jobs and occupations, but also the transformation of traditional ones. In 2017, Serbia's ICT sector generated a gross value added (GVA) that accounted for a minimum of 5% of the country's GDP. At the end of 2017, the contribution of the ICT sector was at the level of the agricultural sector, and definitely higher than the share of the construction, electricity supply or mining sectors. The share of the turnover at the level of the ICT sector, relative to the total turnover of the country's economy, stood at 5.8% at the end of 2017. This share is similar to that of the construction sector, and slightly higher than the share of the transportation and storage sector turnover. Taking into account the pivotal role of the ICT sector in Serbia's economic development, the education sector should take proper stock of the occupation profiles that have so far been recognized as fundamental for the normal functioning of the ICT sector. This is a very important issue, because it is imperative that educational (and economic) policy makers formulate new policies in connection with educational profiles and programmes that must meet the needs of the ICT labour market.

ICT sector employment trends

In upgrading secondary and higher education curricula, special attention must be devoted to the ICT sector workforce needs identified. Over 83% of all surveyed ICT companies in Serbia is anticipating an increase in the demand for ICT products and services in the forthcoming period, and this trend can be extrapolated to the demand for new employees in this sector. Furthermore, in the past year, most companies in the ICT sector (73%) have been recruiting employees specifically in jobs that are related to their core business, while less than half of the companies (45%) recruited new employees in non-core jobs.

A very small share of ICT companies (only 9%) believes that the practice of hiring unreported workers is present in the ICT sector. Usually, these are cases involving recruitment of workers multiple times through youth cooperatives (which is technically a grey area) in different administrative jobs not related to the company's core business. Although unreported employment has not been recognized as an issue in the ICT sector, **fiscal policy makers should consider introducing mechanisms to incentivize ICT companies to employ these unreported workers in the same way as workers in core ICT activities.**

Job complexity and skills requirements

Our analysis of the ICT sector workforce demand, by complexity of the jobs that employees in the sector are hired to perform in the company, reveals that ICT specialists of various profiles account for the biggest share of total employment in the ICT sector. Taking into account management posts in the ICT sector, which by default require specialist knowledge in the ICT activity segment, along with knowledge in the field of project coordination and management, the share of posts that require a high level of ICT skills reaches 67%. Furthermore, the ICT sector has a relatively sizeable segment of demand for occupations that are not strictly related to the sector's core activity, specifically, in non-core activities, such as human resources management, legal affairs, marketing and similar. This points to the **need for introducing multidisciplinary tracks and curricula (primarily at university level) to create educational profiles with knowledge in economics, management, as well as ICT skills, which is essential for Serbian ICT companies to increase their competitive advantage in the domestic and especially international**

market. This is very important because the biggest share of Serbia's ICT companies sell their products and services predominantly in the international market.

The dynamic of mastering the skills required to work in the ICT sector

Most of the surveyed companies reported that the average job induction period for new employees who have the qualifications required for the job stands at slightly over 4 months. However, in cases when a new recruit does not have the formal education required by the job (i.e. overqualified, with informal education in the field, and similar) the induction period automatically increases by additional 11 weeks. To shorten the period required to introduce future workforce to jobs in the ICT sector, the **existing dual education model in secondary schools should be developed further, and undergraduate work placements should be a mandatory part of the course of studies at universities, to be implemented in cooperation with ICT companies.** According to the companies' opinion, presently, the connection between the business sector, i.e. the practical needs of ICT sector companies, and the skills students acquire at college is missing. **A work placement programme would provide students with an opportunity to familiarize with new technologies and software applications (curricula are slow to adjust to these) and acquire skills related to the application thereof through practical work assignments in ICT companies.**

(Mis)match of labour market supply and demand

In Serbia, **the supply-demand mismatch in the ICT sector is considerably higher in the ICT specialist workforce relative to candidates applying for non-ICT jobs.** Specifically, 80% of surveyed companies reported having difficulties finding an adequate number of candidates who meet the requirements of ICT-related job openings in the companies. On the other hand, when it comes to non-ICT jobs, slightly over one third of the companies reported difficulties finding adequate candidates for the positions advertised. Company representatives attributed this difference to the effects of demand-side pressures, i.e. the growing demand for ICT specialists, a trend that has been present in the Serbian market in the past 5 to 7 years. This means that in the previous couple of years, the education system has not been able to meet the needs of the ICT sector. **Although, seemingly, there is a growing number of (mostly private) faculties and new ICT study courses on the market, there is a prominent shortage of adequate workforce, whose knowledge and skills in this field are at a satisfactory level.**

Skills match, by the qualification level

As regards gaps in the basic skills of professionals hired in jobs that are related to the company's core business, by qualification level, these gaps are not as pervasive among employees in jobs with a complexity level requiring medium-level qualification or further training, relative to occupations that require high-level qualifications. Among the latter, a large share of companies identified a lack of soft (social) skills among its staff, especially when it comes to candidates arriving directly from the education system or without any significant work experience. Inadequate work experience in the field was recognized as a shortcoming by one third of the companies in the survey sample, while a slightly smaller percentage reported an unsatisfactory level of job-specific and technical skills among their staff. **The lack of job-specific skills mainly refers to the employee's familiarity with new technologies on the market and, taking into account the fast-paced development of the ICT sector, this also poses a major challenge for the education system, which is traditionally slow in adjusting and changing.**

The need for work experience placements in the system of formal education of the ICT workforce

Employers from the ICT sector believe that the lack of technical skills of the workforce is a consequence of the poor level of practical training provided in formal education with regard to new programming languages, project-based work, or work with technical equipment. This is the reason why employers often impose no restrictions in the recruitment process, in terms of specific degree or field-of-study requirements for candidates applying for the job. Of course, this is not always the case. Large software companies still predominantly hire candidates with an academic degree in electrical engineering and programming (especially in positions with an intermediate and high level of complexity), although the programming segment of the ICT sector is probably the most flexible segment, in terms of not strictly recruiting candidates with completed formal education of a certain level and in the desired field of study. The mismatch between the needs of ICT sector companies and the educational profiles

prevalent in secondary schools and at universities is also confirmed by the fact that, in most occupations, two fifths of the companies opted for a qualifications level ranging from secondary education to an academic degree, while in the remaining occupations the expected qualifications level entailed completed academic-level education. This means that **the lack of a diploma is not necessarily an impediment for getting a job in an ICT-related position, and also the other way around**.

ICT fields that should be integrated into the curricula

Future educational profiles and curricula in ICT must put emphasis on new programming languages and project-based work which must incorporate multidisciplinary knowledge and, in particular, on training the workforce for occupations that require high-level qualifications for various types of engineers and project managers: network administrators, Web programmers, ERP consultants, software engineers, Android developers, integrated circuits design engineers, QA engineers, development of information systems, product managers, DevOps, and similar.

The field of study curricula should aim to shape a workforce that will be able to perform intermediate-to-high and high-level complexity jobs in the field of product/service development and design (creative designers, development of information systems, software developers, test engineers, iOS programmers, QA engineers, DB developers, development of services, integrated circuits design and similar) **or technical maintenance** (system administrators, network engineers, precise mechanics, network security engineers, technical support and similar).

The occupations in highest demand in the ICT sector are software engineers with different profiles. A significant share of companies reiterated that the profiles they currently most needed were developers specialized in PHP, Swift, JS, HTML, Kotlin, NET, C++ or C#. In addition to the shortage of workforce supply in the previously listed occupations, the second occupation in highest demand are ICT analysts. This profile is characterized by an even more prominent level of complexity as it requires knowledge of several disciplines. It includes various project development managers, data analysts, SAP consultants, IT auditors, business analysts and similar. **Career fields with the highest projected demand growth in the future period include a variety of specialist profiles in the field of machine learning, automation, virtual reality, artificial intelligence development, big data, cloud and neural networks analysis.**

The importance of informal education and further training

The mismatch between what the ICT sector needs and what the education system supplies is evident if we consider the fact that most ICT companies frequently require its new employees, recent graduates from secondary or tertiary education starting their first job, to undergo further training. **The trainings are often related to the technical, job-specific requirements that the education system cannot be expected to cover at the level of all profiles, but that could be integrated in the practical training segment and implemented at one of the study levels. The scope of practical training should correspond to the complexity of the specific job, as pointed out by company representatives, which is often not the case at present.**

The introduction of additional requirements related to obtaining licenses, certificates or permits required to work in some of the positions, can also be a potential obstacle to finding adequate candidates for the job. The largest share of companies does not report having these additional requirements for candidates applying for the job. The remaining companies, depending on the position in which candidates are being recruited, require various certificates. As a rule, companies will fund the training and licensing of candidates who lack the required certificate, provided that they meet all other requirements. **The development new curricula (at the secondary and tertiary education level) requires forging cooperation with institutions/companies providing trainings in specific ICT areas (use of software or equipment) in line with employer needs.** Staying on top of the ever-changing markets and new technologies requires employers to innovate their business, and the formal education system is not always able to keep adequate pace with these changes. This is why it is pivotal that the **formal education system increases its flexibility in this segment by offering students the opportunity to complete trainings in other institutions, or work placements in companies, and acquire certificates attesting that they have mastered the new skills in demand on the ICT labour market.**

Methodological coverage of the sector and companies in the sample

With a view to gaining a better understanding of the outlook of different ICT-related occupations, as a first step, we need to define what this sector entails. When analysing different occupations, typically, the term "sector" entails either an economic activity sector, or a skills/education sector. Typically, economic activity sectors are defined in accordance with the ISIC or NACE international standard statistical classifications.[1] In the case of skills, "sector" entails related knowledge and qualifications acquired through formal and informal/non-formal education, trainings and experience. A typical approach to the classification of skills in corresponding sectors is by applying the UNESCO ISCED-F system.[2] The possibility of observing the sectors from two different perspectives is also the first limiting factor, as there is no way to comprehensively define the sector, nor a standard classification that takes into account both the economic dimension and the characteristics of the workers' skills that can be identified with the sector's core activity. In July 2018, the Government of Serbia adopted a Decision on the Universal List of Codes for Entry and Coding of Data in Employment-Related Records, which includes, among other, a new list of occupation codes and list of qualification level codes.[3] With the enactment of this Decision, the method of classification of occupations in the relevant institutions has been aligned with the International Standard Classification of Occupations ISCO-08.[4] Since the new list of codes are not comparable with the previous ones, and their application started on January 1, 2019, the analysis of ICT-related occupations was carried out on the basis of available official data of the National Employment Service (NES) and the Central Registry of Compulsory Social Insurance (CROCSI) that keep records on employment/unemployment according to the Universal Occupations Nomenclature of 1990.[5]

Taking into account the aforesaid limitations, as well as the fact that an official methodology covering the entire sector has yet to be adopted, to clearly define the sector analysis approach for the needs of the Sectoral Councils in Serbia6, we decided that, to begin with, our report will examine the economic definition of the sector and then available data on occupation groups, according to the old occupations classification methodology. To enable international comparability, as a first step, the economic domain of the ICT sector was defined based on the OECD's latest revised methodology *International Standard Industrial Classification* (ISIC Rev. 4). Based on this definition, the ICT sector includes Sector C activities (codes 2611, 2612, 2620, 2620, 2630, 2640, 2680), Sector G (codes 4651 and 4652), Sector J (codes 5821, 5829, 6110-6209, 6311 and 6312) and Sector S (9511 and 9512).7 Based on the defined domain, we looked at ICT sector performance indicators at the level of the economy, and also at the internal structure level, according to different criteria.

As a source of economic indicators, we used the data of the Serbian Business Registers Agency (SORS), classifies companies by a four-digit code, down to the level of branch and group. This enabled us to disaggregate performance indicators for companies classified in the ICT sector according to the international classification, so that these data could be used to analyse the economic activity trends at the sector level. The same activity codes were used to select data from the CROCSI database on the total number of employees in the observed sector, as well as the number of new hires in a given year. Unlike the NES database, the CROCSI database also includes workers who were previously not registered as unemployed. Still, we should keep in mind that the CROCSI database covers only the formally employed in the sector, thus, the resulting values will always give an underestimation of the actual number of workers. We could hypothetically overcome this shortcoming if we analysed the Labour Force Survey (LFS) data, but the LFS in itself is not designed in such a way as to be representative at the level of the individual sectors and lower levels of classification,[8] which is the reason why it was not included as a source of data on total employment.

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1 https://unstats.un.org/unsd/publication/seriesM/seriesm_4rev4e.pdf and https://ec.europa.eu/eurostat/documents/3859598/5902521/KS-RA-07-015-EN.PDF

2 http://uis.unesco.org/sites/default/files/documents/international-standard-classification-of-education-fields-of-education-and-training-2013-detailed-field-descriptions-2015-en.pdf

3 RS Official Gazette No 56/18

4 https://www.ilo.org/public/english/bureau/stat/isco/isco08/

5 http://www.vps.ns.ac.rs/Materijal/mat6577.pdf

6 http://noks.mpn.gov.rs/sr_lat/sektorska-veca/

7 A detailed overview of activities, with activity codes, is provided in Annex A1.

8 This entails analysing the number of employed in a specific sector according to certain characteristics, such as the qualifications level, occupation group, and similar.

Supply and obstacles to employment were analysed using data on registered unemployment, employers' job orders and on the placement of job seekers from the NES register into employment. These data include only a part of the unemployed and employed in the ICT sector, since job seekers are not obliged to register with the NES, while those who took up employment and were not previously registered with the NES are also not included. The criterion we used for selecting unemployed/placements from the NES register whose occupation codes correspond to the ICT sector, were the occupation codes, which in the 2016-2018 period were still kept according to the old occupations classification methodology. In addition to the list of codes kept for this period, each worker registered in the NES (and CROCSI) database is classified on the basis of a six-digit number in which the first two digits indicate the education level, the second two digits the occupation group, while the last two digits are the occupation's order number in a specific complexity category in the individual group. To select the fields of occupation corresponding to the ICT sector, we selected all persons from the NES register who were classified into the groups, according to their field of study, (the second two digits of the occupation code)[9]:

- 24 – Energy technicians;
- 25 – Electro-mechanics technicians;
- 26 - Electricians;
- 27 - Occupations in telecommunications;
- 28 - Occupations in computer science;
- 60 - Occupations in PTT traffic;
- 69 - Information technology specialists and statisticians;
- 83 - Occupations in natural sciences and mathematics.

