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Assessing and Forecasting Current and Future Trends of Ict Employment in European Enterprises

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Abstract: *In the current context, the labor market volatility in the information and communications technology sector (ICT), the challenges faced by companies in identifying and hiring these specialists, as well as the challenges faced by specialists in this field in terms of employment and job retention, necessitate a detailed and comprehensive analysis of the ICT labor market developments in close correlation with the current trends of digitalization of the economy.*
On this premise, the research presented in this article seeks to examine data about European firms that have engaged or tried to hire ICT specialists in the period 2014-2020, as well as the trends for the period 2021-2030. The purpose of the research will be to provide, on the one hand, the development of the selected variables for research during the analysis period and, on the other hand, the trends related to the ICT labor market for the categories of enterprises under study. The study aim will serve as the basis for the development of research questions and hypotheses, which will be tested using two types of methodological techniques, namely linear analysis and linear regression-based predictions.

Keywords: *ICT employment, European enterprises, trends, forecast, linear analysis, linear regression.*

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Introduction

Currently, it is impossible to refute the significant influence that information and communications technology (ICT) and digitalization, in general, have on human society as a whole, given that these technologies have been regarded as the engines of economic progress during the last several decades (Doucek, 2011). The majority of scientific literature recognizes a positive effect of ICT on economic growth (Portillo et al., 2020), with the importance of this sector and its development demonstrated by the increase of the number of companies active in the field, the sector's share of GDP, and the number of specialists working in this field. At the same time, it is evident that the phenomenon referred to cannot manifest itself in the absence of ICT specialists; thus, it is evident that the problems related to employment, the problems related to employability and workforce dynamics in this industry represents a subject that deserves the attention of a scientific research approach.

In order to ensure the development of a digitization system at the level of each economy, ICT professionals are crucial (Leogrande et al., 2022); therefore, the phenomenon of the digital transformation of society has increased the need for specialists with digital skills. On the other hand, because there has been a sharp dynamic or even a certain volatility of the employment models used by European companies in the ICT industry, the evolution of the employment of specialists in this field has begun to show increasing interest of researchers, as the phenomenon in question can impact the economic development of a country and can also be a competitive advantage over other economies.

The subject of the present research starts from the premise that the number of ICT experts in the European Union expanded by 50.5% between 2012 and 2021, which is over eight times the growth for total employment, and that ICT professionals comprised 4.5% of the entire workforce in the EU in 2021 (ICT specialists in employment, 2022).

As human capital is a crucial part of any activity, the study captures certain aspects of the dynamics of the ICT workforce in Europe, while also a certain perspective regarding the need for specialists of European companies in the field of ICT.

The study was conducted within the framework of contemporary realities, which demonstrate that job security and career prospects in the ICT sector are impacted by a multitude of variables other than rigorous specialization and specialized professional abilities. Employers in ICT sector are displaying a growing awareness of the fact that job applicants must

possess a combination of technical and transferable competencies. Therefore, it is anticipated that even among individuals working in the ICT business or specialized in this subject, to be produced certain changes regarding the vision of the idea of employability.

The volatile nature of the labor market in the ICT sector and the difficulties encountered by specialists in this field in terms of employment and job retention can be correlated with the change in the professional profile of those working in this industry, due to the action of multiple factors, the most pertinent of which in this context are rapid technological changes; globalization of markets; the emergence of new ways of working organization; and the demand for specialists with multidisciplinary skills.

In this respect, since labor market statistics are crucial for monitoring of European employment policy, the current research intends to assess data on European enterprises that have hired or tried to recruit ICT professionals between 2014 and 2020. The source of the processed data is the Eurostat's employment statistics in the analysed period. Based on the analysis of data from companies grouped into two categories (enterprises that recruited or attempted to recruit ICT specialists and enterprises that employ ICT specialists), the objective of the research will be realized by presenting, on the one hand: the evolution of the variables considered for research during the period under analysis and, on the other hand, the ICT labor market future trends for the analysed categories of companies. The study objective will serve as the basis for the development of *research questions*:

Q1. How did the labor market change for the two kinds of companies investigated (companies that hired or attempted to recruit ICT professionals and companies that employ ICT specialists)?

Q2. What are the labor market development estimates for the period until 2030 for the two types of examined companies (those that recruited or attempted to recruit ICT professionals and those that employ ICT specialists) from the same perspective?

Review of the literature

Analysis of the labor market may be beneficial to many parties, including government agencies, companies, families, and vocational institutions (Bosselli et al., 2018). At the same time, it is believed that ICT is a key sector for the development of contemporary economies, which also presents an opportunity to increase the international employment rate (Gonzalez et al., 2016). Therefore, governments view ICT specialists as a strategic asset that stimulates economic growth, promotes competitiveness, and boosts business productivity (Garido et al., 2012).

For these reasons, the ICT sector, as the backbone of the Fourth Industrial Revolution, has significant implications for labor markets, and the evaluation of its effects is crucial for the development of policies that support these markets and can bring numerous benefits to workers, organizations, the economy, and society as a whole (Herman, 2020).

Alternatively, the labor market in information and communication technologies has a special relevance because of its constant changes, which reflects the fast development of computer science and associated technologies (Kostoglou et al., 2004). Already, it is apparent that the deployment and acceptance of ICT have permitted and created chances for new methods of working, organizing, and managing work (Hoyos et al., 2013). In this context, it is recommended within the European Union to expand the knowledge, skills, and creativity of the ICT workforce via the effective use of lifelong learning (Varallyai & Herdon, 2013).

This whole collection of variables, such as those documented by the literature and mentioned before, demonstrates the critical necessity of the career management and employability of ICT experts for the survival and growth of organizations in this industry (Marzec et al., 2009). ICT training is intimately tied to employability in the context of a globally networked knowledge economy, where technology skills and procedures are at the center of economic transactions (Garido et al., 2012).

Given that the economic situation to which it refers is continually changing and defined by uncertainty, and that risk and uncertainty are major features that impact the demand and supply of labor, the concerns presented become even more complex. In this regard, it is useful to consider factors that influence the labor market, such as technological change, globalization, rapidly changing markets and services, demographics (the aging of the labor force), environmental and geopolitical factors, which result in the transformation of the employment profile and working modes (Hoyos et al., 2013).

The ICT sector has a higher proportion of highly educated professionals in total employment compared to other sectors of the economy, and the proportion of highly skilled workers has risen steadily over the past decade, in stark contrast to the rest of the sectors of the economy (Barrios et al. 2008). Overall, employment developments in the ICT industry are related with a fragmentation of the labor force and rising disparities in working and job circumstances, such as gender inequality (Kovacs & Casaca, 2008).

Moreover, employability is defined as the degree to which workers possess abilities that the market and employers find desirable and that are

gaining relevance in the ICT industry, particularly for SMEs (Scholarios et al., 2004).

According to Barrett et al. (2001), the examination of issues connected to employability must be founded on a knowledge of the qualities, causes, and combinations between them that might contribute to an individual's greater or lower employability. The elements to which the aforementioned writers allude, which may impact employability, are classified into many categories:

- individual factors, which are further divided into two other categories: unalterable, which cannot be changed (age, labor market history, and criminal record), and alterable, which can be changed to some extent (levels of education and training, difficulties in literacy and calculation, health issues such as drug addiction);

- contextual factors: family (caring for family members restricts people's ability to access jobs or even programs to improve employability), location (if a person lives a certain distance from available jobs, it can be unemployed if it does not have the means of transportation), social networks (the ability to get a job will be influenced by the extent to which a person is aware of vacancies), and institutional factors (the interaction between the tax and social assistance systems).

- demand for labor at the company level, where employability is also determined by the degree to which an individual's characteristics correspond to those required by a firm (for example, if a firm has a particularly negative view of certain characteristics, such as long-term unemployment or old age, a person may be unemployable due to these characteristics);

- demand for labor at the macroeconomic level.

The variety and complexity of the factors that can influence the employability of individuals, including ICT specialists, determine modern employers to constantly adapt their solutions to changing managerial situations, especially if it is considered that, currently, the weight of decisions which must be taken in uncertain and unconventional situations increases significantly at all levels of management

For this reason, supporting decision-making in staff management and their intellectual capacity have assumed strategic significance (Mammadova et al., 2015).

Other contemporary elements identified by some authors (Loogma et al., 2004), such as fast technological development, the globalization of markets, and new methods of labor organization, contribute to the complexity of handling uncertain circumstances. Multiple and hybrid skill profiles are in great demand due to a combination of factors.

Other specialists (Marzec et al., 2009) contend that career patterns have altered drastically, but in the ICT industry and other high-tech industries, these shifts are more evident. This reality is the result of both fast technology advancements and the variety and specialization of ICT experts. In addition, López-Bassols (2002) contends that there is a gap between the skills required by employers and those possessed by the labor force, mostly caused by the rapid changes in skill requirements and classifies the abilities necessary for ICT professionals into three categories: professional - the ability to use advanced IT tools and/or to develop, repair and create them; applied - the ability to apply simple IT tools in general workplace contexts (in non-IT fields); basic or "IT literacy" - the ability to use IT for basic tasks and as a learning tool.

Other publications (Ţiţan et al., 2014) concur with López-Bassols that there is a significant digital skills gap between the requirements of the job market and the digital competencies of people.

Scholarios et al. (2004) emphasize that there is a mismatch between the capabilities of existing and future employees and the demands of enterprises, as well as the temporary nature of labor relations, which makes the ICT industry fragile. In addition, the authors remark that managers of economic organizations are unwilling to enhance the employability of their staff if they are likely to transfer these new abilities elsewhere. In this context, it is deemed vital to narrow the skills gap by identifying, on the one hand, the skills people possess and, on the other, the capabilities employers demand at the time of recruiting (Misra & Khurana, 2017).

Rapid technological advancements raise the unpredictability of the future job profiles of ICT workers. This makes it very difficult for workers to choose their future career path. In addition, the lack of a predetermined professional path creates insecurity in ICT. The definition of qualified staff has evolved greatly. The requirement for a mix of hybrid technical, administrative, and communication abilities stems primarily from the integration of technologies, new methods of organizing work, and the nature of work in information and communications technology. Traditional distinctions between workers and employers are blurred by the tendency toward unstable employment patterns and the advent of new kinds of self-employment. Given the rapid rate of technological change and the rising need for learning and adaptability, the issue arises as to how personnel can sustainably meet these expectations (Loogma et al, 2004).

Therefore, a paradigm shift becomes necessary in terms of how both employees and employers look at things, which is why, in the current

context, it seems that having only professional skills, in the classical sense of the term, became a necessary but not sufficient condition.

This is the reason why some authors (Sehgal & Nassim, 2018) argue that technical, personal, and interpersonal skills, as well as organizational knowledge, are the most important factors which influence the employability.

This opinion is supported by other authors in the scientific literature who assert that the management of employability, where it exists, tends to be focused on evaluation and development plans, primarily to keep ICT professionals up-to-date by increasing employee engagement with the organization and, to a lesser extent, to optimize the full use and development of skills (Scholarios et al, 2004). In addition, the same authors note that developing the employability of ICT professionals is not an absolute priority, but a luxury element for which little time and effort can be expended, and that, in general, employers do not take full responsibility for bridging perceived skills gaps in their enterprises, either through strategies to retain highly qualified staff or through costly training, mentoring, or other development strategies.

