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LABOR DIGITALIZATION IN EUROPE

Persefoni POLYCHRONIDOU[1*]
Department of Economics Sciences, International Hellenic University,
Terma Magnesias Street, Serres 621-24, Greece

Vasilios ZOUMPOULIDIS
Department of Accounting and Finance, International Hellenic University,
Agios Loukas, Kavala 65404, Greece

Stavros VALSAMIDIS
Department of Accounting and Finance, International Hellenic University,
Agios Loukas, Kavala 65404, Greece

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Abstract. *The purpose of this research is the study of the effects of digital transformation on employment and their possible correlation with the labor deficit. The labor deficit in European countries, and especially those of the European Union, is studied. Secondary data regarding Information and Communications Technology (ICT) specialist skills, the employment rate, and the Digital Economy and Society Index (DESI) are collected and analyzed. Data analysis reveals that, on one hand, the labor deficit is undeniable; however, the greatest deficit relates to the lack of digital competences. On the other hand, with rapid technological advancements and the introduction of Artificial Intelligence to the production process, a new environment will be formulated both at the economic and social level. This study is based on the secondary data of specific indexes; in future research, an empirical study will be conducted in European countries to study labor digitalization in depth, especially in the post-COVID-19 era, as this pandemic has increased digitalization in all countries. The adoption of new legislative and prescriptive frameworks is necessary to address the labor deficit. It is necessary to take measures both at the European and national level, as well as to effectively utilize programs and initiatives that will protect the preexisting workforce and will establish the ground for new employees. This can be activated mainly through training, either in the form of new education (reskilling) or re-education*

[1*] Corresponding author Persefoni Polychronidou, e-mail: *polychr@es.ihu.gr*

(upskilling). The originality of this research is based on the fact that it explores the impact of ICT Skills on employment and the dependence between ICT Skills and DESI. Its value is in revealing the structural problems of the labor market in Europe and the cross-country comparison of how digitalization can help to solve the labor deficit problem in European countries.

Keywords: *digital transformation, digital skills, labor deficit, DESI, European countries.*

JEL Codes: *J21; L86.*

1. Introduction

Digitalization is a phenomenon that affects virtually every process in the global economy today (Raj-Reichert et al., 2021). Labor markets are undergoing significant transformations associated with the adoption of new digital technologies (Martindale & Lehdonvirta, 2021). The consequences of digitalization on employment and work organization are very subtle (Cirillo & Zayas, 2019). The results of an empirical analysis suggest that digitalization may represent a major driver of labor productivity and both economic and employment growth, and that inclusive policies may effectively contribute to bridging the gap between the most favored and most disadvantaged parts of the population, thus helping to achieve the 2020 European targets (Evangelista et al., 2014).

Rapid technological advancements have aided businesses in every sector in seeking innovation that would give their businesses the boost necessary to increase their market share. Apart from industrial companies, Alberti and Pizzurno (2013) observed that family firms are significant players in the generation of innovation.

Due to the continuously reducing cost of computerization, technology is replacing human labor in routine tasks. The cost of technology has continued to fall, and manufacturers have thus been incentivized to substitute workers who perform routine tasks with machinery and other capital equipment, such as robots (Atkinson, 2019). This labor-capital substitution decreases the relative demand for workers performing routine occupations, while leading to an increase in the relative demand for workers performing non-routine tasks (Autor et al., 2003). The notion that middle-skill jobs have been disproportionately destroyed and that job distribution has hollowed out in the center has been identified as a key aspect of rising contemporaneous inequality in the labor market (Acemoglu & Autor 2011; Goos & Manning, 2007; Goos et al., 2014). Understanding how the employment structure evolves can advise policy makers in designing policies to best promote sustainable economic growth. This is especially salient given the widespread feeling of technological anxiety (Mokyr et al., 2015). People from more privileged backgrounds tend to be able to obtain greater benefits from new digital technologies (van Deursen & Helsper, 2015).

The debate concerning the structural evolution of the division of labor and its impact on job quality has been a central theme in social sciences for the last 200 years. In the late 1990s, the idea proliferated that technology is skill-biased, favoring high-skilled workers and substituting low-skilled workers. While skill-biased technical change is a good explanation for the increase in the upper tail distribution of the composition of the labor force, it cannot explain a recent phenomenon: the decline in the share of middle occupations relative to high- and low-skilled occupations (Wright & Dwyer, 2003; Goos & Manning, 2007).