The occupation codes used in the report for the job seekers registered with the NES were determined on the basis of the highest completed education level, which should ensure that they reflect to a great extent the most prevalent skills fields in the ICT sector, defined in economic terms. The limitations of such an approach are that it neglects the part of the workforce supply consisting of unemployed or employed who are classified under other sectors according to their occupation code, but who could, technically, also apply for jobs in the ICT sector. This is particularly prominent in the case of employees with a basic education level who, as such, have no specific qualifications in a particular field of occupation. This means that, technically, they do not fall into a specific sector and that they can apply for all jobs that entail the lowest level of qualifications.

In addition, this approach focuses only on narrowly defined sectoral occupations whilst neglecting "support" occupations, such as workers in transport, maintenance, administration, lawyers, economists and similar, i.e. jobs that can often be critical for the sector's performance but are essentially non-core activities. The same approach to identifying workers in the ICT sector, by occupation groups, was applied to the CROCSI database, where, as a first step, data on workers were defined based on the company's core business, subsequently dividing the resulting database of workers into those whose occupation codes correspond to the ICT field of occupations (24-28, 60, 69 and 83).

For analysing the qualifications level of workers classified in the ICT sector according to one of the previously mentioned criteria, we used the data on the highest completed education level according to the National Qualifications Framework (NQF), by merging levels 6.1 and 6.2 into level 60, and levels 7.1 and 7.2 into level 70.[10] Thus, we practically obtained the same system of classification of qualifications levels applied under the European Qualifications Framework (EQF).

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9 http://www.vps.ns.ac.rs/Materijal/mat6577.pdf

10 Unlike the EQF, the NQF also recognizes levels 6.1, 6.2, 7.1 and 7.2, as a result of which we have a higher level of branching of Bachelor's and Master's programmes: 61 - two- to three-year higher education programmes according to the old programmes equivalent to the first university level (up to 180 ECTS) according to the new programmes, 62 - higher education with further specialization lasting up to one year according to the old programmes equivalent to basic academic studies or specialist vocational studies (up to 240 ECTS) according to the new programmes, 71 - basic academic studies according to the old programmes equivalent to master studies according to the new programmes, 72 - specialist and master's studies.

Sampling of companies

In addition to using secondary data on the ICT sector, we also conducted a survey to obtain additional information on the situation in this sector, in terms of the shares of various occupations and the workers' qualifications' structure breakdown, depending on the jobs they perform in this sector. At the first stage, we defined our approach to the sampling of companies. The basic data set from which the sample was taken consisted of 4,094 companies of which 86% were classified into the micro businesses entities category with an average number of 2 employees per registered business entity in this category. Workers in 511 small, medium and large enterprises registered in the ICT sector account for 83% of total employment in this sector. To determine the number of enterprises to be included in the survey sample, an individual weight was established for each of them, based on the ten broader groups, depending on the number of employees and company size. Taking into account the relatively small number of employees in the micro-sized business entities in some of the broader groups relative to the number of employees in large companies in the same groups, we introduced a minimum quota of one surveyed company from each of the ten broader fields and four size groups. Thus, initially there were 21 companies in the sample[11], while the sampling distribution of the remaining companies was accomplished using a weighting system, based on the relative size of the group, depending on the number of employees. Upon establishing that the survey could be conducted on a sample of around 100 business entities in the ICT sector, we created a matrix representing the number of companies to be included in the sample, with an additional restriction. Specifically, the first weighted matrix had a relatively high share of large companies, which is a consequence of a significantly larger number of employees in these companies, and of their high concentration in a small number of large companies. A total of 17 large companies are registered in the ICT sector, suggesting heterogeneity as regards size in the large corporations' group (here, we primarily refer to Telekom Srbija, which accounts for half of total employment in the large companies in the ICT sector). Although the initial weights distribution system suggested that we include 14 companies from the large size category from the broader "Retail Sale" segment, we introduced an additional restriction, of not more than 4 companies from the same broader segment, while at the same time increasing the number of micro, small and medium-sized enterprises to be included in the sample based on their individual weights, to offset the reduction in the number of large companies. In addition to the size of the companies, we also took into account that the individual broader segments be adequately represented according to the shares that employees in these groups have at the level of the micro, small, medium and large enterprises. Based on the foregoing two criteria, a matrix was drawn up to represent the shares of the companies from the various categories, with the assumption that 50 companies would be surveyed.

Table 1. Proposal for the sampling distribution of companies by size and broader activity segment

	Micro	Small	Medium	Large
Manufacture of computers, electronic and optical products	2	2	2	2
Trade in ICT	1	1	1	1
Telecommunications	2	2	3	4
Information technology activities	3	7	7	4
Information service activities	1	1	2	0
Computer repair	1	1	0	0

Source: FREN

Structure of sampled companies

Ultimately, 52 companies participated in the study, by means of a survey and interviews with company representatives, and due care was taken to retain the respective shares of micro, small, medium and large enterprises in the sample, based on the previously developed matrix. Thus, we ensured that all forms of complexities of the organization of production in the ICT sector are adequately covered. The breakdown of surveyed companies by size is presented in Table 2.

11 There are no registered companies in the broader segment of Information service activities. Companies that fall in the large category (over 250 employees), while in the Computer repair segment there are no registered companies that fall in the medium size category (51-250 employees).

Table 2. Companies' share in the sample, by size

Company size	Share
Micro	26%
Small	32%
Medium	28%
Large	13%

Source: FREN

On average, the number of years of activity of the surveyed companies stood at 14 years, while around one-fourth of the surveyed companies has been doing business for up to 5 years. These figures come as no surprise, considering the expansive growth of the ICT sector in the past few years. Nevertheless, the average period of activity suggests the presence of companies that have been going business in this sector for over a decade, long enough to point to certain patterns or new trends in the labour market and workforce supply. There are differences in the share the of dominant markets among the surveyed companies (Table 3).

A typical characteristic of ICT sector companies in Serbia is that a significant share of these companies predominantly sells their products and services in the international market, and the same goes for the companies that participated in the survey. Participation in the broader market allows for a greater degree of interaction between companies and different market participants, which in turn increases the amount of information these companies possess. This was especially addressed in the interviews conducted with representatives of companies in this sector, to compare their experiences with regard to other market participants.

Table 3. Dominant market of sampled companies

Company size	Share
Local	23%
Regional	18%
National	23%
International	38%

Source: FREN

To gain a better understanding of the sector's needs for existing or new profiles, we also took into account the views of the companies from the sample on their business performance in the previous 12 months and their projections regarding future demand. Data on past business performance can shed light on trends in the recruitment needs of companies in the previous period, while expectations about future needs are a potential indicator of future workforce demand. As shown in Table 4, only 9% of the companies from the sample are facing a decline in demand, almost all of these are micro businesses that operate exclusively on the local market, and have been present on the market for over 17 years, on average. As regards projections of workforce demand trends in the forthcoming period, companies in the sample are optimistic (even those that experienced a decline in demand in the previous period), thus, over 83% anticipates an increase in demand which, if materialized, can also be translated into demand for new employees. Of the remaining companies, only one had a negative stance regarding the expected trends in the demand for the company's services in the future period. This company is in the Repair of computers and peripheral equipment segment, which partially explains its negative projections regarding future business trends, taking into account that people are increasingly opting for replacement instead of repair, because of the drop in the price of consumer electronics.

Table 4. Demand in the previous 12 months and expectations for the next 12-month period for companies in the sample

	Demand in the previous 12 months	Demand in the next 12 months
Growth	65%	65%
Unchanged	26%	26%
Decline	9%	9%

Source: FREN

To additionally test our assumptions about the impact of business performance on workforce demand the companies were asked about new hires in the previous 12-month period in core activity positions (ICT-related), and as in non-core positions related to support activities in the company (finance, administration, marketing, human resources management and similar). It should be noted that, to get the full picture on the actual market demand, the question covered all recruitment of new employees, not only under open-ended or fixed-term contracts, temporary and occasional work contracts, but also through temporary-work agencies (staff leasing). Based on the respondents' answers to this question, which are presented in Table 5, we can see that 79% of sampled companies hired at least one worker in the past 12-month period in ICT-related jobs. Two-thirds of these companies hired up to 10 new employees, and the rest hired more than that, in a couple of cases even more than 80 employees. The number of new hires is usually proportionate to the company's size and the demand trends in the previous period, while this is not necessarily the case with other, non-core activities. A total of 45% of the sampled companies hired new staff in these activities, of which two-thirds hired up to ten new workers, while the rest had a higher hiring rate.

Table 5. Recruitment of new employees in ICT-related positions and in other, non-core positions

	ICT	Non-core positions
no new hires in these jobs	21%	55%
Up to 10 workers	51%	23%
11-20	13%	13%
21-40	8%	3%
41-80	3%	5%
Over 80 workers	5%	3%

Source: FREN

Companies were also invited to answer a question related to informal employment in "other" companies in similar business activities, considering that companies are not very likely to report their own practices of hiring workers without a contract. Regardless of the formulation of the question, only 9% of the surveyed companies reported that such practices were present, while only one company stated that these workers are usually hired under several short-term contracts through youth cooperatives (which is technically a "grey area" in this case) in various administrative jobs that are not related to the company's core activity.

To gain a better understanding of the workforce needs in the ICT sector, depending on the complexity of the jobs performed by these workers in these companies, the surveyed companies submitted an overview of the jobs structure divided into predefined groups. Based on their answers we can deduce that, as expected, most workers in the ICT sector are ICT specialists of different profiles (around 57%). Taking into account management posts in the ICT sector, which by default entail knowledge in the specific ICT activity segment, along with knowledge in project coordination and management, the share of posts that require high-level ICT qualifications reaches 67%. Other support activities (human resources management, legal department, marketing, and similar) account for 17%, which is an indication of the presence of a relatively sizeable segment of demand for staff whose competencies are not related to the core business. Another interesting thing about this sector is that 16% of the positions are reserved for other jobs, which usually entail sale of products and services, technical maintenance, transportation and similar, employing staff with qualifications outside the ICT sphere. Such a high percentage is a consequence of the sector structure which also comprises wholesale and retail trade in ICT goods and services. Thus, the analysis includes companies in which most employees are workers in sale, procurement and shipping of merchandise and similar.

INTRODUCTION

Information and Communication Technology (ICT) is undoubtedly one of the 20th century key innovations. ICT covers a wide range of technologies and products, including computer hardware, software, ICT services, as well as a set of other telecommunication functions. According to the traditional definition, the ICT sector is divided into two sub-sectors: Telecommunications and Information Technologies (IT). The IT sub-sector is further divided into three segments, which are hardware, software and services. The main reason for choosing this particular definition is that it provides a clear and simple overview of specific sub-sectors which have not yet converged in Serbia. The briefest description of the Serbian ICT sector would be: huge growth potential on a small base. The recovery of the global economy in the aftermath of the financial crisis of 2008 generated a great need for ICT specialists, and Serbian ICT specialists were recognized as competitive, in terms of quality and price, which led to the expansive growth of demand for these specialists in Serbia's workforce market.

Following the initial boom, the ICT still shows considerable potential for economic and employment growth in Serbia. Considering the sector's dynamic nature, the skills and knowledge of the workforce should keep pace. Human talent, combined with adequate skills will remain a pivotal factor in the diversification of the ICT sector. Serbia's ICT sector is progressively advancing, along with innovations and products that require human resources with specialized skills. To be productive and industry-ready, human transformation requires a multipronged radical reform. The acquisition, retention and further development of talent is a daily challenge for human resources in most companies, all because of the scarce resources that the private and public sectors invest in human capital. Employer demand for skilled workforce will continue to be globally present in a competitive market and this is why adequately skilled and qualified professionals should be given the opportunity to prepare to meet this demand, in sufficient numbers, through adequate education and trainings.

The ICT sector is a driver of innovation in the business and public sectors. Serbia's economic development strategy prioritizes ICT and the comprehensive digitalization of the business sector and public services. This imposes the need for understanding this sector's impact on demand for future skills, for the introduction of rapid and decisive changes in the life-long learning segment and for securing adequate training, including efficient cooperation with companies, all with the aim of bridging the skills gap. Understanding the skills demand requires a constant flow of information between companies, public administration, formal education system, and training providers. Clustering at the geographical and sectoral level, within the national framework, can help bridge that gap between the demand and supply of specific skills.

While there are several factors contributing to the mismatch between the skills acquired by secondary school/university graduates and the skills requirements of the private sector, some of the key challenges employers face when recruiting recent graduates include outdated curricula, in combination with lack of social skills, personal awareness, and experience in global technological trends, accompanied by almost no practical experiences.