Employers can choose either internal or external strategies to address such situations and deal with the tense labor market (López-Bassols, 2002). Internal strategies involve using the existing workforce more efficiently and productively, while external strategies involve expanding the pool of potential employees and attracting new recruits or using external workers.

Other authors (Sehgal & Nasim, 2018) highlight the significance of workplace learning by emphasizing the need for specialists to go beyond the stage of developing solid technical knowledge and to cultivate other important skills, such as transversal skills, which are frequently acquired through on-the-job learning and cannot be obtained through coursework alone.

Methodology

The study was conducted based on the Eurostat data collected between 2014–2020 from 35 states from the European region (Belgium, Bulgaria, Bosnia and Herzegovina, Czechia, Denmark, Germany, Estonia, Ireland, Greece, Spain, France, Croatia, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Hungary, Malta, Netherlands, Austria, Poland, Portugal, Romania, Slovenia, Slovakia, Finland, Sweden, Iceland, Norway, United Kingdom, Montenegro, North Macedonia, Serbia, Turkey) focusing on:

1. ***Enterprises that recruited or tried to recruit ICT specialists***.

There were analyzed 5 information society indicators based on percentage of enterprises without financial sector with 10 or more employees and self-employed persons:

r1. Ent.R/T.pers.ICT (Enterprise recruited/tried to recruit personnel for jobs requiring ICT specialist skills)

r2. Ent.HtF.vac.ICT (Enterprise had hard-to-fill vacancies for jobs requiring ICT specialist skills)

r3. Ent.nHtF.vac.ICT (Enterprise had no hard-to-fill vacancies for jobs requiring ICT specialist skills)

r4. Dif.R.ICT.Lack.Apl. (Difficulty to recruit ICT specialists: Lack of applications)

r5. Dif.R.ICT.Lack.Q (Difficulty to recruit ICT specialists: Applicants' lack of relevant ICT qualifications from education and/or training)

2. ***Enterprises that employ ICT specialists***, with 10 indicators:

e1. All.Ent.w.o.Fs (All enterprises, without financial sector (10 or more employees and self-employed persons)

e2. S.Ent. (Small enterprises (10-49 employees and self-employed persons), without financial sector)

e3. M.Ent. (Medium enterprises (50-249 employees and self-employed persons), without financial sector)

e4. SMEs (SMEs (10-249 employees and self-employed persons), without financial sector)

e5. L.Ent. (Large enterprises (250 employees and self-employed persons or more), without financial sector)

e6. VS.Ent.(Very small enterprises (0-9 employees and self-employed persons), without financial sector)

e7. Micro.Ent. (Micro enterprises (0-1 employees and self-employed persons), without financial sector)

e8. Mini.Ent. (Mini enterprises (2-9 employees and self-employed persons), without financial sector)

e9. Mfg. (Manufacturing (10 or more employees and self-employed persons))

e10. Mfr.prod. (Manufacture of products based on: food, beverages, tobacco, textile, leather, wood, pulp and paper; publishing and printing (10 or more employees and self-employed persons))

Based on these data, the objectives and questions of the research, the following hypotheses are formulated within the study:

Research hypotheses

H1. During the period 2014-2020 the sinusoidal character of the variable enterprises that recruited or tried to recruit ICT specialists shall be verified for the collected data sample.

H2. During the period 2014-2020 the sinusoidal character of the variable enterprises that employment ICT specialists shall be verified for the collected data sample.

H3. In the period 2021-2030 the upward trend of the variable enterprises that recruited or tried to recruit ICT specialists shall be verified for the collected data sample.

H4. In the period 2021-2030 the upward trend of the variable enterprises that employment ICT specialists shall be verified for the collected data sample.

On the basis of the collected information from several annual periods, a trend analysis was projected by plotting the data on a horizontal line in order to discover general patterns from the given information. It is most commonly used to demonstrate data movements over a period of time or to demonstrate a correlation between two variables. Consequently, it is recommended to use the linear trend line with linear information sets if the data points on a chart have an appearance that is comparable to that of a continuous line on the chart. An upward or downward trendline is generally used to describe a steady increase or decrease in value during time. The reliability of a trendline is measured by its R^2 value; the closer the R^2 value is to one, the closer the trendline matches the data it is measuring. At the same time, given the plotting data that rapidly grows or declines and then levels out, the logarithmic trendline was considered because it is capable of containing both positive and negative numbers.

For the hypotesis H3 and H4, will be employed forecasting methodology. Forecasting is the process of calculating or predicting a forthcoming data based on current values. If an x-value is provided, the projected value is represented by the letter "y." The known values are the existing x- and y-values, and the new value is projected by applying linear regression to estimate the given data. Based on this aspect the FORECAST Excel function was used, based on the equation $m + nx$, where:

$$m = \bar{y} - n\bar{x}$$

and

$$n = \frac{\sum (x-\bar{x})(y-\bar{y})}{\sum (x-\bar{x})},$$

where x and y are the averages for the samples.

In order to better define the forecast based on the historical values existing in the period 2014-2020, we used the FORECAST.ETS function based on the Exponential Smoothing (ETS) algorithm. Because of the nature of this function, it is necessary to structure the timeline so that there is a continuous step between the various points. Furthermore, the FORECAST.ETS function, based on the Exponential Smoothing (ETS) technique, was used to better define the forecast based on the historical values existing in the period 2014-2020. The anticipated value is a prolongation of the historical values at the goal date that has been selected.

The next parameters are passed into the function syntax:

- Target_date - requisite argument; time or period for prediction (x value). represents the point in the chronology at which a prediction should be calculated.

- Values - requisite argument; existing or previous values (y values), contains the data-dependent matrix or range, also called y-values

- Timeline - requisite argument; numeric chronology values (x values). is the independent matrix or range of values, also called x values.

- Seasonality – noncompulsory; seasonality calculation (0 = no seasonality, 1 = automatic, n = length of season in chronological units), represents the length of the seasonal pattern expressed in chronological units.

- Data completion – noncompulsory; missing data processing (0 = treats as zero, 1 = average), by default, the function will provide the missing data points by averaging the neighboring data points, and if zero is provided, it will treat the missing data points as zero.

- Aggregation – noncompulsory; controls which function is used to aggregate data points when the timeline contains duplicate values. The default value is 1, which specifies AVERAGE.

The trend of increasing or decreasing the percentage of values (T_{per}) used in this study, depending on the previous year, was also analyzed. In order to find out the percentage increase of the value from 2015 with reference to the year 2014, we realized the difference between the new value (N_v) and the value of the previous year (P_v), divided to the value of the previous year $T_{per} = (N_v - P_v)/P_v$. For indicators r4 and r5 of ***Enterprises***

that recruited or tried to recruit ICT specialists, the trend was analyzed only for 2020, due to lack of data reported in the period 2014-2019.

Results and discussions

Enterprises that recruited or tried to recruit ICT specialists

Analyzing the data related to Enterprise recruited / tried to recruit personnel for jobs requiring ICT specialist skills in the European states during the 7 years (2014-2020) we can observe a decreasing trendline at this level (figure 1).

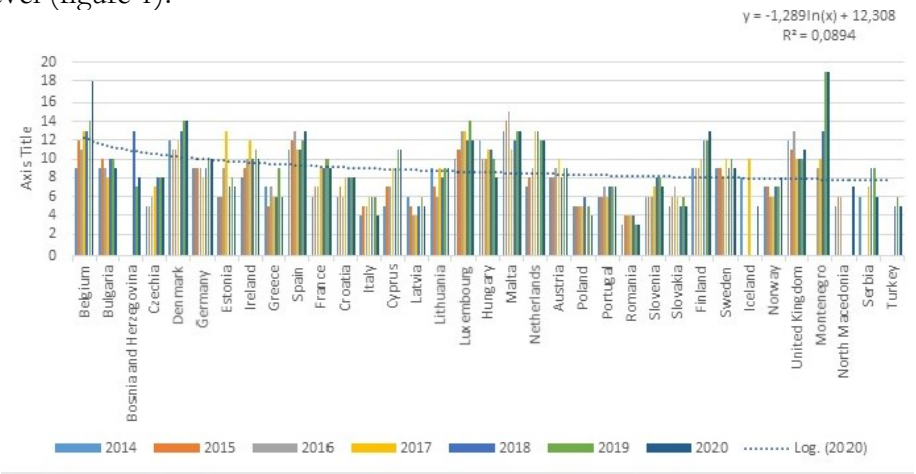

Figure 1. Trend analysis 2014-2020 for indicator r1

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

Among the States, Belgium and Montenegro presented the highest proportion of enterprises employing ICT specialists, with 18% and 19% respectively in 2020, compared to 2014. The lowest percentage of businesses that recruited or tried to recruit individuals with ICT specialist skills was offered by Italy, Poland, and Romania, each with an average of 4 percent of enterprises falling into this category (figure 2).

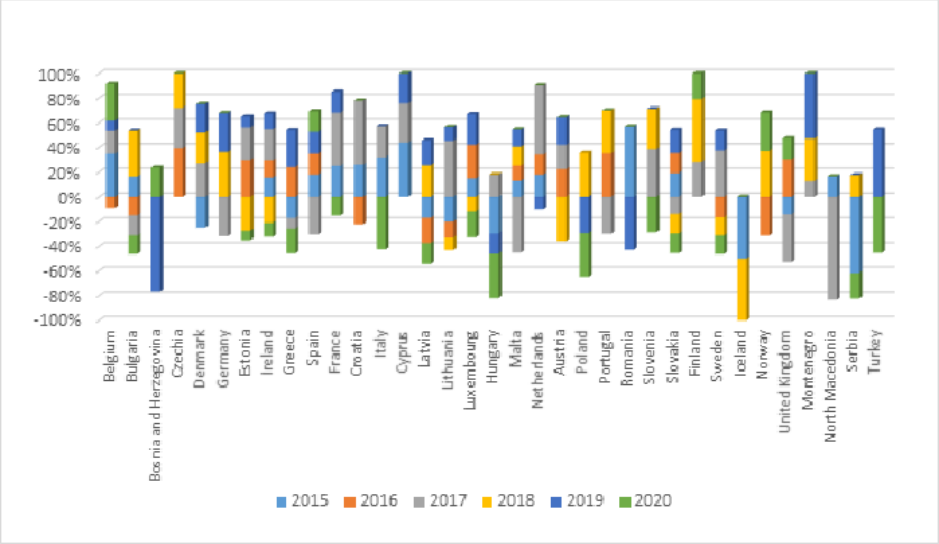

Figure 2. Analysis of the percentage increase / decrease trends 2014-2020 for indicator r1

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

For indicator r2, 5 (Belgium, Luxembourg, Malta, Netherlands, Finland) out of the 35 states have 8 to 11 percentage of enterprises that had hard-to-fill vacancies for jobs requiring ICT. Also, it can be seen a decreased trendline from the first year of recorded data (2014) to the last one (2020), the difference between the two trendlines the difference between the two being about 3% (figure 3).