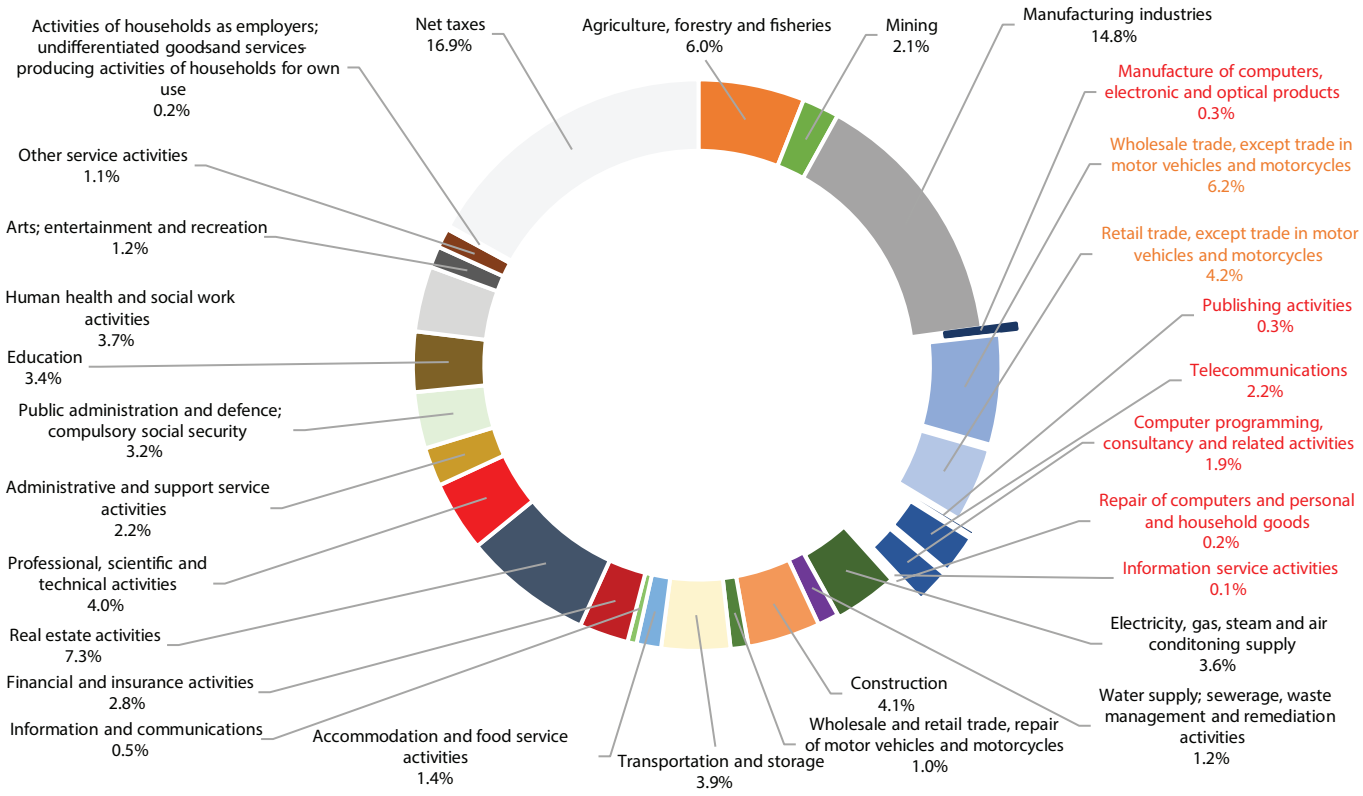
An increasing number of small and medium enterprises is registering the need for employees with advanced technical skills and practical experience. The lack of qualified and experienced developers and certified specialist staff is continuously hindering their efforts to increase the number of services and expand their client base.

At the same time, the "brain drain" to neighbouring countries poses yet another challenge for local ICT companies in their efforts to retain qualified workforce. Consequently, we need concerted efforts and coordination between the private, public and academic sectors – whose role is pivotal in bridging the gap between the skills graduates acquire and the business sector requirements – whilst keeping a focus on improving their skills and competencies in line with leading global trends and sector-specific needs.

1. Overview of the ICT sector

Looking at the share of Gross Value Added (GVA) in the Gross Domestic Product (GDP), by economic activity in Serbia, in 2017, the contribution of the ICT sector is, to some extent, blurry because of the impossibility to monitor the GVA down to the level of branches (identified by three-digit numerical codes) and groups (identified by four-digit numerical codes). Official data of the Statistical Office of the Republic of Serbia monitor the aforementioned indicator down to the level of divisions (identified by two-digit numerical codes), which is why we cannot accurately encompass the value added of the ICT sector as a percentage of the GDP. Still, with some reservations concerning the share of trade in computer equipment, software, electronic and telecommunications parts in total Wholesale and retail trade, except of motor vehicles and motorcycles, we can conclude that the ICT sector GVA accounts for a minimum 5% share of Serbia's GDP. The maximum possible value of 15% is really overrated due to the much bigger contribution of Wholesale and retail trade in foods, clothes, footwear and other products[12]. Considering the share of other sectors in Serbia, we can conclude that the ICT sector's share is probably similar to the level of the Agriculture, Forestry and Fisheries sector of around 6%, and definitely greater than the share of Construction (4.1%), Electricity, gas and steam supply (3.6%) or Mining (2.1%). This finding can be additionally corroborated by an approximate indicator, in the form of the ICT sector turnover share relative to Serbia's total turnover, which stood at 5.8% at the end of 2017. This is similar to the 6.1% share of the Construction sector turnover, and slightly higher than the Transportation and Storage sector turnover accounting for 5.5% of the country's total turnover.[13]

Chart 1. Share of ICT sector GVA in GDP, by activity, Serbia, 2017



Source: Statistical Office of the Republic of Serbia

12 https://data.stat.gov.rs/Home/Result/0902010301?languageCode=sr-Cyrl

13 Statistical Yearbook of the Republic of Serbia – 2018, Statistical Office of the Republic of Serbia

1.1. SORS data on registered businesses and employment in the ICT sector

A total of 4,544 registered companies and sole proprietors with 43,164 employees were registered in Serbia's ICT sector in 2017. A breakdown by status shows that the biggest number of these (4,107) are active companies and sole traders employing 42,679 workers, while the rest are companies and sole proprietors who are either in bankruptcy, in liquidation, or deleted from the register. In other words, almost 90% of total registered companies and sole traders in the ICT sector actively operates with almost 99% of total employed workers in the sector.

Table 6. Total number of registered companies and sole traders in the ICT sector with number of employees, by status of the legal entity at the end of 2017 (%)

	Number of companies/sole proprietors		Number of employees	
Status	in absolute terms	%	in absolute terms	%
Active	4,094	90.1	42,679	98.9
In bankruptcy	28	0.6	0	0.0
In forced liquidation	7	0.2	5	0.0
In liquidation	220	4.8	153	0.4
Deleted	182	4	298	0.7
Blocked account	13	0.3	29	0.1
Total	4,544	100	43,164	100

Source: SORS

To avoid the negative impact of data on companies with problematic statuses (in bankruptcy, in liquidation, and similar) on the findings concerning the characteristics of companies and sole proprietors registered in the ICT sector, we will just analyse the data on active companies in this sector. A breakdown by size shows that 87.5% of a total of 4,094 active companies and sole traders are micro companies employing around 16.9% of the total workforce in the sector. The remaining 12.5 % of the total number of active companies are small, medium and large companies, which employ the remaining 83.1% of workers. It is noteworthy that 0.4 % of active companies in the ICT sector are large companies that employ almost 38.6% of the total number of workers in the sector. Furthermore, around 2.3% of companies in the medium-sized category employs around 23.7% of the total workforce in active ICT sector companies.

Table 7. Active ICT sector companies with number of employees, by size, at the end of 2017

	Number of companies/sole proprietors		Number of employees	
Size	in absolute terms	%	in absolute terms	%
Micro (up to 10 employees)	3,583	87.5	7,225	16.9
Small (11-50 employees)	398	9.7	8,887	20.8
Small (51-250 employees)	96	2.3	10,108	23.7
Large (over 250 employees)	17	0.4	16,459	38.6
Total	4,094	100	42,679	100

Source: SORS

The ICT sector comprises 24 individual branches, subsequently classified into 7 domains, for simplification reasons, based on the similarities they share, as well as in line with the suggestions of the ISIC rev. 4 methodology that we used to initially define the sector's make-up. The largest share of companies/sole proprietors is registered in the segment of Information technology activities, numbering over half of the total registered entities in the sector. Manufacture of computers and optical products accounts for the second largest share with 14.5% of total registered companies in the sector, while the rest of the companies are evenly distributed among the remaining larger segments, with the exception of Leasing and licensing of computer software, which comprises only 20 companies, i.e. 0.5%. As regards the breakdown of the segments by number of workers, and by number of registered companies/sole proprietors, Information technology activities dominate with a share of 42.7% in total employment. This segment is directly followed by the branches classified under the Telecommunications segment, employing 36.3% of the total workforce in the ICT sector. Employers in the Computer repair segment account for the smallest share of total employment in the ICT sector (slightly over 1.5%).

Table 8. Active business entities registered in the ICT sector, with number of employees, by activity branch and segment, at the end of 2017

Activity branch	Number of companies/sole proprietors	Number of employees	Activity segments
Manufacture of electronic elements	54	700	Manufacture of computers, electronic and optical products
Manufacture of loaded electronic boards	3	88	
Manufacture of computers and peripheral equipment	424	2,654	
Manufacture of communication equipment	77	437	
Manufacture of consumer electronics	36	196	
Manufacture of magnetic and optical media	1	0	
Wholesale trade in computer hardware and software	116	577	Trade in ICT
Wholesale of electronic and telecommunications equipment and parts	86	169	
Retail sale of telecommunications equipment in specialized stores	46	333	
Retail sale of computers, peripheral units and software in specialized stores	35	1,144	
Publishing of computer games	4	138	
Publishing of software	16	144	
Wired telecommunications activities	270	13,623	Telecommunications
Wireless telecommunications activities	57	1677	
Satellite telecommunications activities	4	27	
Other telecommunications activities	42	159	
Computer programming activities	1,755	15,409	Information technology activities
Information technology consultancy activities	361	1,791	
Computer facilities management activities	17	140	
Other information technology services	156	911	
Data processing, hosting and related activities	129	1,334	Information service activities
Web portals	137	378	
Repair of computers and peripheral equipment	235	626	Repair of computers
Repair of communication equipment	33	24	

Source: SORS

A breakdown of these groups by size confirms the pattern observed at the level of the entire sector that the biggest share of entities falls into the micro-sized entities' category. Depending on the segment observed, the share of micro entities ranges from the lowest on record, 84% in Telecommunications, to a high 97% in the Computer repair segment, as expected, considering that the activities in this sector typically involve small service shops. The number of business entities classified in the small-sized companies' category account for a mere 9.7% of total registered active entities in the sector, most of which are in the Telecommunications segment and in the Information technology activities segment, with a share of 10% and 11%, respectively, relative to their group. This number declines further as we move toward the medium-sized and large companies. At the level of all segments, there are 96 medium and 17 large enterprises. Companies that employ 250+ workers are present in only four of the segments and half of them are in Telecommunications (8), while 6 are registered in the Information technology activities segment.

Table 9. Number of active business entities in the ICT sector by activity segment and size, at the end of 2017

ACTIVE COMPANIES/SOLE PROPRIETORS BY ACTIVITY SEGMENT AND SIZE					
	Micro	Small	Medium	Large	Total
Manufacture of computers, electronic and optical products	525	56	12	2	595
Trade activities in ICT	274	22	6	1	303
Telecommunications	313	38	14	8	373
Information technology activities	1,969	259	55	6	2289
Information service activities	242	15	9	0	266
Computer repair	260	8	0	0	268
Total	3,583	398	96	17	4,094

Source: SORS

If we look at the number of employees in companies disaggregated by size, as previously mentioned, micro-sized companies account for the smallest share of employment (around 17% of the total employment in the sector). Since the number of micro entities, same as in other sectors, is several times higher than the number of small, medium and large enterprises, by comparing their number with the number of workers, we arrive to an average of 2 employees per registered company/sole proprietor in this size category. The average number of employees in small enterprises stands at 22 at the level of the sector, while medium-sized companies have 105 employees, on average. In the case of large corporations, and there are only 17 of them at the level of the ICT sector, the average number of workers reaches 968.

By company type, limited liability companies account for the largest share (91.4%), and employ around 74% of the total number of employees in the sector. There are only 12 joint-stock companies in the sector (around 0.3%), employing almost 20% of the total number of workers at the sector level. The reason for such a high share of employment in this category is that practically only one of these joint-stock companies, Telekom Srbija, employs almost 8 thousand people. The remaining 11 joint-stock companies, are disaggregated as follows, by company size: four companies fall into the micro-size category (up to 10 employees), four into the small-size category (from 11 to 50 employees), and the remaining three fall into the medium-sized category (from 51 to 250 employees).

Table 10. Number of active business entities in the ICT sector by company type, at the end of 2017

Company type	Number of companies/ sole proprietors	Share in ICT sector (%)	Number of employees
Joint stock company	12	0.29%	8,323
Limited liability company	3,743	91.40%	31,776
Public enterprise	6	0.15%	961
Sole proprietor	275	6.72%	470
Foreign company branch	37	0.90%	1,115
Limited partnership	6	0.15	6
Partnership	11	0.27	20
Public joint-stock company	1	0.02	1
Cooperative	3	0.07	0
Closed joint-stock company	1	0.02	7
Total	4,094	100.00%	42,679

Source: SORS

1.2. SORS data on financial performance indicators for business entities in the ICT sector

An analysis of financial performance indicators of active business entities in the ICT sector indicates that the highest assets value was found in the business entities operating in the Telecommunications segment. Again, this can be explained by the high share that Telekom Srbija has in this group. The situation is similar in the business revenues category, where the same corporation generates almost 40% of revenues in this activity segment, i.e. over 18% of total revenues of active business entities in the ICT sector. By assets and business revenues, the segments of Information technology activities, and Manufacture of computers, electronic and optical products account for 14.9% and 8.6% of total assets in the observed segments, respectively, and for 25% and 18%, respectively, of business revenues generated by 4,094 entities in the ICT sector in 2017.

Table 11. Financial performance indicators of active business entities in the ICT sector by activity segment, at the end of 2017

	Number of companies/sole proprietors	Number of employees	Total assets (RSD, millions)	Business revenues (RSD, millions)
Manufacture of computers, electronic and optical products	595	4,075	47,607.76	83,198.49
Trade in ICT	303	2,505	16,650.50	36,309.01
Telecommunications	373	15,486	394,013.30	212,850.50
Information technology activities	2,289	18,251	81,958.73	116,710.10
Information service activities	266	1,712	7,412.03	12,429.98
Computer repair	268	650	2,647.52	3,088.23
Total	4,094	42,679	550,289.87	464,586.24

Source: SORS

If we look at the profitability of active business entities in the ICT sector at the close of 2017, we see that over 71% of sector companies operated with a net profit, i.e. 2,813 of 4,094 in total. At sector level, the net profit amounted to 43.6 billion dinars, of which the highest share was accounted for by the Telecommunications with, once again, Telekom Srbija generating 46% of the total profit at the group level, and 33%, at the level of active business entities in the ICT sector at large. If we look at the sector at large, Information technology activities ranked second with a net profit of RSD 8.1 billion, followed by Manufacture of computers, electronic and optical products with a total net profit of RSD 2.8 billion. The total loss of ICT sector companies amounted to RSD 2.9 billion and is dominantly concentrated in Information technology activities (over 50%). This loss is attributable to the combined losses of four companies in the Computer programming segment and Computer consultancy services segment. In the Telecommunications sector, 82 companies closed the year with a net loss, with practically two companies accounting for the highest share of loss (54%) at the level of the broader group.

Table 12. Profitability of active business entities in the ICT sector by activity segment, at the end of 2017

	Number of companies operating with a profit	Profit in millions RSD	Number of companies operating with a loss	Loss in millions RSD	Number of companies operating at the break-even point	Net profit	Net profit margin rate[14]	ROA[15]
Manufacture of computers, electronic and optical products	417	2,918.74	119	417.25	59	2,501.49	3.01%	5.25%
Trade in ICT	215	1,012.85	71	91.70	16	921.15	2.54%	5.53%
Telecommunications	239	32,048.72	82	484.79	52	31,563.93	14.83%	8.01%
Information technology activities	1,618	9,672.20	484	1,606.65	187	8,065.55	6.91%	9.84%
Information service activities	148	630.80	85	209.92	33	420.88	3.39%	5.68%
Computer repair	176	153.73	72	57.10	20	133.73	4.33%	5.05%

Source: SORS

14 Net profit/business revenues

15 Net profit/assets

The net profit margin rate, which shows the ratio of net profits to business revenues, is set at 9.39% at the level of the entire sector, and is the highest in the Telecommunications segment at 14.83%, at the group level. The net profit margin rates for the other segments are below the average for the sector, due to the significantly higher net profit margin rate in the Telecommunications segment. Nevertheless, Information technology activities also have a prominent share relative to other segments, with a net profit margin rate of 6.91%. The return on assets (ROA), which is the percentage of profit a company earns relative to its overall assets, is set at 7.92% at the sector level, with the highest ROA in the Information technology activities segment. In this case, the Telecommunications segment ranks second, and its ROA index is below the net profit margin rate, which suggests that companies in this segment require a substantial amount of fixed assets to perform their core activity and generate profit, which is not the case with other ICT segments.

2. ICT sector labour market

2.1. CROCSI data on formal employment

Data on new formally employed persons in companies whose core business is related to the ICT sector are shown in Table 13, by level of education. The first figure is the number of workers with no more than one record in the CROCSI database related to the start of employment with one of the sector companies in the observed year, while the other figure is the total number of records in the CROCSI database related to the start of employment relationship in the observed companies. The total number of records is technically always higher because it includes workers who were either promoted several times in the course of the year, or changed position within the company for technical reasons, or were hired several times under short-term contracts due to the specific nature of the job. Still, the total number of all records on new employment also contains information on employees who were transferred from one job to another due to the objective need for that particular job, which provides us with an insight into the demand trends in the given sector. Because of that, the data on the number of newly employed workers with a single record, and the total number of records, represent the lower and upper threshold, respectively, of the new demand for workers in the ICT sector. In 2018, the number of new employees with a single record increased by 21% relative to the previous year, while the growth rate of the total number of records stood at 4%. A breakdown by education level shows that 50% of newly employed workers is engaged in jobs that require a secondary school degree, while 39% of new employees is hired in jobs that require minimum qualifications level five or above.

Table 13. New hires in the ICT sector, by education level, 2016-2018

Education level	2016		2017		2018	
	single	total	single	total	single	total
10	140	176	165	193	242	266
20	75	217	89	123	88	109
30	789	1,221	869	1,237	967	1,309
40	5,137	6,345	5,298	7,829	7,129	8,354
50	48	65	101	142	72	91
60	870	1,060	1,054	1,416	1,136	1,357
70	3,853	4,946	4,286	5,559	4,380	5,627
80	6	6	15	15	15	17
Unknown	0	0	0	0	0	0
Total	10,918	14,036	11,877	16,514	14,312	17,130

Source: CROCSI

The figures on new formal employment in companies whose core business is related to the ICT sector are shown in Table 14, by ICT sector activity segment and age. In 2018, total employment in the ICT sector amounted to 57,396 employees. A major concentration of the workforce is found in two ICT sector segments, considering that the Information technology activities and Telecommunications segments employ around 50% and 30% of the total number of workers in the ICT sector, respectively.

Workers aged 30-54 years dominate in the age structure with a 72% share of the total number of workers. The number of workers over the age of 60 years, who in the next five-year period, approximately, are expected to leave the sector due to old-age retirement, stands at 1,317, i.e. a mere 2.3% of all employees in the ICT sector. The most favourable age structure, with an above-average share of workers below the age of 30 years is typical of the Information technology activities and the Trade activities in ICT segments.

Relative to 2017 (Annex A3), the total number of employees in the ICT sector increased by slightly less than 11%, as a result of the increase in the number of employees across all segments of this sector. The age structure did not change significantly in the observed period, aside from a slight increase in the share of workers below the age of 30 years.

Table 14. Number of workers in the ICT sector, by company activity and age group, average for 2018

ICT sector activity segment	Age group					Total
	Up to 24	25-29	30-54	55-59	60+	
Manufacture of computers, electronic and optical products	215	383	3,227	369	197	4,391
Trade activities in ICT	335	619	2,195	57	41	3,247
Telecommunications	448	980	13,148	1,758	491	16,824
Information technology activities	1,939	5,753	19,741	637	388	28,458
Information service activities	115	409	1,752	155	109	2,540
Computer repair	87	154	1,464	141	92	1,937
Total	3,139	8,297	41,526	3,116	1,317	57,396

Source: CROCSI

Data on the gender ratio, presented in Table 15, indicate that the ICT sector is dominated by men, who account for two-thirds of the workforce in the entire sector. This ratio is particularly prominent in the Computer repair segment, in which men account for almost three-fourths of the workforce. On the other hand, a balanced gender ratio is only found in the Information service activities segment. The sector's gender ratio did not change significantly relative to 2017 (Annex A4).

Table 15. Number of workers in the ICT sector, by company activity and gender, average for 2018

ICT sector segment	Sex		Total
	Male	Female	
Manufacture of computers, electronic and optical products	2,782	1,609	4,391
Trade activities in ICT	1,930	1,317	3,247
Telecommunications	10,396	6,428	16,824
Information technology activities	19,836	8,621	28,458
Information service activities	1,278	1,262	2,540
Computer repair	1,415	522	1,937
Total	37,637	19,759	57,396

Source: CROCSI

Table 16 shows the breakdown of workers in individual ICT sector activity segments, by education level, in 2018 (the number of employed, in absolute terms, are provided in Annex A5). The ICT sector typically has a very high share of workers with technical college and university degrees, relative to other sectors of the economy. Thus, workers with a technical college degree account for around 44% of the workforce employed in this sector. This share was estimated under the realistic assumption that the educational structure of employed in the "unknown" category corresponds to that of other workers, for whom data on professional qualifications are available. A particularly high share of employed with technical college and university degrees is present in the Information technology activities segment (61.3%). Data for 2017 and 2016, presented in Annex A6a and A6b, indicate that the structure of employed by education level has not significantly changed, except for a slight increase in workers with technical college and university degrees.

Table 16. Number of workers in the ICT sector, by company activity and education level, average for 2018

ICT sector activity segment	Qualifications level[16]									Total
	10	20	30	40	50	60	70	80	Unknown	
Manufacture of computers, electronic and optical products	3.4	1.1	16.1	42.3	0.5	6.8	17.1	0.1	12.5	7.7
	0.7	0.9	6.7	69.8	0.4	4.4	13.5	0.0	3.6	5.7
Telecommunications	1.1	0.5	9.3	48.2	1.5	5.5	16.9	0.0	16.9	29.3
Information technology activities	1.0	0.2	1.4	29.7	0.5	8.9	42.5	0.3	15.6	49.6
Information service activities	1.2	0.5	3.6	48.2	1.2	6.4	25.3	0.3	13.4	4.4
Computer repair	2.6	0.8	11.9	48.6	1.1	4.5	5.1	0.1	25.3	3.4
Total	1.3	0.4	5.6	39.8	0.8	7.2	29.4	0.2	15.3	100.0

Source: CROCSI

We also analysed the extent to which actual qualifications of workers in the ICT sector match job qualifications requirements (Table 17). The data required for this analysis were available for around two thirds of the total number of employed in the sector. These data include the job title, the professional qualifications required for the job and the actual qualifications of the employee in that job. The term "overqualified workers" refers to workers who have a higher education level than is required for a particular job. On the other hand, "underqualified" refers to workers who have a lower qualifications level than is required for a particular job. According to the CROCSI database, "overqualified workers" are defined as those whose formal qualifications level is higher than the qualifications level required for the job by more than one qualifications level, according to the NQF[17].

Workers with an adequate level of qualification that corresponds to the job requirements account for 73% of all employed in the ICT sector. On the other hand, the share of overqualified workers stands at 14%, while underqualified workers account for a 13% share. Relative to the previous two years (Annex A7a and A7b), the share of workers with an adequate qualifications level has seen a decline by one percentage point. A breakdown by ICT sector segments reveals that the highest share of overqualified workers is found in the Information service activities, approximately one-fourth of the workforce, and Trade activities in ICT, where around 22% of employed have a relatively higher education level than required for the job. On the other hand, an above-average share of underqualified workers is found in the Information technology activities segment (slightly over 17%).

Table 17. Job qualifications requirements versus workers' qualifications level in the ICT sector, December 2018

ICT sector segment	Employed, in total	Share of employed for which data are available	Overqualified workers	Underqualified workers	Workers with an adequate qualifications level
Manufacture of computers, electronic and optical products	4,540	3,060	464	331	2,265
Trade in ICT	3,448	3,054	669	275	2,110
Telecommunications	16,890	9,612	1,547	888	7,177
Information technology activities	30,691	20,441	2,052	3,400	14,989
Information service activities	2,798	1,926	506	249	1,171
Computer repair	1,976	1,073	145	137	791
Total	60,343	39,166	5,383	5,280	28,503

Source: CROCSI

Across the entire ICT sector, slightly over half of the jobs requires ICT-related qualifications (Table 18). The highest share of jobs requiring ICT-related qualifications is found in the Information technology activities segment (around 62%). On the other hand, in the Trade in ICT segment, a mere 9% of jobs requires ICT-related qualifications.

16 The qualifications level includes the following categories: 10 – first level (unskilled workers), 20 – second level (semi-skilled workers), 30 – third level (skilled workers), 40 – fourth level (workers with four-year secondary education), 50 – fifth level (highly skilled workers), 60 – sixth level (workers with a technical college degree), 70 – seventh level (workers with a higher education degree), 80 – eighth level (workers with a postgraduate doctoral degree).

17 http://noks.mpn.gov.rs/sr_lat/uporedna-tabela-nivoa-kvalifikacija-i-vrsta-obrazovanja/

Around 63% of workers employed in jobs that require ICT-related qualifications have adequate qualifications, i.e. training/education in the field of ICT. This share has seen a decline in December 2018 relative to December 2017, when it stood at 65% (Annex A7). In the Information technology activities and Telecommunications segments, which have the biggest absolute number of jobs that require ICT-related qualifications, the matching ratio with adequately qualified staff is above the average, ranging up to 70%.

A share of workers with ICT-related qualifications are employed in jobs that require qualifications from other fields of study. Of the total number of jobs that require qualifications from other fields, 15% are filled with workers with an ICT-related education.

Table 18. Workers in the ICT sector who have ICT-related qualifications, December 2018

ICT sector activity segment	Employed, in total	Share of workers for which data are available	Jobs requiring ICT-related qualifications		Jobs requiring other types of qualifications	
			Total number	Share of total number with ICT-related qualifications	Total number	Share of total number with ICT-related qualifications
Manufacture of computers, electronic and optical products	4,540	3,060	1,534	707	1,526	281
Trade in ICT	3,448	3,054	269	164	2,785	439
Telecommunications	16,890	9,612	4,647	3,175	4,965	762
Information technology activities	30,691	20,441	12,716	8,062	7,725	1,183
Information service activities	2,798	1,926	635	245	1,291	95
Computer repair	1,976	1,073	351	236	722	89
Total	60,343	39,166	20,152	12,589	19,014	2,849

Source: CROCSI

2.2. NES data on placement of registered jobseekers

Potential demand for workforce in the ICT sector can partly be assessed based on data on the number of persons who were registered as unemployed with the NES, and who were placed into employment, i.e. with respect to whom confirmation of obligatory social insurance registration was received. However, these data are an underestimation of the actual workforce demand in the ICT sector, for two reasons. First, they only include formally employed workers, resulting in a lower total number of employed in the sector. This is also a drawback of the CROCSI database, however, considering the low level of informal employment in this sector, we are of the view that this factor does not have a significant impact on the assessment of the actual demand in the ICT sector. The second reason why these data do not reflect actual sector needs is that any new hires who were previously not on the NES unemployment register are also not included in these records. An additional challenge is capturing data on workers with the lowest level of qualifications whose field of occupation is classified under the ICT sector.[18] In fact, according to NES practices, the occupation code assigned to each worker is determined based on the field in which the worker has the highest completed education level, while workers with the lowest education level are either classified in one of the occupation fields based on their previous work experience, or in the general group 109900 – Persons without occupation and qualifications. As the codes selected to define sector occupations classify workers in the Agribusiness sector either by field of education or previous experience, we must bear in mind that a large share of workers with the lowest education level (persons without occupation and qualifications), who could potentially be part of the supply in this sector, are not represented in the following segment.

Data in Table 19 show the number of employed with ICT-related occupations in the 2016-2018 period, by level of education. Taking into account that, as previously explained, these data do not include all new hires, we can conclude that the minimum annual demand stands at around 23,000 workers. Also, the trend in the total number of placements from the NES register in the observed period is registering a constant decline in the number of placements. Around three quarters of job seekers registered with the NES placed into employment has secondary-level qualifications (three-year and four-year secondary education), while a 15% share is highly educated.

18 For a more detailed explanation about the classification of workers in fields of ICT-related occupations, please refer to the methodology section.

Table 19. NES placements of job seekers with ICT-related occupations, by qualifications level

Qualifications level	Total number, at annual level		
	2016	2017	2018
10	2	3	0
20	111	114	94
30	6,039	5,982	5,183
40	12,730	12,683	11,890
50	247	222	182
60	2,031	2,020	1,860
70	3,953	3,732	3,495
80	23	21	24
Total	25,136	24,777	22,689

Source: NES

A breakdown by basic occupation groups classified into the ICT sector reveals that the biggest share of employed is registered in groups of occupations in science and mathematics (28%), Electro-mechanics technician (22%), energy engineers (18%) and occupations in computer science (14%). Also, there is an evident declining trend in the number of placements in all six occupation groups in the period from 2016 to 2018.