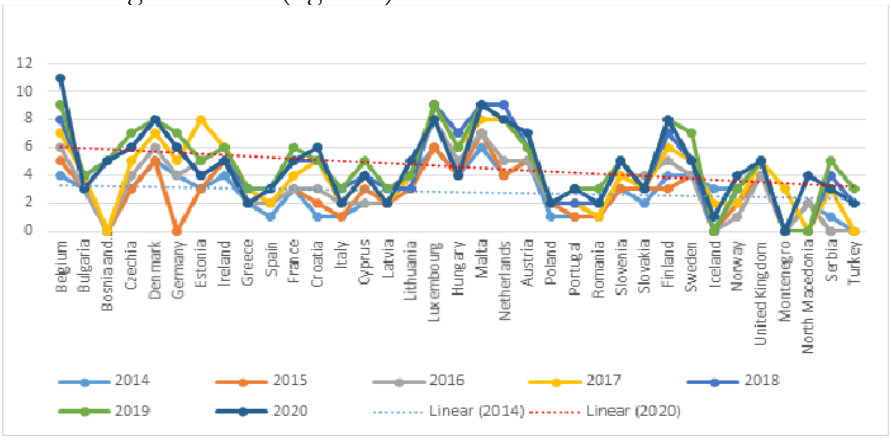

Figure 3. Trend analysis 2014-2020 for indicator r2

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

The trends of increase and / or percentage decrease of the analyzed period (for r2) starting with 2015, highlight the fact that the largest percentage decreases, on average, are registered in the case of Germany, Hungary, Iceland, Montenegro, North Macedonia and Serbia. Bosnia and Herzegovina is the only state in this indicator with no percentage increase or decrease (figure 4).

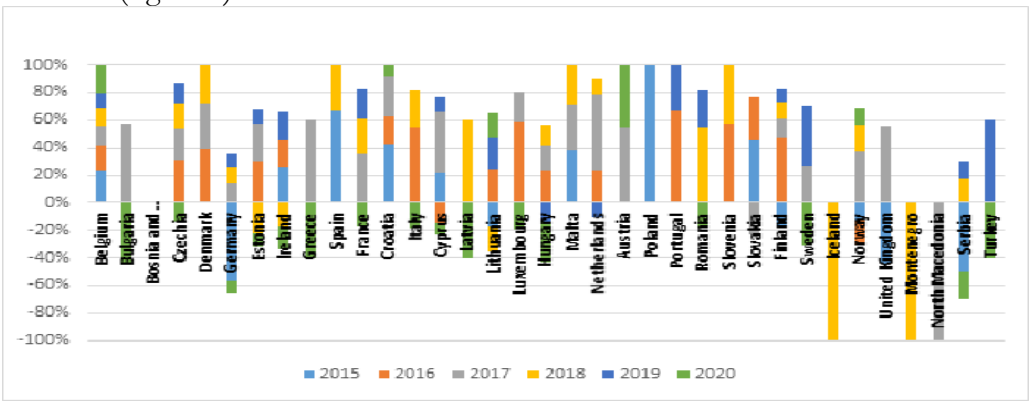

Figure 4. Analysis of the percentage increase / decrease trends 2014-2020 for indicator r2

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

Regarding the indicator r3. Ent.nHtF.vac.ICT, the highest percentage of enterprise that had no hard-to-fill vacancies for jobs requiring ICT specialist skills is met in Spain (up to 10%) and Montenegro (up to 13%). At the opposite pole is Romania, followed by Bosnia and Herzegovina, Iceland and Turkey (figure 5).

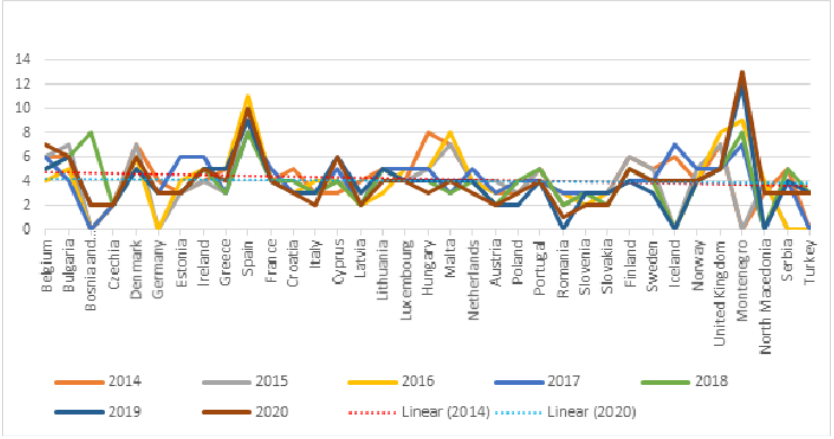

Figure 5. Trend analysis 2014-2020 for indicator r3

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

The following analysis for r3 is graphically represented below and set in the foreground the previous data for percentage increase / decrease trends 2014-2020 (figure 6).

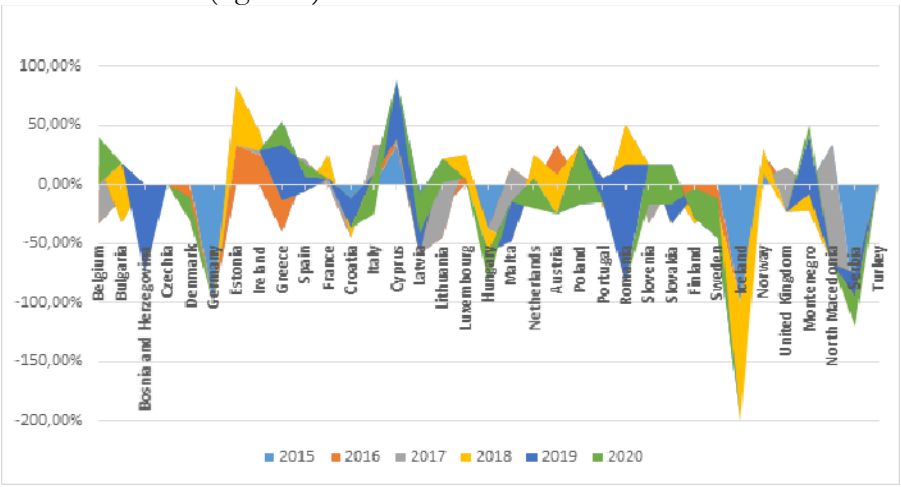

Figure 6. Analysis of the percentage increase / decrease trends 2014-2020 for indicator r3

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

When it comes to filling positions for information and communication technology professionals, enterprises encounter substantial challenges due to a lack of applications (r4), which will only be recorded by a slightly lower spectrum of enterprises in 2020. In the mentioned year, businesses that recruited or attempted to attract information and communication technology specialists were met with the same challenges. The highest percentages recorded for this indicator are found in Belgium (8%) followed by Netherlands (7%) and Malta (6%). Also, no data was available or submitted from Bosnia and Herzegovina, Czechia, Ireland, Greece, Italy, Lithuania, Romania, Iceland, United Kingdom, Montenegro, North Macedonia and Turkey (figure 7).

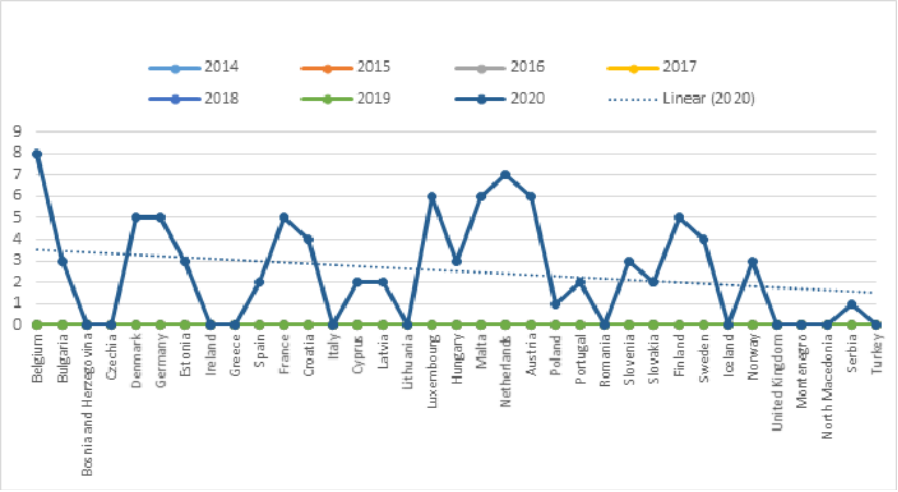

Figure 7. Trend analysis 2014-2020 for indicator r4
(Source: authors' own conception based on Eurostat data collected between 2014–2020)

The same aspects stand for indicator r5, where the data available are found only for 2020, regarding difficulty to recruit ICT specialists: applicants' lack of relevant ICT qualifications from education and/or trening (figure 8).

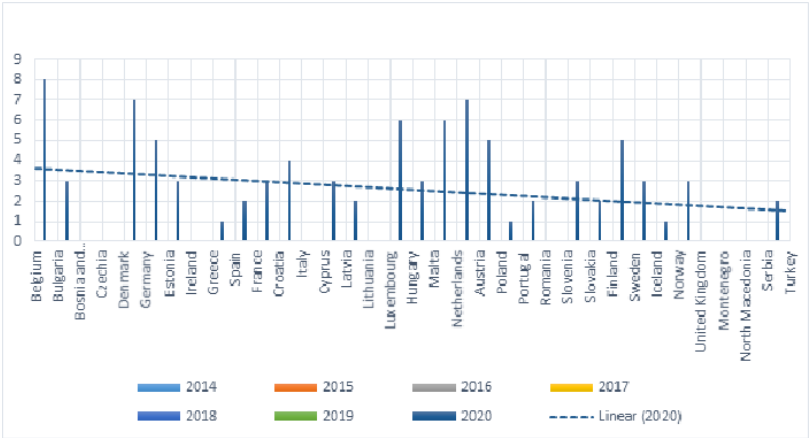

Figure 8. Trend analysis 2014-2020 for indicator r5
(Source: authors' own conception based on Eurostat data collected between 2014–2020)

Based on the analysis and the results obtained, it can be observed that the sinusoidal character of the variable *Enterprises that recruited or tried to recruit ICT specialists* is verified during the period 2014-2020 for the collected data sample (hypothesis H1 is validated).

Enterprises that employ ICT specialists

According Eurostat provided data among the 35 European states, in the last decade, it can be observed that all enterprises, without financial sector reported consistent data regarding Enterprises that employ ICT specialists. ICT specialists were relatively more numerous in Ireland and Finland (28%) by the year 2014 shortly followed by Hungary and Netherland (27%). As moving forward to the year 2016, number of persons employed as ICT specialists grew for Ireland (35%) but at the same time decreased for states like Romania (11%). Moving forward, the trendline remains constant with a slightly decreasing variation of 2% between 2019-2020, the highest percentage of enterprises (29%) being met by 2020 in Hungary, Malta and United Kingdom.

Regarding these analyses some states data was not available or had low reliability for this indicator, such as Iceland (for 2015, 2016, 2018, 2019), Montenegro (for 2014, 2015), North Macedonia (between 2017-2019), Serbia (for 2015, 2016) and both Turkey and Bosnia and Herzegovina (between 2014-2017) (figure 9).