Table 20. NES placements of registered job seekers with ICT-related occupations, by occupation

Jobs in the ICT sector	Total number, at annual level		
	2016	2017	2018
24 - Energy technicians;	4,828	4,760	4,112
25 - Electrical Mechanics;	5,611	5,629	4,948
26 – Electronics Technicians;	2,338	2,155	1,952
27 - Occupations in Telecommunications;	891	867	741
28 - Occupations in Computer Science;	3,354	3,370	3,127
60 - Occupations in PTT traffic;	269	312	280
69 - Information Technology Specialists and Statisticians;	1,507	1,485	1,277
83 - Occupations in Natural Sciences and Mathematics.	6,338	6,199	6,252
Total	25,136	24,777	22,689

Source: NES

The 55+ cohort accounts for the smallest share in the age structure of job seekers registered with the NES placed into employment, (only 7% in 2018). On the other hand, there is no significant difference in the number of placements from the 15-29 and 30-54 cohorts. The trend of decline in the absolute number of job seekers registered with the NES placed in employment at the level of the entire sector is present in the 15-29 and 30-54 age groups. On the other hand, there is an evident annual increase in the number of employed over the age of 55 years (Table 21).

Table 21. NES placements of registered job seekers with ICT-related occupations, by age

Age group	Total number, at annual level		
	2016	2017	2018
15-29	12,275	11,597	10,328
30-54	11,607	11,596	10,677
55+	1,254	1,584	1,684
Total	25,136	24,777	22,689

Source: NES

In the 2016-2018 period, around 40% of placements from the NES register is found in the following occupations: computer service technician, energy technician, exact sciences/mathematics secondary school graduate, auto electrician, electrician, electronics technician and Electro-mechanics technician (Table 22). Other occupations all have a share of less than 4%, respectively, in the total number of placements from the NES register.

Table 22. NES placements of registered job seekers with ICT-related occupations, by specific occupation

Occupation code	Occupation title	Average annual number of placements, 2016-2018	Share in total number of placements in the ICT sector
402800	Computer service technician	1,892	7.82%
402400	Energy technician	1,844	7.62%
408300	Exact sciences/mathematics secondary school graduate	1,572	6.50%
302564	Auto electrician	1,352	5.59%
302431	Electrician	1,071	4.43%
402600	Electronics technician	1,044	4.31%
302500	Electro-mechanics technician	982	4.06%
Total for occupations with the biggest share		9,757	40.33%

Source: NES

2.3. Data on employer recruitment needs reported to the NES

In addition to data on NES placement of registered job seekers, data on employer requests for job matching services received by the NES (job orders) can also serve as an indicator of workforce demand in the ICT sector. This figure, too, is an underestimation of the actual demand, because employers are not obliged to recruit through the NES, they can also opt to use private employment agencies or in-house recruitment, which means that the actual recruitments needs are higher.

In 2018, recruitment needs reported by employers in the ICT sector stood at 842 workers (Table 23). According to NES data, 47% of total notified job openings were filled by workers registered as unemployed with the NES, with cancellation of job orders and lack of knowledge and skills of candidates in the required occupation being the key reasons reported by the NES for failing to meet the remaining recruitment needs. When we compare the number of placements with the number of job matching services, the NES placement success rate in 2018 stood at the level of 41%, with the lowest success rate in Telecommunications (27%) and the highest in the Computer repair segment (70%). Half of the job orders concerns jobs in companies classified in the Information technology activities segment (programming, consultancy services in ICT, management of computer equipment). If we consider the strong growth of this sector in the previous period, it is evident that the NES data do not reflect real demand for workers in the sector, nevertheless, they may give us an indication of the demand for positions that employers are not able to fill through the primary employment channels, despite the currently favourable working conditions (flexible working hours, high average salary, various bonuses, etc.).[19]

Relative to 2017, the number of job orders slightly increased, but the interesting thing is that it is still lower than in 2016 (Annex A9a and A9b). In comparison with the previous two years, in 2018, the number of job orders is lower in almost every segment of activity in the ICT sector, except Information technology activities, where we see an increase in the total number of job orders by 65% relative to 2017, but only 14% relative to 2016.

Table 23. Requests for job matching services by ICT sector employers, 2018

ICT sector activity segment	Number of employees required	Number of placements	Number of job matching services	Success rate
Manufacture of computers, electronic and optical products	89	60	120	50%
Trade in ICT	78	41	88	47%
Telecommunications	172	56	204	27%
Information technology activities	421	185	465	40%
Information service activities	48	26	49	53%
Computer repair	34	30	43	70%
Total	842	398	969	41%

Source: NES

19 These channels entail in-house recruitment, public vacancy notices, employment agencies and platforms, hiring students in the final year of studies, and similar.

A breakdown of jobs, in respect of which job matching services were requested by employers from the NES, by education, in 2018, is presented in Table 24. In 80% of cases, jobs in which employers recruited entailed minimum secondary education, while the demand for occupations entailing post-graduate degrees was also in relatively high demand (31%). In comparison with the structure of job requirements from 2016 and 2017 (Annex 10a and A10b), we see an increase in the demand for occupations corresponding to the fourth level of qualifications while, in parallel, the demand for occupations that entail higher levels of education is in slight decline, at an annual rate of approximately 9%. Still, these data should be interpreted with caution when analysing the demand trends, because they account for only a small share of the total job market in the ICT sector.

Table 24. Requests for job matching services by ICT sector employers, by education level, in 2018, (%)

Education level	Number of workers required	Number of placements	Success rate
10	3%	4%	55%
20	2%	2%	30%
30	15%	13%	35%
40	45%	45%	43%
50	0%	0%	100%
60	4%	2%	18%
70	31%	34%	45%
80	-	-	-

Source: NES

Around 43% of the total number of job orders from employers in the ICT sector concerns ICT-related jobs (Table 25). The remaining demand for workers mostly concerns workers with knowledge in law and economics, machine engineering and social sciences and humanities. Relative to 2016 and 2017 (Annex A11a and A11b) employers submitted an increased number of job orders to the NES for ICT-related jobs, in the following groups of occupations: energy technicians, computer scientists and statisticians, as well as occupations in sciences and mathematics.

Table 25. Requests for job matching services by ICT sector employers, in 2018

Jobs in the ICT sector	Number of workers required	Number of placements	Number of job matching services	Success rate
24 - Energy technicians;	25	14	33	42%
25 – Electro-mechanics technicians;	13	4	14	29%
26 – Electronics technicians;	33	9	50	18%
27 - Occupations in telecommunications;	44	16	40	40%
28 - Occupations in computer science;	102	72	134	54%
60 - Occupations in PTT traffic;	3	1	3	33%
69 - Information technology specialists and statisticians;	119	34	134	25%
83 - Occupations in the exact sciences and mathematics.	29	24	29	83%
Total	368	174	437	40%

Source: NES

2.4. NES data on registered jobseekers, with length of unemployment spell

NES data on registered jobseekers were used as the main source of information on the potential workforce supply in the ICT sector. The number of persons registered as unemployed the NES with formal qualifications in the ICT field in 2018 stood at 40,225, on average. This number registered a clear declining trend in the period from 2016 to 2018, at an annual rate exceeding 12%. By level of education, the structure of the unemployed registered with NES fully corresponds to the structure of NES placements from the unemployment register. Specifically, around 81% of workers has secondary-level qualifications (three-year and four-year secondary education), while around 10% are highly educated workers (Table 26).

Table 26. Registered job seekers with ICT-related occupations, by education level

Education level	Average number of unemployed, at annual level		
	2016	2017	2018
10	14	11	11
20	371	315	252
30	14,019	12,107	10,205
40	27,693	25,016	22,359
50	657	579	479
60	3,676	3,227	2,845
70	4,986	4,561	4,047
80	17	23	26
Total	51,433	45,838	40,225

Source: NES

If we look at the narrower classes of activity into which workers can be classified according to their registered occupation, we can see a similar trend at the level of the entire ICT sector. In fact, we are witnessing a declining trend in the number of unemployed registered with the NES across all occupation groups. Around 70% of unemployed are in occupations in sciences and mathematics, Electro-mechanics technicians and energy engineers (Table 27).

Table 27. Registered jobseekers with ICT-related occupations, by field of occupation

Jobs in the ICT sector	Average number of unemployed, at annual level		
	2016	2017	2018
24 – Energy technicians;	10,573	9,234	7,980
25 – Electro-mechanics technicians	12,386	10,785	9,096
26 – Electronics technicians;	4,972	4,318	3,725
27 - Occupations in telecommunications;	1,801	1,599	1,392
28 - Occupations in computer science;	5,116	4,602	4,189
60 - Occupations in PTT traffic;	728	673	593
69 - Information technology specialists and statisticians;	3,188	2,788	2,502
83 - Occupations in the exact sciences and mathematics.	12,669	11,838	10,748
Total	51,433	45,838	40,225

Source: NES

A breakdown by age group, presented in Table 28, leads us to conclude that more than 15% of unemployed workers are over the age of 55 years. In parallel, a trend of increase was seen in the absolute number of persons in this group, as well as in their share in the age structure of the unemployed. On the other side, the absolute number of unemployed below the age of 55 is declining from year to year, as is the relative share of those below the age of 30 years, while the relative share of the 30-54 cohort is relatively stable.

Table 28. Registered jobseekers with ICT-related occupations, by age

Age group	Average number of unemployed, at annual level		
	2016	2017	2018
15-29	17,946	14,791	12,084
30-54	27,464	24,665	21,605
55+	6,024	6,382	6,535
Total	51,433	45,838	40,225

Source: NES

By specific registered occupation, three-year and four-year secondary education profiles account for the biggest share of registered unemployment in the ICT sector (Table 29). Around 41% of unemployed is found in the following occupations: secondary school graduate in the field of exact sciences and mathematics, energy technician, computer service technician, auto electrician, electrician, electro-mechanics technician, electronics technician.

Table 29. Registered jobseekers with ICT-related occupations, by specific occupation

Occupation code	Occupation title	Average number of unemployed, per year, in the 2016-2018 period	Share in total unemployment in the ICT sector
408300	Exact sciences/mathematics secondary school graduate	3,811	8.32%
402400	Energy technician	3,529	7.70%
402800	Computer service technician	2,912	6.35%
302564	Auto electrician	2,790	6.09%
302431	Electrician	2,079	4.54%
302500	Electro-mechanics technician	1,775	3.87%
402600	Electronics technician	1,733	3.78%
Total for occupations with the biggest share		18,630	40.65%

Source: NES

The average length of the unemployment spell for the persons registered as unemployed with the NES is yet another performance indicator of the supply-demand match in the ICT sector. This figure concerns only registered unemployment, i.e. the unemployed who were registered with the NES before taking up employment. A jobseeker is not obliged to register with and seek employment through the NES, so this figure does not include all potential cases, but is a good indicator of the transition rate from unemployment to work.

According to data presented in Table 30, the transition rates in the most important occupations in the ICT sector were relatively stable in the observed period. At the level of the entire sector, the average length of the unemployment spell stood at around 20 months. Job seekers in the most important occupation fields, presented in Table 30, typically experience a slightly shorter length of unemployment spell of around 16 months.

Table 30. Average unemployment period (in months), by occupation in the ICT field

Occupation code	Occupation title[20]	2016	2017	2018
408300	Exact sciences/mathematics secondary school graduate	20.60	21.98	22.78
402400	Energy technician	19.76	19.93	19.77
402800	Computer service technician	17.29	17.06	15.85
302564	Auto electrician	20.02	22.68	22.68
302431	Electrician	19.91	23.83	22.70
302500	Electro-mechanics technician	18.65	19.62	20.58
402600	Electronics technician	17.19	16.56	16.28
In total for all ICT-related occupations		20.03	21.37	20.82

Source: NES

As regards the length of the unemployment spell by educational structure (Annex A12), the shortest unemployment spell is experienced by job seekers with degrees from technical colleges (around 19 months), as well as by those with four-year secondary education degrees and higher education degrees (around 17 months). On the other side, the jobless with the longest unemployment spell are unskilled workers (even exceeding 30 months). The shortest unemployment spell is typical of the youngest population, thus, the unemployment spell for unemployed aged 15-29 years amounts to 14 months (Annex A14). When comparing the individual ICT sectors, the shortest unemployment spell is typical of computer service technicians (around 15 months), and the longest in PTT traffic occupations (around 29 months).

20 We listed the most important occupations, by number of unemployed registered with the NES, and by number of placements from the NES register.

3. Analysis of the match between the workforce required by the ICT sector and that currently supplied by Serbia's education system

3.1. The labour demand and supply match

To identify potential obstacles in the recruitment of new workers and potential structural gaps of candidates applying for jobs in the ICT sector, the surveyed companies were invited to answer a set of questions concerning the characteristics of average candidates hired in specific jobs. Table 31 shows the average job induction period for new employees, according to information obtained from employers. This information reveals how prepared workers are, on average, to meet job-specific requirements. Considering that workers with no formal education in ICT can also be employed in this sector, and vice-versa, in the survey this issue is covered by a matrix that includes both different focuses of prior education and the positions, which may, but do not necessarily have to be related to the company's core activity. Regardless of the workers' prior education and job performed, the average new employee induction period stood at slightly over 4 months. For new employees in ICT-related jobs with prior education corresponding to the requirements of the position, the induction period ranges from 2 to 12 months. Despite this, the biggest number of companies reported an induction period which is closer to the lower threshold of this range, consequently the average job induction period stands at 13 weeks. When hiring an employee in the same jobs, but with a type/field of formal education that does not correspond to the job requirements (overqualified, or with informal education in the field, and similar) the induction period increases by additional 11 weeks. In the interviews, company representatives reported cases that confirm companies will recruit even workers who do not meet formal education requirements for a particular job, related to the field of study or level of education, but who are able to satisfy all of the technical requirements imposed by the job, thanks to their extensive working experience, and self-directed learning. These observations will be addressed in more detail in the segment on interviews with representatives of companies from the sector.

Table 31. Job induction period for new employees (in months)

	ICT-related jobs	Other jobs
Prior education in job-related area	3.11	3.59
Prior education in non-related areas	5.50	4.03

Source: FREN

If we look at the companies' answers to questions concerning difficulties finding adequate candidates for the job, we can deduce that the supply-demand gap in the ICT sector is considerably higher in the ICT specialist workforce relative to candidates applying for non-ICT jobs (Table 32). As regards ICT-related positions, 80% of surveyed companies reported having difficulties finding an adequate number of candidates who meet the requirements of the job openings in the companies. As regards the share of non-ICT jobs, slightly over one third of the companies reported difficulties finding adequate candidates for the positions advertised. In the interviews, company representatives attributed the identified difference to the effects of demand-side pressures, i.e. the growing demand for ICT specialists, which has been a trend in the Serbian market in the past 5 to 7 years.

Table 32. Difficulties finding adequate candidates for the job

	ICT-related jobs	Other jobs
Yes	80%	36%
No	12%	56%
No answer	8%	8%

Source: FREN

Table 33 provides an overview of the employers' answers related to identified gaps in the basic skills of employees in jobs pertaining to the company's core business activity, by education level. A 23% share of surveyed companies reported no significant gaps in the basic skills groups among workers hired to perform jobs with a complexity level that requires completed secondary school or further training, while the remaining share of companies reported appreciable gaps in at least one of the listed skills groups. The biggest gaps reported by 41% of surveyed companies are linked to prior working experience in similar positions. An appreciable lack of technical skills ranked second, as around one third of surveyed companies recognized a skills gap in this area, while a slightly lower percentage (31%)

reported staff had unsatisfactory soft skills. If we look at occupations which entail a higher level of qualifications and complexity, the number of companies that reported a soft skills gap among their workforce reaches a high 41%. In the interviews too, sector representatives stated that the biggest gap was in the soft skills segment, particularly in the case of candidates who arrive directly from the education system or with little prior work experience. Lack of work experience in the field was recognized as a problem by one third of the companies in the survey sample, while a slightly smaller percentage reported an unsatisfactory level of specialist and technical skills among their staff. The lack of specialist skills mainly refers to the employee's familiarity with new technologies on the market, this also poses the greatest challenge for the education system, considering it is traditionally slow in changing and adjusting to the fast-paced developments in the ICT sector.

Table 33. Lack of skills in workers

	Technicians (secondary school, specialization)	Specialists and managers (Bachelor's, Master's, PhD)
Specialist and technical skills	33%	31%
Basic skills (literacy, computing, languages)	5%	8%
Soft skills (working with people, team work, communication skills and similar)	31%	41%
Relevant work experience	41%	33%
Licenses/certificates	8%	10%
There is no gap	23%	31%

Source: FREN

In interviews with company representative included in the survey, we established that employers attribute the shortage of technical skills of the workforce to the poor level of practical training provided in the formal education system in particular with regard to contemporary programming languages, project-based work or work with technical equipment. Information acquired in interviews confirmed the data obtained through the survey concerning the possibility of hiring workers in core jobs (ICT-related jobs) who have no prior formal education in the required field or expected education level. Around 60% of surveyed companies as well as all interviewed companies confirm that such recruitment practices are present in cases when no requirements are made with respect to specific qualifications level or field of study that candidate are expected to have in order to be hired. Naturally, this does not mean that most workers employed in these jobs are either overqualified or acquired knowledge and skills through self-learning. The large software corporations still predominantly recruit exclusively candidates with university degrees in electrical engineering and computer programming, especially in positions of an intermediate and high level of complexity. Still, their representatives reiterate that the ICT sector, in the software development segment, probably has the most flexible system, in terms of not restricting recruitment with formal requirements related to the expected qualifications level and field of study.

This stance is additionally confirmed by the answers to the survey question where the surveyed companies were invited to list the most prevalent jobs/occupations in their business processes, along with the combination of skills and knowledge that candidates for the position are expected to have, as well as their expected level of qualifications/education. Listing the most frequent occupations, with the expected qualifications level and field of study, we are able to estimate the degree to which the educational profiles prevalent in secondary schools and at the tertiary level are able to match the ICT sector demand. Of the total number of occupations listed, around 39% of companies opted for the qualifications level that corresponds to the medium-qualifications level, all the way to high-qualifications level (university degree). In the remaining occupations, the expected qualifications level entailed the completion of the tertiary education level (Table 34). This supports the statements recorded in the interviews that the lack of a diploma is not necessarily an impediment for getting an ICT-related job, or the other way around.

Table 34. Expected level of qualifications/education for the most frequent jobs reported

	Share
Primary or secondary education	39%
Tertiary education	61%

Source: FREN

Occupations that require a higher qualifications level are different groups of engineers and project managers: network administrators, Web programmers, ERP consultants, software engineers, Android developers, integrated circuits design engineers, QA[21] engineers, development of information systems, product managers, DevOps[22] and similar. Also in these jobs, which entail a higher level of complexity, half of the companies reported cases of employees without any formal education in the ICT field. This is even more prominent in the case of jobs in which the expected qualifications level is either lower or from a broader range – almost 70% of companies reported cases when employees were recruited despite not having the formal qualifications required for the position.

The most prevalent occupations reported by the companies are grouped into wider categories, and presented in Table 35. Most new workers are hired in **jobs of an intermediate-to-high and high-level of complexity in the field of product/services development and creation** (creative designers, development of information systems, software developers, test engineers, iOS programmers, QA engineers, DB developers, development of services, integrated circuits design and similar) **or technical maintenance** (system administrators, network engineers, precise mechanics, network security engineers, technical support and similar). For 60% of the listed occupations, employers expect workers to have, as a minimum, qualifications level six or higher (technical college degree, bachelor's, master's, PhD), but this figure is an underestimation of the actual demand for highly skilled professionals. A specific characteristic of the ICT sector is that companies do not have strict requirements concerning a formal degree of a certain level, if the candidate has the work experience and practical skills required for working in a certain position. As a consequence, for around 24% of the most prevalent occupations, companies stated that candidates recruited in these jobs can have a qualifications level ranging from four to seven. If we look at the required knowledge and skills, all jobs have an intermediate-to-high and high level of complexity, and according to the traditional classification, one would expect workers to possess, as a minimum, qualifications level five according to the NQF system. The occupations in highest demand in the ICT sector are software engineers with different profiles. A large number of companies reiterated that the profiles they currently most need are programmers specialized in PHP, Swift, JS, HTML, Kotlin, NET, C++ or C#. In addition to the shortage of workforce with the occupations listed above, the second occupation in highest demand are ICT analysts. This is a profile characterized by an even more prominent level of complexity as it requires knowledge from several disciplines. This includes various project development managers, data analysts, SAP consultants, IT auditors, business analysts and similar. Annex A15 provides and overview of expected knowledge/skills for the listed occupation groups, by qualifications level selected by the companies.

Table 35. Share of the most frequent jobs reported, by broader job group

	Share
Software engineers	48%
ICT analysts	19%
Network and system administration specialists	16%
Repair of equipment and technical support	10%
Various ICT specialists	7%

Source: FREN

In addition to existing workforce needs, the companies were invited to provide their projections concerning the future demand for certain occupations, taking into account the dominant trends in the sector and the economy at large. Career fields with the highest projected demand growth in the future period include a variety of specialist profiles in the field of machine learning, automation, virtual reality, artificial intelligence development, big data, cloud and neural networks analysis. Annex A16 provides and overview of the knowledge and skills that workers in these jobs are required to have.

The gap between the skills the business sector needs and the skills the education system supplies can also be observed by monitoring further trainings targeting new employees starting their first job immediately after completing secondary or tertiary education. Around 60% of the surveyed companies reported that newly hired workers are always or often referred to further training. The training courses are often related to the technical characteristics

21 Quality assurance

22 DevOps jobs combine software development with IT operations with the aim of shortening the systems development life and provide continuous delivery with high software quality.

of the job that the education system cannot be expected to cover at the level of all profiles, but that could be included in the practical training part at some stage of the studies. The scope of practical training should correspond to the complexity of the specific job, as pointed out by company representatives, which is currently often not the case.

The introduction of additional requirements related to obtaining licenses, certificates or permits as a requirement for working in some of the positions is yet another potential obstacle to finding adequate candidates. The largest share of companies does not report having these additional requirements for candidates applying for the job. The remaining companies, depending on the position for which the candidates are being recruited, require various certificates, and if a candidate lacks the required certificate but meets all other requirements, as a rule, these companies will fund the training course for the candidate to obtain the required certificate.

3.2. Information obtained in interviews with company representatives

Aside from data on the mismatch of current supply of educational profiles and the structure of workforce demand in the ICT sector obtained through the survey, additional information was collected through a set of interviews with companies from this sector. Meetings were organized with representatives of the human resources departments (HR), as well as production and processing executives in companies selected for this segment of the analysis.

With the fourth industrial revolution, the demand for specific knowledge and skills that was initially restricted only to ICT sector is slowly spilling over to other sectors of economic activity, driving the increase in demand for ICT staff. These changes in turn triggered a shift in the expectations of businesses with regard to the specialist training of candidates in certain technologies, programming languages and project procedures, specifically, from narrowly specialized professionals to multidisciplinary, all-around workers with a strong ICT background, and basic knowledge of biology, economics, machine engineering, chemistry and similar. In line with the traditional segmentation, the dominant two shares in Serbia's ICT sector are companies in telecommunications and information technology. Based on interviews with representatives of companies, we can formulate a few general observations regarding the workforce demand in the ICT sector, as well as a couple of specific ones with regard to individual segments of this sector.

A view shared by all company representatives is that the expanding application of ICT in all spheres of the economy is driving the increase in the need for versatility of workers in positions related to development, testing and implementation of products and services. In comparison with former times, when an employee was required to have knowledge of a certain programming language or technical training in operating a specific type of equipment, new jobs and emerging markets require the ability to implement these knowledge and skills in different environments, which entails knowledge of the workflow and functioning in other economic activity sectors. As stated by sector representatives, one of the potential ways to better prepare future candidates in the labour market for the new work environment is to introduce project-oriented activities in the curricula to be implemented in groups that would correspond to an average-size team in a typical company. The respondents emphasized that most candidates arriving directly from the education system have no prior knowledge of the typical assignments and jobs that the position they are applying for entails. In this regard, candidates are not even familiar with the implementation of typical projects they are supposed to be assigned to, or the breadth and types of communication between the team members or company organizational units carried out on a daily basis. This shortcoming has an impact on the average period of adjustment of new recruits with no prior experience and the on-boarding support required to get them working to full capacity. Innovations in teaching in certain subjects, which entails defining an assignment at the beginning of the course of study and subsequently working in groups in the course of the semester, could help students prepare for the challenges they face in their first employment. This proposal is a potential solution for the social skills gap identified in a significant number of candidates applying for jobs in the ICT sector requiring minimum qualifications level six, or higher. The survey finding concerning the inadequacy of social skills was confirmed in the interviews, where respondents emphasized that in addition to the lack of team work and organization skills, many candidates have no basic understanding of communication and interaction with clients or business partners. Respondents also pointed out that financial literacy is at a very low level among candidates with no working experience taking up employment in ICT specialist jobs, which hampers their efficiency in jobs in ERP systems, in the development of various software applications or in the delivery of IT support to business users.

Interviewed companies, and companies from the sample at large, have a presence not only in the local market, but also in markets in the Balkan region and beyond. Comparing the availability and qualifications of the workforce in the region, the shared conclusion is that Serbia is facing a similar problem in terms of the workforce shortages due to the expansive growth of the ICT sector, typical of most other countries of the former Yugoslavia. The issues identified with regard to the training and job readiness of candidates arriving directly from the education system are also similar to neighbouring countries, with several sources singling out Slovenia as a leader in terms of the teaching methodologies of educational institutions and work experience placement programmes implemented during studies. One of the reasons that Slovenia has made headway relative to other educational systems is the reform in the vocational education and training (VET) sector, implemented more than ten years ago. In fact, the national curriculum framework reform allowed for adjustments to be made to up to 20% of the curricula, based on recommendations of key stakeholders, in accordance with the needs of the local labour market. Learning outcomes are designed in such a way as to maximize the emphasis on acquired professional competencies (linking theory with practice, on-the-job training in companies) and on upgrading key competencies and general knowledge. Many practical assignments and research projects are incorporated in the curricula with an emphasis on team work and practical training in line with the needs and requirements of businesses. In addition, schools and businesses established cooperation programmes that focused on teacher training as well as mentorships in practical training programmes. Slovenia's example could serve as a basis for reforming the modus operandi of educational institutions in Serbia, considering that the lack of work experience placements was recognized as one of the biggest shortcomings by representatives of the business sector. Businesses also pointed out that there is no institutional support or clear coordination related to the work placement programme of higher education establishments in Serbia, which makes it impossible for companies to properly plan their staff capacities and possibilities, as a result of which these work placements are often just done as a formality. The current approaches are characterized by insufficient coordination and the absence of a clear system of work experience placements, which leads to the loss of opportunities for practical instruction through which secondary school and university students can familiarize with the latest market trends and make their first steps in their chosen career path.

The lack of coordination and of a universal approach at the branch level is also found on the side of employers, who are the other key market stakeholder. Currently, there are six functioning ICT clusters[23] in Serbia that bring together sector companies, however, cooperation with universities and research institutes is still organized at local level without channelling pressure toward the Ministry of Education, Science, Technological Development and the universities so that they adjust the curricula and methods of work to market needs. Respondents highlighted that the creation of excellence centres at universities and secondary schools in other countries proved to be an excellent practice. The curricula and partnerships with the business sector in these centres are designed to create a workforce that will be clearly profiled in the new technologies segment at the end of the education cycle. Cooperation with some of the VET schools and faculties, organized by CISCO, is an example of a similar practice in Serbia, albeit on a smaller scale, designed to familiarize students with the latest trends in telecommunications using equipment that does not lag behind the equipment telecommunications workers use in the field. However, rather than being the product of a structural approach in connecting businesses with educational institutions, this example of cooperation is a product of individual activities of employers endeavouring to secure future workforce. A drawback of this approach is its inefficiency, as only large corporations with sufficient resources can influence the curricula, as well as its narrow reach considering that, rather than changing the entire curriculum, only one of its segments is complemented with practical work with technical equipment.