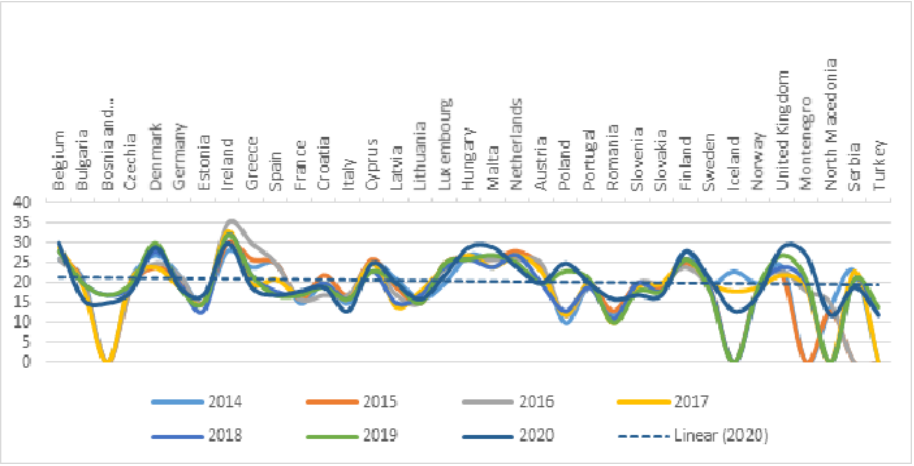

Figure 9. Trend analysis 2014-2020 for indicator e1

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

Moving forward the trend analysis the analysis was focused on 7 categories of enterprises based on their employees and self-employed persons among 2014-2020.

For indicator e2. S.Ent, the trendline for the analyzed period is almost identical in a descending slope. The states with the highest percentage data provided were Ireland, with the highest point registered in

2016 (30%), followed by Greece that in the same year reached 25%. By the year 2020 Ireland leads the ranking with 26% of small enterprises that employ ICT specialists followed by a 2% difference from Hungary and the United Kingdom (24%). Also, for this indicator, some states do not have available or reliable data: Turkey and Bosnia and Herzegovina (between 2014-2017), Serbia (in 2015 and 2016), North Macedonia (between 2017-2019) and Iceland (2018, 2019) (figure 10).

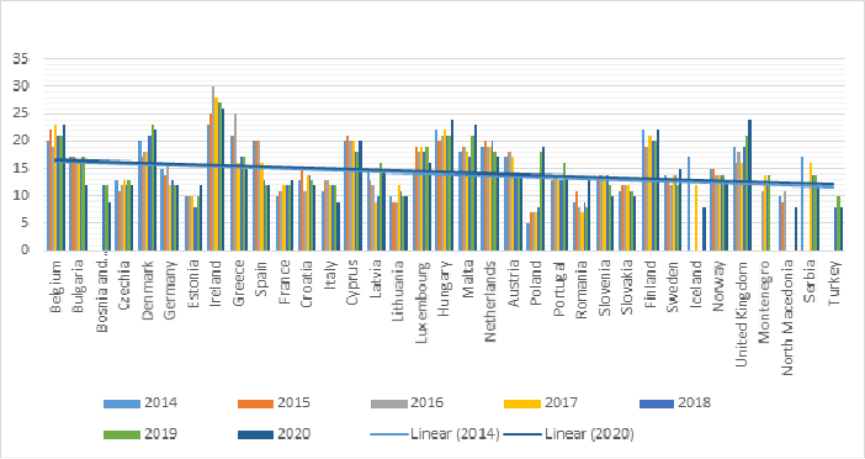

Figure 10. Trend analysis 2014-2020 for indicator e2
(Source: authors' own conception based on Eurostat data collected between 2014–2020)

In the last decade, the progression slightly decelerated for **e3. M.Ent.,** comparing the two trendlines from 2014 to 2020. Despite this decelerated trend, medium enterprises provided higher employability compared to the previous indicator (*e2* with an average of 16%), with an average of 42% in the analyzed period for the 35 states (figure 11).

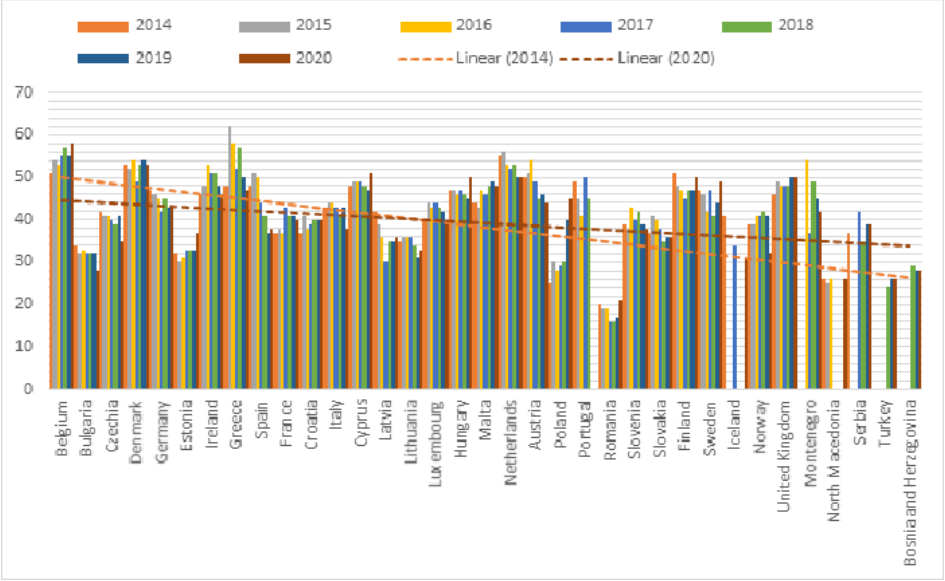

Figure 11. Trend analysis 2014-2020 for indicator e3

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

According to the European Commission, 99% of all firms in the European Union (EU) are considered to be classified as small and medium-sized enterprises (SMEs). The term "small and medium-size enterprises" (SMEs) refers to companies that do not exceed a specified level in terms of their sales, capital, or number of workers. The characteristics of a small or medium-sized business are defined in a manner that is unique to each nation (SME). There are some size requirements that need to be fulfilled, and on sometimes, the sector where the enterprise is active will also be taken into consideration. The criteria provided by the EU are more precise. According to these classifications, a small-sized organization is an enterprise that has less than 50 employees, and a medium-sized enterprise is a business that has 50 to 249 employees.

The trendline analyses on indicator e4. SMEs reflects a growth of 5% between 2014 and 2020. The lowest average point in this time period is registered by Romania and Turkey, with 11%, meanwhile the highest average point is represented by Ireland with 30% (figure 12).

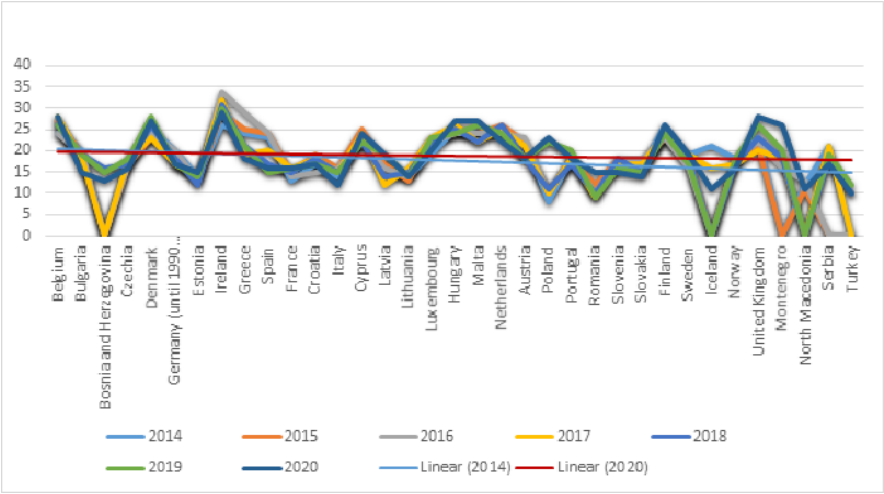

Figure 12. Trend analysis 2014-2020 for indicator e4
(Source: authors' own conception based on Eurostat data collected between 2014–2020)

Large enterprises (e5.) have a ratio of 75 percent, whereas small and medium-sized businesses only have 19 percent. During the same time period, between 2014 and 2017, the highest recorded average statistics for e5. L.Ent. was approximately 77%. The problem of enterprises that employ information and communications technology specialists is more prevalent in Romania, where the ratio between 2014 and 2020 reaches 45 percent, making it the only state in this category with a percentage lower than 60 percent (figure 13).

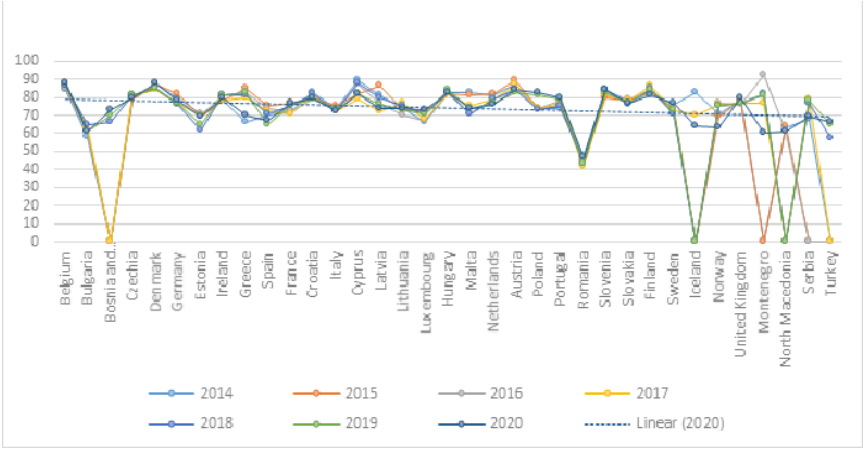

Figure 13. Trend analysis 2014-2020 for indicator e5
(Source: authors' own conception based on Eurostat data collected between 2014–2020)

For the next 3 indicators e6. VS.Ent., e7. Micro.Ent. and e8. Mini.Ent. there is a small amount of data available to be analysed.

For e6, 5 states provided such kind of information for Very small enterprises, starting form 2017. The highest percentage of enterprises here is available between 2017-2020 for United Kingdom (10% ratio) followed by Portugal (7%), Sweden (4%), Spain (3%) (figure 14).