Business sector representatives reiterated that the ICT sector predominantly hires workforce with qualifications level six and higher, but that several reskilling projects were implemented in the previous period, involving workers from other occupation fields in the ICT segment, due to the expansion of the market and sector. Trainings and courses organized in cooperation with the National Employment Service were mostly rated as successful by business sector representatives, and they reiterated that everyone who showed a positive personal attitude and the readiness to learn new things was hired after completing the training. The general belief is that the Personal Income Tax Law, enacted in December 2019, will have an impact on the cost of labour, introducing a now significant number of sole

23 The Central Serbia ICT Cluster, the Vojvodina ICT Cluster, the Subotica ICT Cluster, ICT Network, the Niš Advanced Technology Cluster and the Zrenjanin ICT Cluster.

proprietors registered in the ICT sector who do not meet independent contractor status criteria. A potential outcome of this measure is the incursion into the "grey area" of business, or a "brain drain" of ICT specialists from the country. Another potential outcome, anticipated by some respondents, is that it could relieve the pressure on sector wages. In the case of the latter option, the demand for overqualified workforce would decline over the short term, due to the possibility of companies to hire already experienced candidates with the required formal education.

The labour market trends in the ICT sector, reported by sector representatives in the interviews, were additionally confirmed by the ManpowerGroup (MPG) company, which is a leader in innovative workforce solutions and connecting employers with the top talent available on the labour market. Representatives of companies noted the constant shortage of experienced professionals in the ICT workforce market, which is a consequence of an accelerated growth in demand due to the sudden boom the sector has experienced, in parallel with a much slower growth on the supply side, owing to the brain-drain, which resulted in the substantial emigration of highly experienced professionals in search of opportunities for higher income and more stable social conditions in other countries. Of all job orders placed with the NES, 35% of employers required a minimum of 5 years of work experience, while the remaining 65% expected the candidates to have a longer active professional experience in similar positions. In the case of 62% of the total job openings notified by employers, candidates were required to have minimum secondary education, while for the remaining positions employers expected an academic degree, as a minimum. As established in the interviews with representatives of the business sector, licenses or certificates are considered as an advantage, but are not a requirement for the job, as confirmed by MPG data which indicate that some type of additional certification was required for a mere 4% of the positions.[24] The biggest share of job orders received from employers seeking to recruit top talent concerned demand for software engineers, software testers, software architects, system engineers, network engineers, database administrators, security system engineers, IT auditors, SAP consultants, team leaders, development team leaders, project managers, business analysts, data analysts and technical support engineers.

The impact of the Covid-19 pandemic on Serbia's ICT sector

The pandemic caused by the coronavirus is already affecting the Serbian economy, and the global economy at large, on many fronts. As a consequence, the role of the digital, i.e. ICT sector, will also experience a transformation. Digital technologies have become the leading tool not only for detecting, monitoring and finding treatment for the virus, but also for mitigating its adverse effects on most sectors of the economy. The impact of the Covid-19 pandemic on the ICT sector in the European Union Member States and Serbia is, so far, reflected in the following:

- companies that earn most of their revenues from e-commerce were less affected by the crisis;
- companies whose employees are in jobs that are oriented toward ICT technologies to a significant extent were less affected by the negative effects of the crisis in the short-term;
- hardware supply chains were strongly negatively affected by factory closures in China, Italy and other countries;
- the market saw the emergence of a high degree of uncertainty, shrinking demand as well as contracted work;
- confusion arose in connection with contracted work, as to whether the contracted commitments are still in force or whether the "force majeure" clause may be applied;
- in the short term, a smaller number of layoffs and company closures was registered in the ICT sector relative to other sectors, even though changes are expected here too, and it is evident that small and medium enterprises were more affected than large corporations;
- many of the state aid packages target low-paying jobs, and not medium and small ICT companies, which is bound to increase staff attrition, diminish competitiveness, and jeopardize the survival of these companies, and hamper further development of start-ups that would have had better prospects in regular conditions;

24 The specific licenses required were: Project Management Professional (PMP), MiCROCSIft Certified Solutions Associate (MCSA), Cisco Certified Network Associate (CCNA) and ISO.

- the widespread opinion is that there are no significant issues with "working from home", i.e. "teleworking", in the ICT sector, however, there are some limitations:
    - Internet connectivity issues: fixed and mobile internet networks are overloaded and access to high-speed internet has become more difficult, especially in the country's rural regions;
    - trade restrictions in goods have affected the hardware supply chains that are critical to teleworking, such as laptops, monitors, and printers;
    - ICT stores are mostly closed, as a result of which opportunities for the procurement of basic equipment are shrinking;
    - technical maintenance staff and training providers in the use of certain ICT solutions are less available due to travel restrictions;
    - issues with security of online data, and cyber-crime, (especially when accessing data that were so far reserved only for internal company networks) are now much more prominent.

The following actions should be taken to mitigate the negative economic impact of the Covid-19 pandemic, with a view to helping the Serbia's ICT business sector and education system adjust to the news circumstances and the ICT sector continue its growth as the major driver of Serbia's global competitiveness:

- create support packages for the digital transformation of health care, education, transportation, agriculture and tourism,
- finalize the budget revision with a view to providing support to companies for recovery from the crisis, and reallocating funds to segments that have a proven high return on assets (ROA) ratio over the long-term, according to experiences in developed countries, digital education, improvement of security of data in cyberspace, health care, environmental protection and digitalization of small and medium enterprises in key branches of the economy,
- help small and medium enterprises to transition online, for instance, by using e-commerce to increase their competitiveness,
- invest in digital education platforms to enable teachers, professors, instructors and all online education and training providers to perform their job smoothly and efficiently – whilst keeping in mind how important it is to train teachers in the use of digital tools and online learning platforms,
- accelerate the introduction and development of state-of-the-art technologies in the broadband internet area (primarily the 5G network)
- adoption of new and adjustment of existing legal solutions facilitating online economic activities, which were very much present in the ICT sector even before the crisis, as well as progressively increasing the use of digital signatures.

Conclusion

Information and Communications Technology (ICT) has been the fastest growing sector in Serbia in the past three years, providing a basis for the growth of its digital economy. The sustained increase in demand for ICT products and services (primarily in the domain of software development), by other sectors of the economy, as well as by individuals and households, enabled not only the creation of new jobs and occupations, but also the transformation of traditional ones. In 2017, the ICT sector in Serbia created a gross value added (GVA) that accounted for a minimum 5% share in the country's GDP. In 2017, the contribution of the ICT sector stood at the level of the agricultural sector, and was definitely higher than that of the construction, electricity supply or mining sectors. The share of the ICT sector turnover, relative to the total turnover of Serbia's economy, stood at 5.8% at the end of 2017. It is similar to the share of the construction sector turnover, and slightly higher than the share of the transportation and storage sector turnover. Taking into account the pivotal role of Serbia's ICT sector for the country's economic development, the education sector should take proper stock of the occupations that have so far been recognized as critical for the normal functioning of the ICT sector.

In the foregoing chapters we analysed economic and financial aspects of the ICT sector in Serbia and, in particular, its labour market characteristics, to gain understanding of the skills gap between the skills this sector needs and the current skills supply of Serbia's educational system. The workforce demand and supply were analysed individually, by interpreting data obtained from relevant state institutions, on the one side, and data obtained through a survey and in interviews with representatives of the major companies in Serbia's ICT sector, on the other side. On the basis of the analysis, we provided guidelines and recommendations with respect to the planning of the future education of the workforce, in accordance with ICT sector needs.

The conclusion is that in upgrading secondary and higher education curricula, special attention must be devoted to identified ICT sector recruitment needs. The major share of surveyed ICT companies in Serbia is anticipating an increase in the demand for ICT products and services in the forthcoming period, which can be extrapolated to the demand for new employees. While unreported employment is not seen as an issue in the ICT sector, fiscal policy makers should consider introducing incentives for ICT companies to hire the unreported workers in the same way as workers in core ICT activities.

As regards the analysis of the ICT sector's recruitment needs, depending on complexity of the jobs these workers are hired to perform in the company, various profiles of ICT specialists account for the biggest share of workers in ICT sector companies. Furthermore, the ICT sector has a sizeable segment of demand for occupations that are not strictly related to this sector's core activity, specifically in non-core activities such as human resources management, legal affairs, marketing and similar. This fact points to the need for introducing multidisciplinary tracks and curricula (primarily at university level) to create workforce with qualifications profiles that include knowledge of economics, management skills, in parallel with ICT skills that are essential for Serbian ICT companies to increase their competitive advantage in the local and especially international markets. This is very important because the biggest share of Serbia's ICT companies sell their products and services predominantly in the international market.

To shorten the period required to introduce future employees to the job in the ICT sector, the existing dual education model in secondary schools should be developed further and, additionally, undergraduate work placements should be a mandatory part of the course of studies at universities to be implemented in cooperation with ICT companies. According to the companies' opinion, presently there is no connection between the business sector, i.e. the practical needs of ICT sector companies, and the skills students acquire at college. Through a work placement programme, students would get the opportunity to familiarize with new technologies and software applications (curricula are slow to adjust to these) and acquire skills to apply these through practical assignments in ICT companies.

In Serbia the skills gap in the ICT field is considerably higher with respect to candidates applying for ICT-related jobs than those applying for non-core jobs. In recent years Serbia's education system has not been able to keep pace with ICT sector needs. Although the number of (mostly private) faculties and new ICT tracks seem to be constantly growing, there is a prominent shortage in adequate workforce with satisfactory knowledge and skills in the field.

A significant share of companies in the ICT sector has identified a lack of soft (social) skills among its workers, especially when it comes to candidates arriving directly from the education system or without any significant work experience. The lack of specialist skills primarily refers to the employee's familiarity with new technologies on the market, and this is also the greatest challenge for the education system which is traditionally slow in changing and adjusting to the fast-paced developments in the ICT sector.

Employers from the ICT sector believe that the lack of technical skills of the workforce is a consequence of the poor level of practical training provided in formal education with regard to new programming languages, project-based work, or work with technical equipment. This is the reason why employers impose no restrictions in the recruitment process, in terms of requiring a specific degree or field of education from the candidates applying for the job. This means that the lack of a diploma is not necessarily an obstacle for getting hired in a position closely related to the ICT activity, but also vice-versa. Future educational profiles and curricula in ICT must put emphasis on new programming languages and project-based work, incorporating multidisciplinary knowledge and, in particular, on training the workforce for occupations that require high-level qualifications for various groups of engineers and managers responsible for project management.

The mismatch between what the ICT sector needs and what the education system supplies is evident based on the fact that most ICT companies often refer its new employees, recent graduates from secondary or tertiary education starting their first job, to further training. The training courses are often related to the technical characteristics of the job that the education system cannot be expected to cover at the level of all profiles, but that could be incorporated in the practical training segment that could be implemented at some stage of the studies.

When developing new curricula (at the secondary and tertiary education level) cooperation should be established with institutions/companies organizing trainings in specific ICT areas (use of software or equipment) in line with employer needs. Constant changes in the markets and development of new technologies impose the need for employers to innovate their business and the formal education system is not always able to keep pace with that. This is why it is imperative that the formal education system increase its flexibility in this segment by enabling students to acquire certificates attesting that they have mastered the new skills required in the ICT labour market, through trainings in other institutions or through work placements in companies.

To ensure that the ICT sector, as the major driver of Serbia's global competitiveness, continues its growth, and with a view to mitigating the adverse impact of the Covid-19 pandemic on the entire economy, a set of measures should be introduced to support digital transformation of all key business stakeholders; the budget should be revised to provide support to companies for recovery from the crisis and funds should be reallocated to digital education, health care, environmental protection and digitalization of small and medium companies in key branches of the economy; investments are needed in digital education platforms; state-of-the-art broadband internet technologies should be introduced; existing legal solutions should be adjusted, and new ones introduced, to enable online economic activities, which were very much present in the ICT sector even before this crisis.

ANNEX

A1. Overview of ICT sector activities

2611 Manufacture of electronic components

2612 Manufacture of loaded electronic boards

2620 Manufacture of computers and peripheral equipment

2630 Manufacture of communication equipment

2640 Manufacture of consumer electronics

2680 Manufacture of magnetic and optical media

4651 Wholesale trade in computer hardware and software

4652 Wholesale of electronic and telecommunications equipment and parts

4741 Retail sale of computers, peripheral units and software in specialized stores

4742 Retail sale of telecommunications equipment in specialized stores

5821 Publishing of computer games

5829 Publishing of software

6110 Cable telecommunications

6120 Wireless telecommunications

6130 Satellite telecommunications

6190 Other telecommunications activities

6201 Advanced computer programming

6202 Information technology consultancy activities

6203 Computer facilities management activities

6209 Other information technology services

6311 Data processing, hosting and related activities; web portals

6312 Web portals

9511 Manufacture of computers and peripheral equipment

9512 Manufacture of communication equipment

A2. Number of companies/sole proprietors, with number of employees, by statistical activity group registered in the ICT sector, at the end of 2017

	Number of companies/sole proprietors	Number of placements	
Manufacture of electronic elements	65	701	Manufacture of computers, electronic and optical products
Manufacture of loaded electronic boards	3	88	
Manufacture of computers and peripheral equipment	460	2,667	
Manufacture of communication equipment	82	437	
Manufacture of consumer electronics	45	197	
Manufacture of magnetic and optical media	1	0	
Wholesale trade in computer hardware and software	129	582	Trade in ICT
Wholesale of electronic and telecommunications equipment and parts	96	182	
Retail sale of telecommunications equipment in specialized stores	61	355	
Retail sale of computers, peripheral units and software in specialized stores	43	1,158	
Publishing of computer games	6	141	
Publishing of software	20	147	
Wired telecommunications activities	306	13,766	Telecommunications
Wireless telecommunications activities	64	1,691	
Satellite telecommunications activities	4	27	
Other telecommunications activities	46	162	
Computer programming activities	1,929	15,577	Information technology activities
Computer consultancy activities	400	1,825	
Computer facilities management activities	19	140	
Other information technology services	175	928	
Data processing, hosting and related activities	143	1,350	Information service activities
Web portals	157	389	
Repair of computers and peripheral equipment	252	629	Computer repair
Repair of communication equipment	35	25	

Source: SORS

A3. Number of workers in the ICT sector, by company activity and age group, average for 2017

ICT sector segment	Age group					Total
	Up to 24	25-29	30-54	55-59	60+	
Manufacture of computers, electronic and optical products	159	358	3,112	362	174	4,165
Trade in ICT	238	505	1,778	44	37	2,600
Telecommunications	434	997	13,519	1,598	422	16,969
Information technology activities	1,576	4,903	16,809	533	308	24,129
Information service activities	78	320	1,504	161	90	2,153
Computer repair	83	157	1,421	147	81	1,889
Total	2,568	7,240	38,142	2,845	1,111	51,906

Source: CROCSI

A4. Number of workers in the ICT sector, by company activity and gender, average for 2017

ICT sector segment	Sex		Total
	Male	Female	
Manufacture of computers, electronic and optical products	2,679	1,487	4,165
Trade in ICT	1,584	1,017	2,600
Telecommunications	10,588	6,382	16,969
Information technology activities	16,892	7,237	24,129
Information service activities	1,090	1,063	2,153
Computer repair	1,387	502	1,889
Total	34,219	17,687	51,906

Source: CROCSI

A5. Number of workers in the ICT sector, by company activity and education level, average for 2018

ICT sector segment	Education level									Total
	10	20	30	40	50	60	70	80	Unknown	
Manufacture of computers, electronic and optical products	150	49	709	1,857	23	300	752	5	547	4,391
Trade in ICT	24	28	217	2,266	13	144	437	1	117	3,247
Telecommunications	183	76	1,567	8,102	257	933	2,849	8	2,849	16,824
Information technology activities	283	52	389	8,441	136	2,526	12,099	86	4,447	28,458
Information service activities	30	12	91	1,225	31	162	642	8	340	2,540
Computer repair	50	16	231	941	21	87	98	1	491	1,937
Total	721	232	3,204	22,832	480	4,152	16,876	110	8,789	57,396

Source: CROCSI

A6a. Number of workers in the ICT sector, by company activity and qualifications level, average for 2017

ICT sector segment	Qualifications level									Total
	10	20	30	40	50	60	70	80	Unknown	
Manufacture of computers, electronic and optical products	84	48	641	1,785	23	280	687	6	612	4,165
Trade in ICT	26	21	177	1,794	7	127	350	2	97	2,600
Telecommunications	197	78	1,616	7,971	252	904	2,810	10	3,133	16,969
Information technology activities	289	54	308	7,469	104	2,048	10,547	70	3,241	24,129
Information service activities	31	9	70	1,045	19	139	525	9	307	2,153
Computer repair	46	16	215	959	21	81	95	1	455	1,889
Total	672	225	3,026	21,023	425	3,580	15,013	97	7,846	51,906

Source: CROCSI

A6b. Number of workers in the ICT sector, by company activity and qualifications level, average for 2017

ICT sector segment	Qualifications level									Total
	10	20	30	40	50	60	70	80	Unknown	
Manufacture of computers, electronic and optical products	97	76	544	1,997	21	263	747	2	700	4,447
Trade in ICT	22	15	169	1,193	8	100	262	1	33	1,802
Telecommunications	194	72	1,600	7,562	252	879	2,644	7	3,364	16,574
Information technology activities	211	29	224	5,491	64	1,274	7,745	22	962	16,022
Information service activities	17	9	49	729	8	110	370	2	127	1,421
Computer repair	31	15	133	588	8	52	67	0	136	1,029
Total	572	216	2,718	17,560	361	2,677	11,835	34	5,322	41,295

Source: CROCSI

A7a. Match between job qualifications requirements and workers' qualifications level in the ICT sector (vertical mismatch), December 2017

ICT sector segment	Employees, total	Share of workers for which data are available	Overqualified workers	Underqualified workers	Workers with an adequate education level
Manufacture of computers, electronic and optical products	4,202	2,709	424	255	2,030
Trade in ICT	2,890	2,562	562	241	1,759
Telecommunications	16,809	9,415	1,501	827	7,087
Information technology activities	26,091	18,323	1,688	2,868	13,767
Information service activities	2,257	1,459	330	207	922
Computer repair	1,919	1,035	145	113	777
Total	54,168	35,503	4,650	4,511	26,342

Source: CROCSI

A7b. Match between job qualifications requirements and workers' qualifications level in the ICT sector (vertical mismatch), December 2016

ICT sector segment	Employees, total	Share of workers for which data are available	Overqualified workers	Underqualified workers	Workers with an adequate education level
Manufacture of computers, electronic and optical products	4,303	2,724	407	238	2,079
Trade in ICT	2,211	2,023	420	178	1,425
Telecommunications	16,566	9,916	1,743	590	7,583
Information technology activities	17,071	13,607	1,897	1,849	9,861
Information service activities	1,508	1,011	927	0	84
Computer repair	1,008	682	623	0	59
Total	42,667	29,963	6,017	2,855	21,091

Source: CROCSI

A8a. Workers in the ICT sector with ICT-related qualifications (field-of-study or horizontal mismatch), December 2017

ICT sector segment	Employees, total	Share of workers for which data are available	Jobs requiring ICT-related qualifications		Jobs requiring other types of qualifications	
			Total number	Share of total number with qualifications in ICT	Total number	Share of total number with qualifications in ICT
Manufacture of computers, electronic and optical products	4,202	2,709	1,271	647	1,438	260
Trade in ICT	2,890	2,562	258	165	2,304	371
Telecommunications	16,809	9,415	4,526	3,190	4,889	790
Information technology activities	26,091	18,323	11,341	7,481	6,982	1,044
Information service activities	2,257	1,459	511	212	948	59
Computer repair	1,919	1,035	319	214	716	85
Total	54,168	35,503	18,226	11,909	17,277	2,609

Source: CROCSI

A8b. Workers in the ICT sector with ICT-related qualifications (field-of-study or horizontal mismatch), December 2016

ICT sector segment	Employees, total	Share of workers for which data are available	Jobs requiring ICT-related qualifications		Jobs requiring other types of qualifications	
			Total number	Share of total number with qualifications in ICT	Total number	Share of total number with qualifications in ICT
Manufacture of computers, electronic and optical products	4,303	2,724	917	600	1,730	454
Trade in ICT	2,211	2,023	365	94	1,611	73
Telecommunications	16,566	9,916	4,300	3,321	5,495	1,135
Information technology activities	17,071	13,607	4,965	2,615	7,354	2,712
Information service activities	1,508	1,011	141	56	818	167
Computer repair	1,008	682	202	126	467	51
Total	42,667	29,963	10,890	6,812	17,475	4,592

A9a. Requests for job matching services by ICT sector employers, 2017

ICT sector segment	Number of workers required	Number of placements	Number of job matching services	Success rate
Manufacture of computers, electronic and optical products	112	87	130	67%
Trade in ICT	96	46	101	46%
Telecommunications	251	91	256	36%
Information technology activities	254	127	255	50%
Information service activities	46	19	49	39%
Computer repair	45	17	45	38%
Total	804	387	836	46%

Source: NES

A9b. Requests for job matching services by ICT sector employers, 2016

ICT sector segment	Number of workers required	Number of placements	Number of job matching services	Success rate
Manufacture of computers, electronic and optical products	88	58	90	64%
Trade in ICT	92	41	94	44%
Telecommunications	233	79	234	34%
Information technology activities	369	180	377	48%
Information service activities	63	23	64	36%
Computer repair	27	14	27	52%
Total	872	395	886	45%

Source: NES

A10a. Requests for job matching services by ICT sector employers, by education level, 2017, %

Education level	Number of workers required	Number of placements	Success rate
10	3%	3%	44%
20	4%	7%	97%
30	26%	30%	52%
40	30%	24%	36%
50	1%	1%	25%
60	5%	4%	40%
70	31%	31%	47%
80	-	-	-

Source: NES

A10b. Requests for job matching services by ICT sector employers, by qualifications level, 2016, %

Qualifications level	Number of workers required	Number of placements	Success rate
10	3%	2%	27%
20	1%	2%	58%
30	15%	13%	40%
40	37%	31%	37%
50	0%	0%	50%
60	7%	13%	80%
70	37%	39%	48%
80	-	-	-

Source: NES

A11a. Requests for job matching services by ICT sector employers, for ICT-related jobs, 2017

Jobs in the ICT sector	Number of workers required	Number of placements	Number of job matching services	Success rate
24 – Energy technicians	81	39	97	40%
25 – Electro-mechanics technicians	17	10	18	56%
26 – Electronics technicians	19	16	24	67%
27 - Occupations in telecommunications	25	12	25	48%
28 - Occupations in computer science	94	51	94	54%
60 - Occupations in PTT traffic	6	-	6	0%
69 - Information technology specialists and statisticians	66	22	66	33%
83 - Occupations in the exact sciences and mathematics	5	4	5	80%
Total	313	154	335	46%

Source: NES

A11b. Requests for job matching services by ICT sector employers, for ICT-related jobs, 2016

Jobs in the ICT sector	Number of workers required	Number of placements	Number of job matching services	Success rate
24 – Energy technicians	23	16	26	62%
25 – Electro-mechanics technicians	16	8	17	47%
26 – Electronics technicians	11	8	11	73%
27 – Occupations in telecommunications	42	18	42	43%
28 – Occupations in computer science	187	87	189	46%
60 – Occupations in PTT traffic	1	-	1	0%
69 – Information technology specialists and statisticians	115	54	115	47%
83 – Occupations in the exact sciences and mathematics	12	15	18	83%
Total	407	206	419	49%

Source: NES

A12. Average duration of unemployment (months), by qualifications level

Qualifications level	2016	2017	2018
10	10.50	8.00	-
20	24.59	34.26	31.71
30	21.44	23.43	23.63
40	20.38	20.94	20.36
50	20.31	26.82	26.38
61	26.46	28.02	28.36
62	16.73	19.53	17.80
71	16.65	18.28	17.38
72	18.28	23.23	26.61
80	9.39	19.57	22.75

Source: NES

A13. Average duration of unemployment (months), by activity

Jobs in the ICT sector	2016	2017	2018
24 – Energy technicians	21.11	23.22	22.91
25 – Electro-mechanics technicians	20.68	21.91	21.83
26 – Electronics technicians	20.15	21.03	20.81
27 - Occupations in telecommunications	20.30	20.94	19.58
28 - Occupations in computer science	16.31	16.92	15.98
60 - Occupations in PTT traffic	25.59	24.11	29.04
69 - Information technology specialists and statisticians	22.46	24.81	23.35
83 - Occupations in the exact sciences and mathematics	19.72	21.10	20.33

Source: NES

A14. Average duration of unemployment (months), by age

Age group	2016	2017	2018
15-29	15.74	15.46	14.36
30-54	23.34	25.58	24.88
55+	31.63	34.15	34.91

Source: NES

A15. Expectations with regard to knowledge and skills for the jobs in highest demand, by qualifications level

Job	Required knowledge and skills for qualifications level 1 and 2	Required knowledge and skills for qualifications level 3 and 4
Software engineers	Knowledge of software creation process Knowledge of PHP scripting language Programming languages Swift programming language Knowledge of testing automation tools Java Script Thinking in algorithms Web site development Programming Photo editing programmes Kotlin programming language Knowledge of HTML Analytical skills Software development basics Computer science basics Knowledge of unit and integration testing tools Knowledge of CSS Development of communication protocols Development of mobile applications	Collecting training materials Technical knowledge Knowledge of Visual Basic Web site development Knowledge of a specific programming language Software design Knowledge of Pascal and Basic programming languages Work experience Software development basics Communication skills Organization skills Knowledge of agile methodologies for software development Good knowledge of structural design for embedded systems (firmware, software, hardware) Excellent knowledge of C and C++ programming languages Uploading training content to LMS Mobile applications Development of analytical applications Software analysis Knowledge of embedded development tools (IAR, Keil, STM Cube, MCU Espresso…) Python Java Economics Communication skills Work experience in embedded systems development projects Patience CI/CD Knowledge of Agile software methodology LMS management Development of business applications Knowledge of GIT and similar repo tools Strong analytical skills Knowledge of a specific system Knowledge of test-driven methodologies
ICT analysts	Knowledge of business processes analysis Communication skills Creativity Computer skills Abstract thinking ability Knowledge of statutory business documents Analytical skills	Knowledge of a specific system Knowledge of business processes Prioritization of tasks Product design Market knowledge Computer networks Databases Sales planning Modelling of business processes Communication abilities Data processing Monitoring regulations Market research Analytical skills Leadership Data collection and processing Business modelling

Network and system administration specialists	Technical knowledge Knowledge of software Knowledge of hardware Basic IT skills Hardware and software customer support English language Designing systems Communication skills Installation of systems	Communications Network maintenance System testing English language Network design Research and development of new technologies Analysing and upgrading existing systems Knowledge of hardware Antivirus protection Creating queries Data collection and processing Creating databases Communication in computer networks Development of operational systems
Repair of equipment and technical support	Communication skills Knowledge of a specific programming language Identifying malfunctions Knowledge of software and hardware Repair procedures Technical knowledge	Knowledge of electronics and electrical engineering Knowledge of software development tools for microcontrollers Development of software scripts Electronics basics Software development basics Data collection Identifying malfunctions Software testing Knowledge of devices English language
Various ICT specialists	Design Communication skills Eloquence Knowledge of visual tasks Image processing Video processing programmes Photography Product pitching skills Freehand drawing skills	Testing programmes Programming languages Statistics Detection of problems and logical thinking Computer architecture Knowledge of bioinformation tools Coding Digital electronics Analytical skills Working with scripting languages Working with loaded electronic board development tools Knowledge of equipment and PCB design

A16. Expectations with regard to a significant increase in demand for certain occupations, along with required knowledge and skills

Job	Required knowledge and skills
Computer security Machine learning Virtual reality Artificial intelligence Neural networks Linux and Unix	Design AI / advanced mathematics Web programming Advanced computer programming and algorythmics Java programming language Advanced computer programming Knowledge of machines Computer programming Cloud engineering Administration Knowledge of information technologies Industry 4.0 related knowledge Programming skills JavaScript Specialized certificates HTML Databases Security certification 3D modelling Big data analysis Mathematics and probability Amazon services ANGULAR