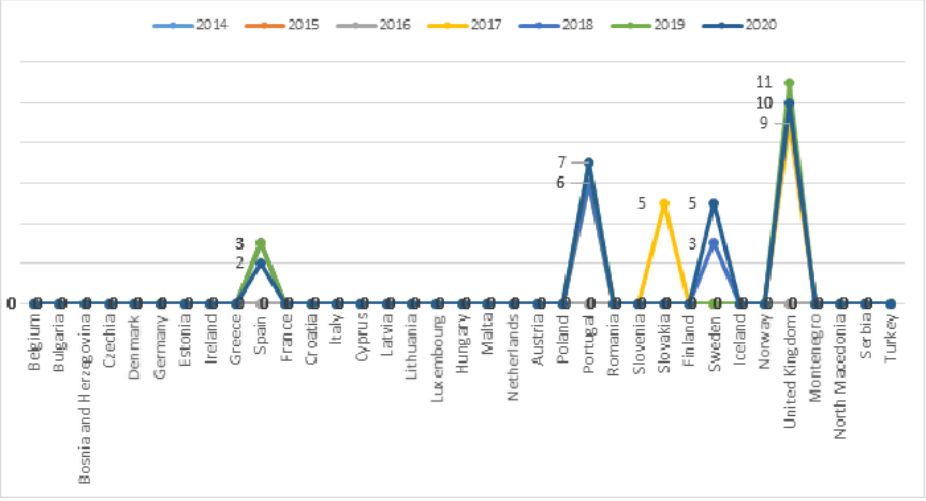

Figure 14. Trend analysis 2014-2020 for indicator e6

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

The graphic from indicator e7. Micro.Ent. presents the only available data for Portugal (2020), Slovakia (2017) and Sweden (2018, 2020) (figure 15).

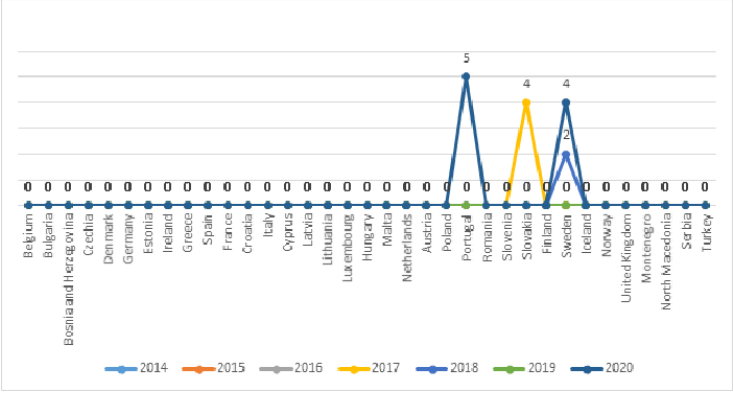

Figure 15. Trend analysis 2014-2020 for indicator e7

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

Mini enterprises (e8.) graphic represent the available data for the following states: Belgium (10%, 2018-2020), Netherlands (8%, 2018-2020), Portugal (7%, 2017), Slovakia (7%, 2017), and Sweden (6%-7%, 2018, 2020) (figure 16).

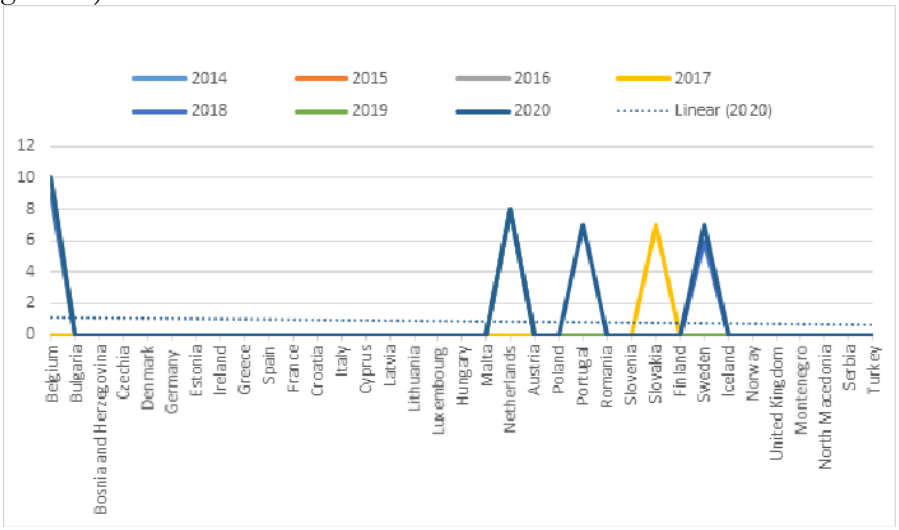

Figure 16. Trend analysis 2014-2020 for indicator e8

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

In the last decade, Manufacturing enterprises with 10 or more employees and self-employed persons (e9.) trendline had recorded a decrease of 5% from 2014 to 2020. Therefore, analyzing the graphic below we can consider that some European states are consistent in providing data with low reliability for this indicator. Greece followed by Belgium and Bosnia and Herzegovina are the first three states that for at least 4 or more than 5 years provide no such data. From all 35 countries analyzed, Ireland has the highest percentage of enterprises (37% average) being in the first position of the ranking. The last position is occupied by Romania, with an average of 9% based on the data available for every year during 2014-2020 (figure 17).

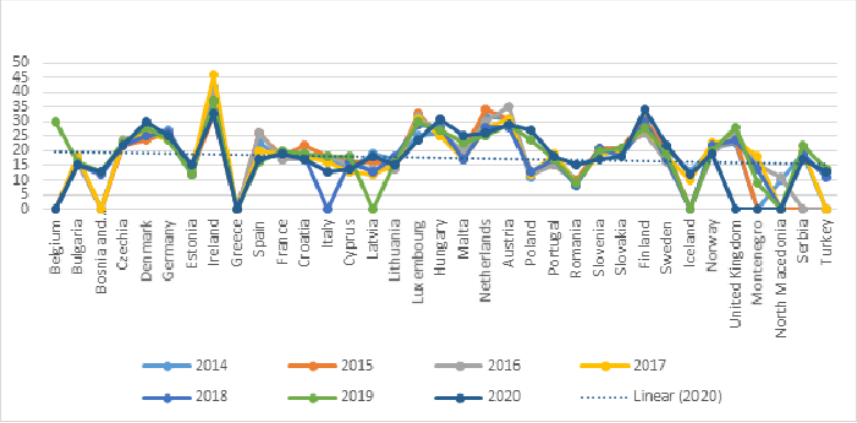

Figure 17. Trend analysis 2014-2020 for indicator e9
(Source: authors' own conception based on Eurostat data collected between 2014–2020)

The last indicator e.10, which refers to manufacture of products based on: food, beverages, tobacco, textile, leather, wood, pulp and paper; publishing and printing, provides a constant linear trendline in a relatively slight decrease. One more time, Ireland is the leading state based on the average percentage (32%) of enterprises during the related period of time, and Romania is situated as the last state with the lowest percentage (7%) (figure 18).

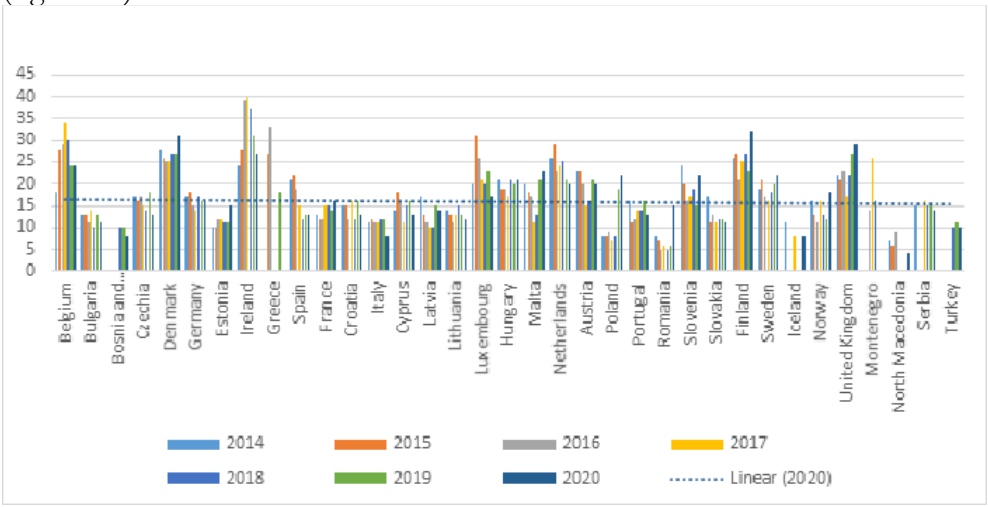

Figure 18. Trend analysis 2014-2020 for indicator e10
(Source: authors' own conception based on Eurostat data collected between 2014–2020)

Based on the analysis and the results obtained, it can be observed that the sinusoidal character of the variable *Enterprises that employ ICT*

specialists is verified during the period 2014-2020 for the collected data sample (hypothesis H2 is validated).

Forecast 2021-2030

Based on the provided data from Eurostat, we managed to forecast for the time period 2021-2030, the future trend of ***Enterprises that recruited or tried to recruit ICT specialists*** and ***Enterprises that employ ICT specialists***, according to the indicators previously mentioned. The prediction was made for the 35 European states using percentage of enterprises as measurement unit.

Attempting to predict variations in employment is a highly difficult task since it needs analysts to both estimate how technology will develop and how labor markets will change and also the interest that the individuals will show towards the emerging technologies.

The forecasting takes into account the evolution of the previously analyzed indicators, for a period of approximately 10 years, between 2021-2030 based on the historical values existing until 2020. For this reason, the graphical representations for each indicator are represented separately for the 35 European states, starting with 2020 for the analysis of future trends.

Focusing on ***Enterprises that recruited or tried to recruit ICT specialists and its 5*** society indicators the expected trends are growing. For indicator r1. Ent.R.T.pers.ICT the highest percentage of enterprises is met in Montenegro starting from 2021 (26%) to 2030 (54%) the increase registered every year being 7%. Most states are experiencing increases, but the forecast also shows states whose percentage is set to fall sharply by the year 2030 (Hungary, Romania, Iceland, North Macedonia) (figure 19).

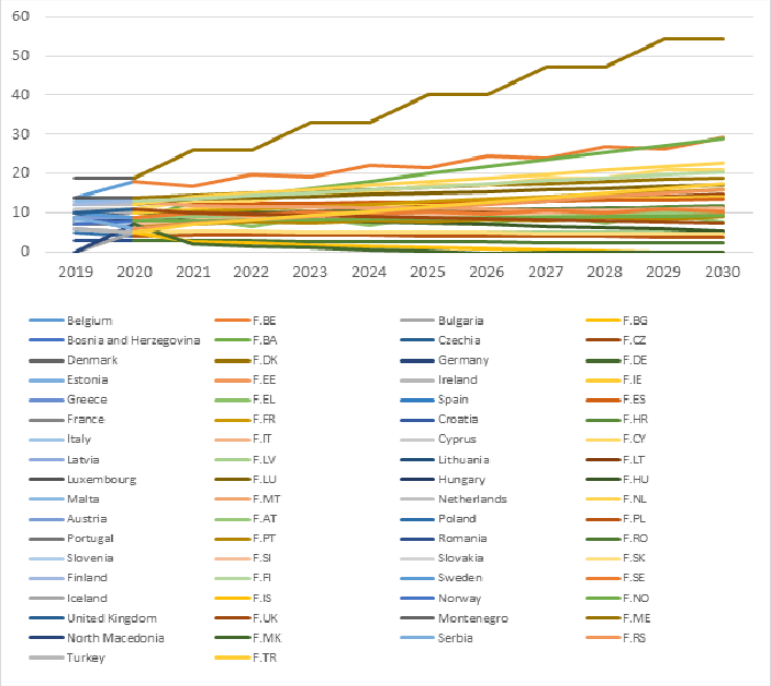

Figure 19. Forecast for indicator r1

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

Based on the forecast resulted from r2. Ent.HtF.vac.ICT, Belgium records the highest increase with an average of 17% between 2021-2030, followed by Netherland (14%) and Bosnia and Herzegovina (11%). Although, many states have an ascendent trendline, Iceland and Montenegro records percentages equal to zero for this period (figure 20).

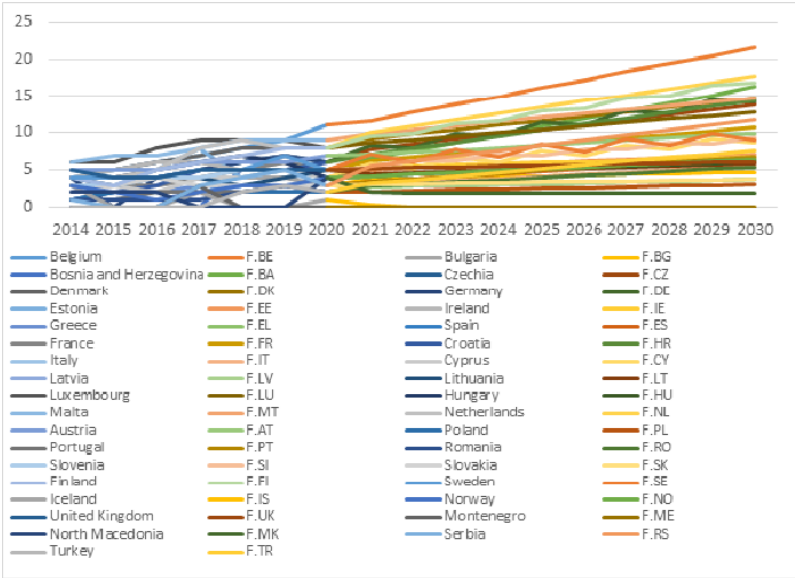

Figure 20. Forecast for indicator r2

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

The previous indicator (r2) is in antithesis with r3 based on the percentage of enterprises that had no hard-to fill vacancies for jobs requiering ICt specialists where Montenegro leads the ranking with an average of 25%, based on the resulted forecast represented below (figure 21).

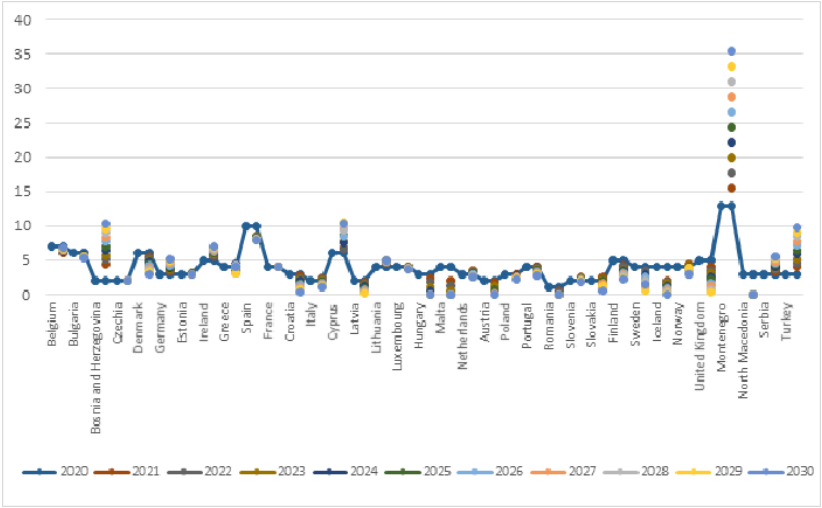

Figure 21. Forecast for indicator r3

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

The forecast of indicator r4 highlight a decrease from 2020 to 2021 for all 35 states regarding the difficulty to recruit ICT specialists, lack of applications, and starting from 2021 the slope has an ascending trend until the last year (2030). Bosnia and Herzegovina, Ireland, Italy, Lithuania, Romania, United Kingdom, Montenegro and North Macedonia are located at pole 0 due to the lack of historical percentages recorded in previous years (figure 22).

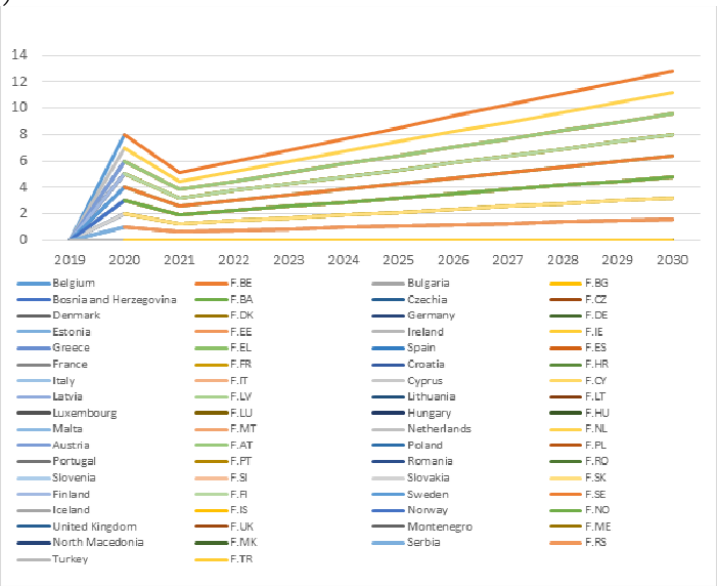

Figure 22. Forecast for indicator r4

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

The last indicator forecasted r5, based on *applicants' lack of relevant ICT qualifications from education and/or training* follows the pattern of the previous one regarding the slope between 2020-2021, followed by a consistent growth starting from 2022 until 2030 (figure 23).

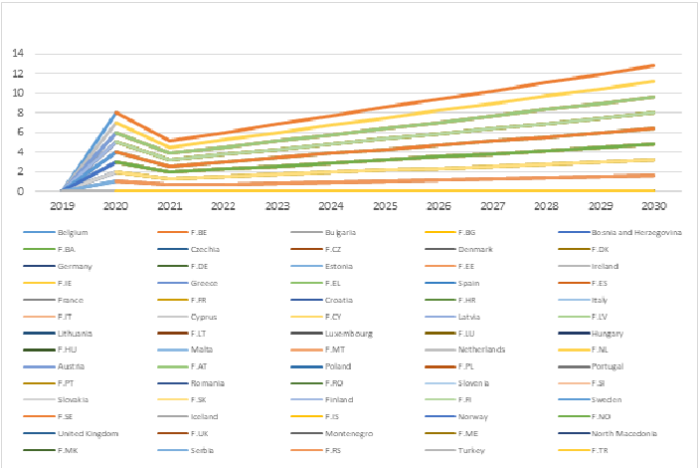

Figure 23. Forecast for indicator r5

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

According to the data submitted for analysis and the results obtained, during the period 2020-2030 the upward trend of the variable *Enterprises that recruited or tried to recruit ICT specialists* for the collected data sample is checked (hypothesis H3 is validated).

Moving forward to the forecast of *Enterprises that employ ICT specialists*, indicator e1. All.Ent.w.o.Fs, the forcast divides the trendline into two almost equal halves: ascending and descending (figure 24).

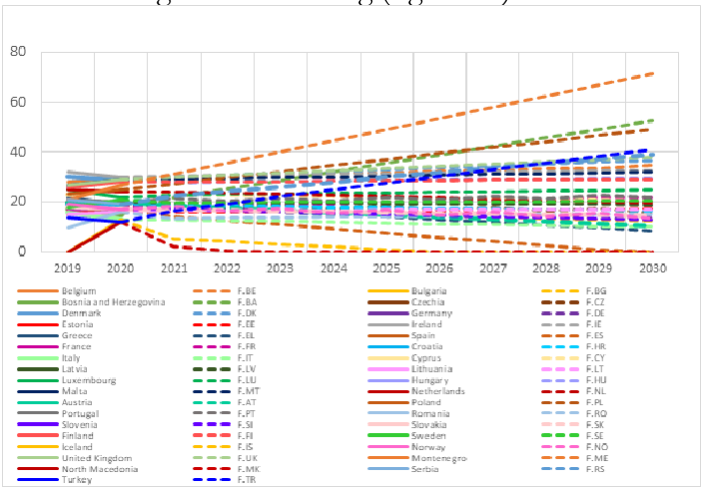

Figure 24. Forecast for indicator e1

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

The ascending trendline focuses on 17 European states the first position being occupied by Belgium with an average rate of 32% the highest forecasted percentage of enterprises being recorded in 2030 with 72%, and followed by Bosnia at a distance of 20 percent in the same year (figure 25).

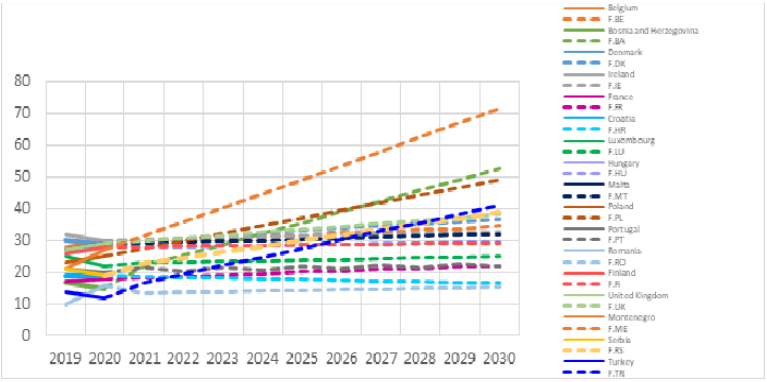

Figure 25. Ascending Trendline Forecast for indicator e1

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

The descending trendline forecast involve 18 of the 35 states, the lowest recorded data during 2021-2030 being met by North Macedonia, Iceland and Spain with the steepest decline since 2021 (figure 26).

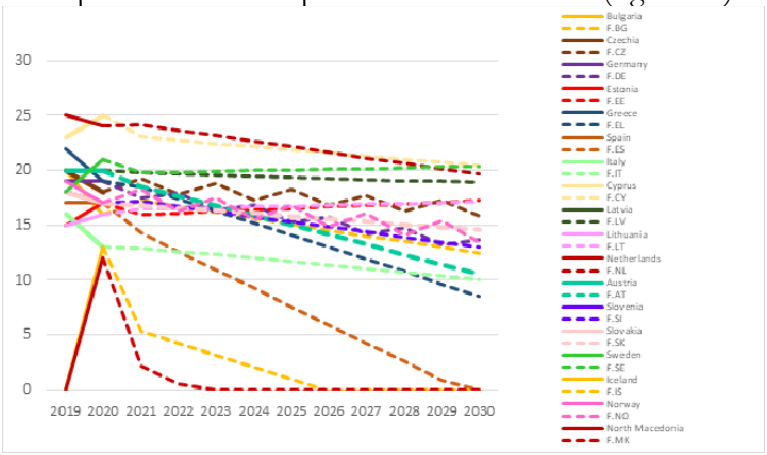

Figure 26. Descending Trendline Forecast for indicator e1

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

Analyzing the small enterprises (e2) forecast the trendline is on average slightly ascending. North Macedonia conjunctively with Spain and Iceland records 0% of Enterprises that employ ICT specialists on this sector.

At the other end among the best rated states are Poland with an average of 30%, Bosnia and Herzegovina (25%) and United Kingdom (28%) (figure 27).

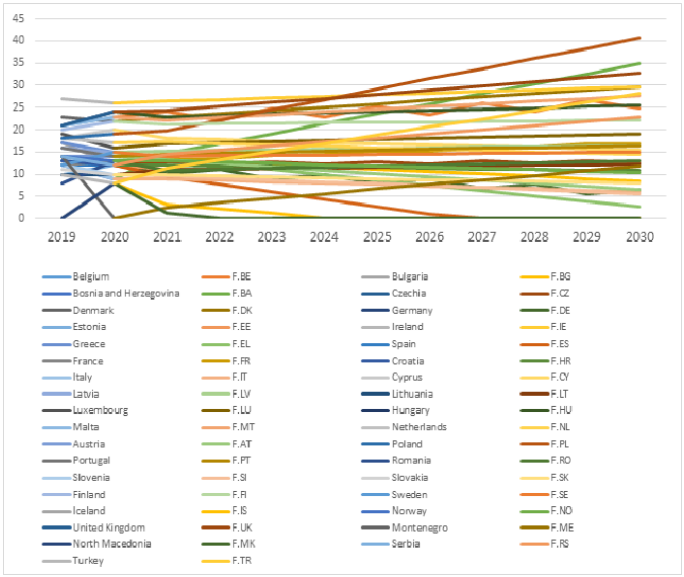

Figure 27. Forecast Forecast for indicator e2
(Source: authors' own conception based on Eurostat data collected between 2014–2020)

According to the next indicator (e3) te forecast of medium enterprises emphasize Montenegro with the highest percentage starting from 2021 (59%) seconded by Belgium with 57% in the same year. Moving forward based on the forecast Montenegro keeps the first position in percentage of enterprises until 2030 (figure 28).

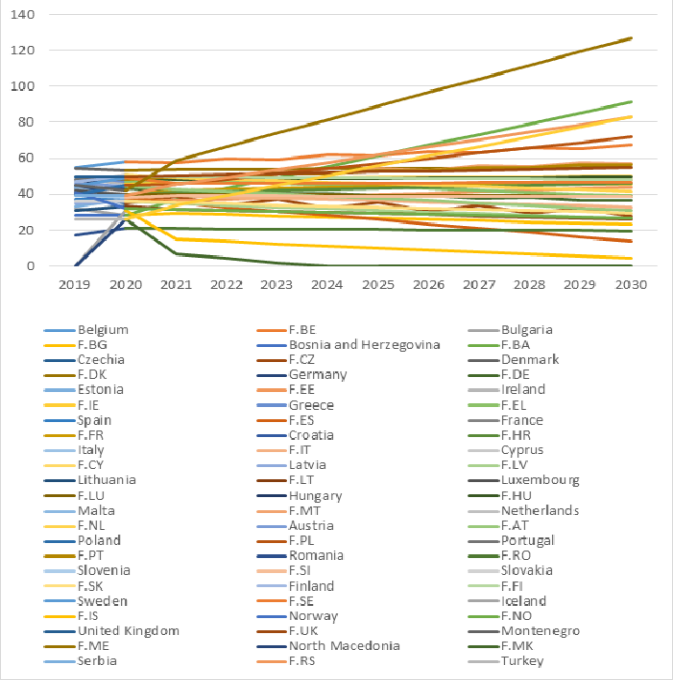

Figure 28. Forecast for indicator e3

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

The generated forecast for 2021-2030 in small and medium-sized enterprises (e4) keeps Montenegro on the first place and North Macedonia, Iceland and Spain on the last place, based on the trendline throughout the analyzed period. The analysis allows us to conclude that there are various similarities among the 35 states regarding the increase and decrease of percentages compared with the previous indicator (figure 29).

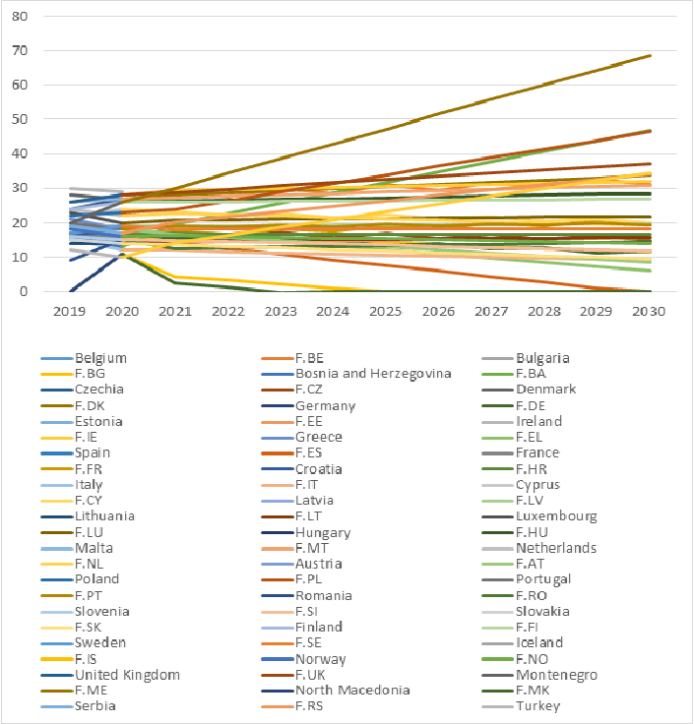

Figure 29. Forecast for indicator e4

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

As can be seen from the data presented below regarding indicator e5. L.Ent., the percentage of large Enterprises that employ ICT specialists is the highest of all indicators analyzed for this section. Bosnia and Herzegovina have a starting forecast point of 93% in 2021, closely succeeded by Montenegro with 98% (figure 30).

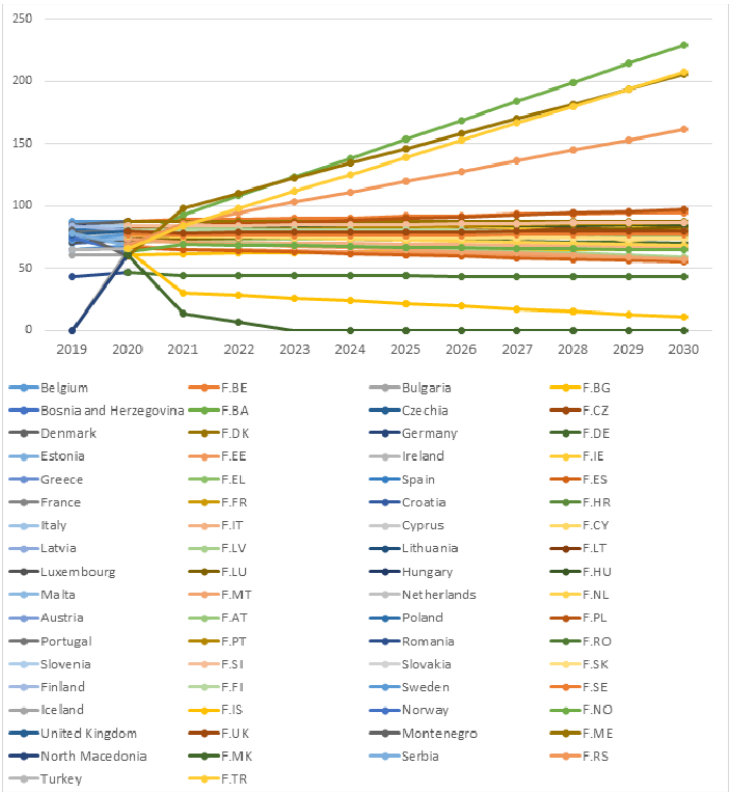

Figure 30. Forecast Forecast for indicator e5
(Source: authors' own conception based on Eurostat data collected between 2014–2020)

Through e6. VS.Ent. forecast, only 4 states will increase percentage in e6. VS.Ent based on the historical data available most ups and downs percentages being recorded during the period of 2021-2030 by Sweden. With an average of 25% United Kingdom leads the forecast with the highest average percentage forecasted in the considered period (figure 31).

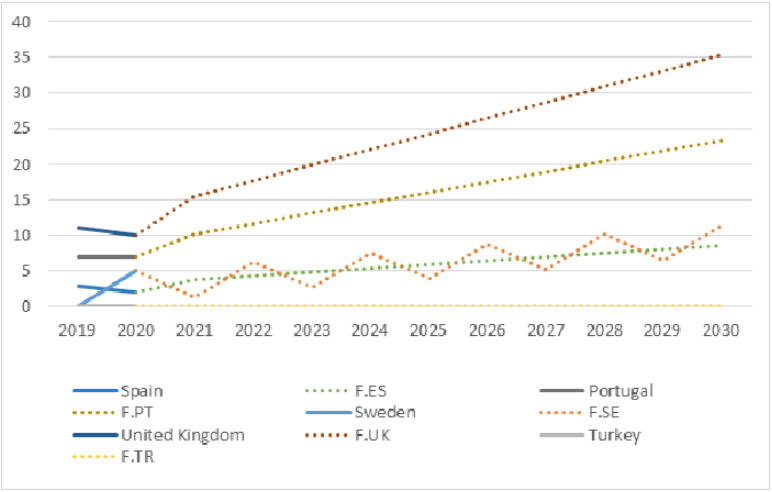

Figure 31. Forecast for indicator e6
(Source: authors' own conception based on Eurostat data collected between 2014–2020)

The next graphic for indicator e7. Micro.Ent. displays only two of 35 states with available historical data, resulting in a growing trendline forecasted between 2021-2030: Portugal and Sweden (figure 32).

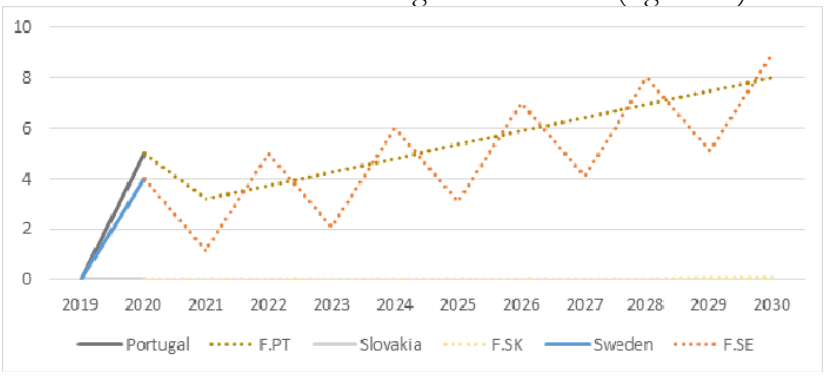

Figure 32. Forecast for indicator e7
(Source: authors' own conception based on Eurostat data collected between 2014–2020)

Mini enterprises (e8.) are represented by 3 states from Europe, where Belgium has an average forecast 22%, Netherland 18% and Sweden 10% in an upward trendline (figure 33).

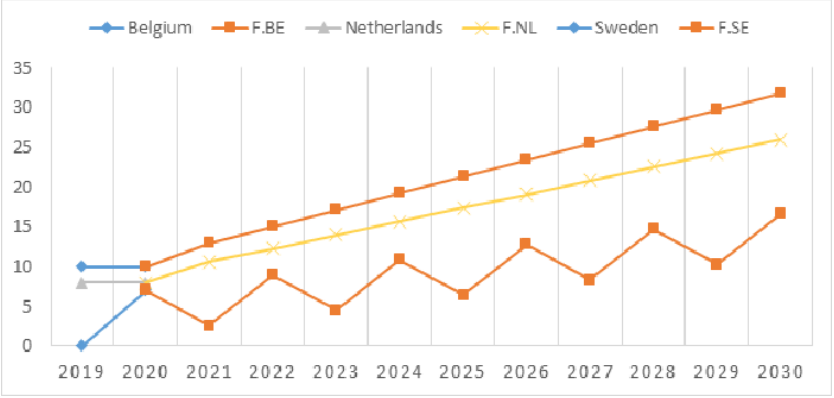

Figure 33. Forecast for indicator e8

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

In the next decade for **e9. Mfg.**, the progression forecast is a growing one for Poland, Turkey, Bosnia and Herzegovina, Serbia, Finland, Hungary, Denmark and Malta. The lowest percentage of enterprises are recorded by Italy, United Kingdom North Macedonia leading to 0% in the last forecasted year (figure 34).

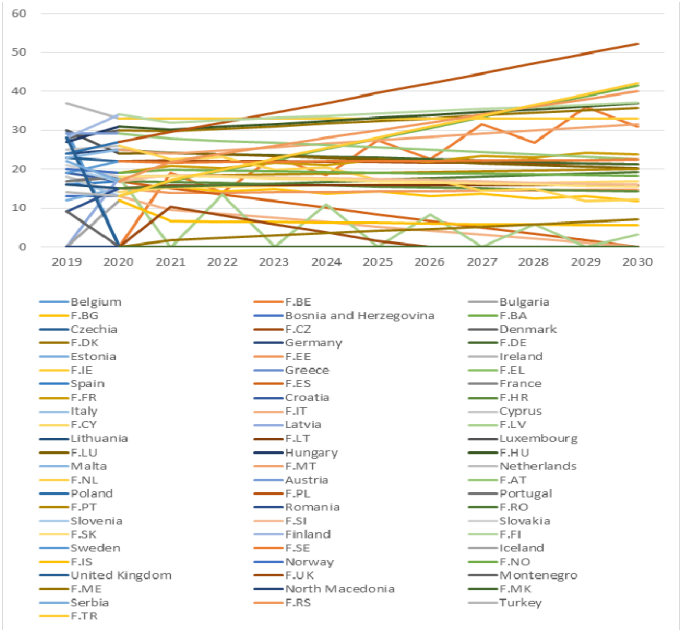

Figure 34. Forecast for indicator e9

(Source: authors' own conception based on Eurostat data collected between 2014–2020)

The forecast for the last indicator e10. Mfr.prod. emphasizes Poland with 24% starting 2021 leading to 44% in 2030. It is important to note that the *Manufacture of products based on: food, beverages, tobacco, textile, leather, wood, pulp and paper; publishing and printing sector* shows zero values for the whole period only for North Macedonia (figure 35).

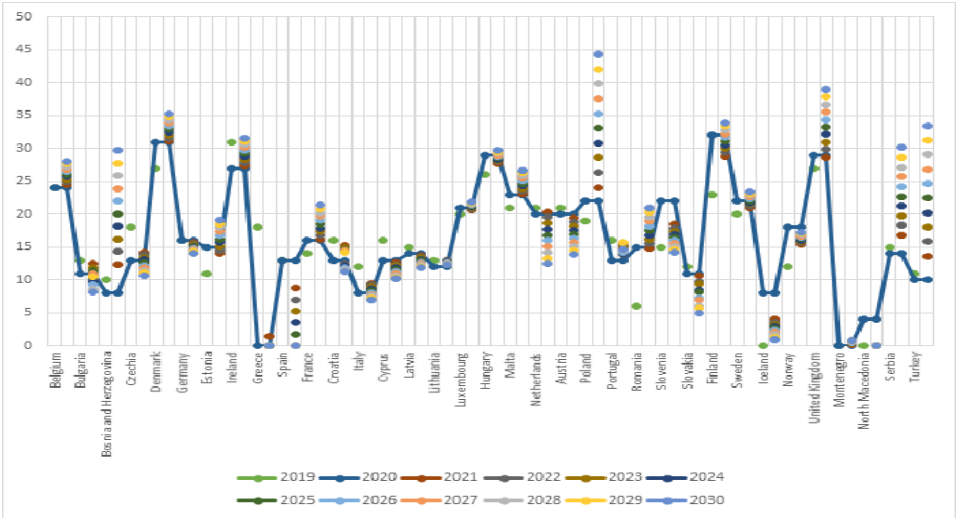

Figure 35. Forecast for indicator e10
(Source: authors' own conception based on Eurostat data collected between 2014–2020)

According to the data submitted for analysis and the results obtained, during the period 2020-2030 the upward trend of the variable *Enterprises that employ ICT specialists* for the collected data sample is checked (hypothesis H4 is validated).

Conclusions

Study overview

Considering the importance of human capital in the economy but also the volatility of the labor market in correlation with the accentuated trend of digitization and its impact on human society and economic growth, the study captures various aspects related to the dynamics of the labor force in the field of ICT in Europe, these technologies being considered the engines of economic growth in the last decades.

The analysis of the dynamics of the labor market represented by ICT specialists is relevant in the current context of the development of

increasingly advanced digitization systems in the economy and the increase of the need for specialists with digital skills. Moreover, this phenomenon was amplified by the effects of the pandemic crisis on the European economies, emphasizing the role of digitization in the economic plan.

The study is based on the Eurostat data collected between from 35 states from the European region and was focused on two main categories of enterprises: enterprises that recruited or tried to recruit ICT specialists (with 5 indicators) and enterprises that employ ICT specialists (using 10 indicators). Starting from this categories, a trend analysis was projected by plotting the data on a horizontal line in order to discover general patterns, to demonstrate data movements over a period of time (2014–2020) or the correlation between two variables.

For analysis there were used two types of methods, represented by a trendline, which is generally used to describe a steady increase or decrease in value during time and the forecasting method based on linear regression.

Considering the first category of eneterprises, enterprise recruited or tried to recruit personnel for jobs requiring ICT specialist skills in the European states during the analysed period (2014-2020), there were recorded a decreasing trend with differences between the states with highest proportion of enterprises employing ICT specialists (such as Belgium and Montenegro with 18% and 19% respectively in 2020, compared to 2014) and the states with lowest percentage (such as Italy, Poland, and Romania, with an average of 4% of this category of enterprises). The same decreasing trend was registered by the enterprises that had hard-to-fill vacancies for jobs requiring ICT (a difference of 3% in the anlysed period).

Considering the difficulty to recruit ICT specialists (lack of applications or lack of relevant ICT qualifications from education and/or training for the applicants) in general, the enterprises face challenges due to a lack of applications or the lack of information and communication technology professionals. The pandemic crisis underlined the necessity for digitalization and the need for TIC specialists and the European states took some measures in order to support this important sector for economic growth.

Regarding the second category - enterprises that employ ICT specialists – the evolutions were different among the analysed states, with a sinusoidal evolution. Therefore, a high and increasing percentage was recorded in states such as Hungary, Malta, United Kingdom, Ireland and Finland and the low percentage were recrded in states such as Bulgaria, Bosnia Hertegovina, Italia, Romania, Slovenia, Islanda in 2020. The analysis was detailed considering the different categories of eneterprises, Therefore,

for the small and medium enterprises sector, the trend was in marely decending the the period 2014-2020 but despite this decelerated trend, the medium enterprises provided higher employability.

For the large firms, the trendline analyses reflects a growth of 5% between 2014 and 2020. By comparison, the large enterprises have a ratio of 75%, whereas small and medium-sized businesses only have 19%. The highest average point is represented by Ireland (30%) while the lowest average point in this time period was registered by Romania and Turkey, with 11%.

By sectors, the manufacturing enterprises with 10 or more employees and self-employed persons had recorded a decrease of 5% from 2014 to 2020. From all 35 countries analyzed, Ireland has the highest percentage of enterprises (37% average) while the last position is occupied by Romania (9% average).

The results obtained underline the answer to the research question regarding the the situation at the level of the 2 categories of companies analyzed (enterprises that recruited or tried to recruit ICT specialists and enterprises that employ ICT specialists) from the perspective of the evolution of the labor market.

Considering the importance of the digitalization and the TIC sector specialists for the economic development, in the study we try to forecast for the time period 2021-2030, the future trend of ***Enterprises that recruited or tried to recruit ICT specialists*** and ***Enterprises that employ ICT specialists***, for the 35 European states according to the indicators previously mentioned.

For the first category - ***Enterprises that recruited or tried to recruit ICT specialists -*** and its 5 indicators the expected trends are growing. Most states are experiencing increases, but the forecast also shows states whose percentage is set to fall sharply by the year 2030 for some states, such as: Hungary, Romania, Iceland, North Macedonia.

For the second category - ***Enterprises that employ ICT specialists,*** the forcast divides the trendline into two almost equal parts: ascending and descending. The ascending trendline focuses on 17 European states the first position being occupied by Belgium with an average rate of 32% followed by Bosnia at a distance of 20 percent in the same year. On the other side, the descending trendline forecast involve 18 of the 35 states, the lowest recorded data during 2021-2030 being met by North Macedonia, Iceland and Spain with the steepest decline since 2021.

Accordingly, the results underline and contributed to the answer of the second research question (what are the forecasts for the period until

2030 for the two categories of companies analyzed, *enterprises that recruited or tried to recruit ICT specialists* and *enterprises that employ ICT specialists*, seen in the same light, the development of the labor market).

Methodological and empirical implications

Based on the processing of certified and verifiable data, this research was structured in such a way as to allow the achievement of the proposed objectives and the formulation of pertinent opinions regarding the topic addressed. The study was constructed in order to allow a cursive and logical approach to the ideas presented, based on a structure whose main components are:

- identifying and extracting from the relevant specialized literature some opinions expressed by other researchers, which can support the ideas expressed in our scientific approach;

- providing details on the research method used, so that the readers of our study can easily access and understand the ideas and conclusions formulated by the authors;

- the presentation and interpretation of the results obtained following the application of the research method used, as well as the creation of potential solutions to the identified problems;

- the formulation of pertinent conclusions, based on the main findings and points of view previously expressed during the entire study, as well as the presentation of proposals and new directions for future research.

Consequently, a paradigm change in the way both workers and employers see things becomes essential, which is why, in the present setting, it appears that possessing merely professional abilities in the traditional sense is no longer sufficient.

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