The impact of technology and digitalization on the labor market is a widely investigated topic in economic literature (Nicoletti et al., 2020; Grigoli et al., 2020). In the early 2000s, a set of studies created a stir in the social sciences by arguing that technological change leads to polarized employment structures (Autor et al., 2003; Goos & Manning, 2007; Wright & Dwyer, 2003). Instead of technology being skill-biased and leading to occupational upgrading, the routinization thesis views information communication technologies (ICT) as task-biased (Murphy & Oesch, 2018).

The Skill-Biased Technological Change hypothesis (SBTC) arose from the observation that demand is shifting in favor of more educated workers (Katz & Autor, 1999; Goldin & Katz, 2008; 2009; Acemoglu & Autor, 2011). In spite of its success in explaining many decades of data, however, SBTC cannot explain the phenomenon of job polarization. The key to understanding changes in labor demand is job polarization (Maselli, 2012).

This study investigates the digitalization processes, ICT skills, and employment rates in European countries in order to assess the problem of the labor deficit. In order to detect the possible solutions to the labor deficit, we use two specific indexes, ICT Specialist Skills and the Digital Economy and Society Index, and correlate their values with the corresponding values of employment rates in the EU27 for the last six years. The outcomes of this study support views on: (a) structural problems of the labor market in Europe; (b) the impact of digitalization on employment and the substitution of jobs; and (c) a cross-country comparison on how digitalization processes are used and help to solve the labor deficit problem in selected European countries.

2. Baseline

The polarization of labor is a phenomenon where the demand for labor does not rise linearly with skill level, but rather resembles a U-shaped function as depicted in Figure 1 (Maselli, 2012). Instead, there is a polarization in favor of both low-skilled and high-skilled jobs. As rich countries grow richer, growth in the consumption of services tends to outpace growth in the consumption of goods (David & Dorn, 2013). Employment in the goods-producing sector is disproportionately composed of middle-skill workers, while service sector workers are concentrated at the top and bottom of the skill distribution. Figure 1 illustrates the phenomenon of job polarization in the EU27 between 2000 and 2010. We would normally expect demand for workers to rise as the skill content of these occupations increases in a linear fashion. Instead, the figure is U-shaped, as predicted by job polarization. This is the result of an approximately 20% increase in the demand for low-skilled and high-profile occupations between 2000 and 2010, and a 4.5% decrease in the demand for middle-skilled occupations. Polarization occurred in 17 of the EU27 countries.

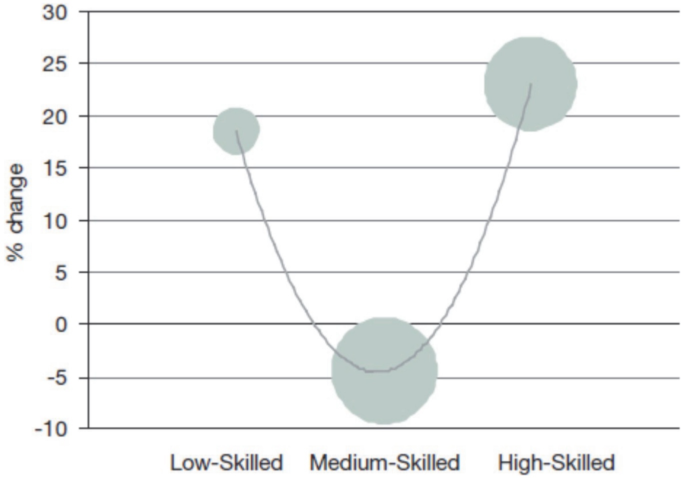

Figure 1. *Job polarization in the EU27, 2000–2010.*

Source: *Maselli, 2012*

The skills content of low-skilled jobs increased, leading to the phenomenon of up-skilling. Low-skillness should therefore be viewed as a fluid concept, the definition of which depends on the context. Job polarization may therefore be a misleading concept because low-skillness encompasses a wide range of jobs (Beblavý & Veselková, 2014).

The mere accessibility of ICT facilities is only a pre-condition for moving towards a digitalized society (Evangelista et al., 2014). ICT Specialist Skills is a very generic term which also includes other professions related to the ICT sector, such as: ICT Programmers, who develop programs and applications; ICT Users, who utilize the programs to produce data; Data Analysts, who effectively analyze the produced data to offer possible solutions; and ICT Service Managers, who should be able to gather information from all the above stages and take the most appropriate decision. This term also contains not just the knowledge that someone can attain from educational institutions, but also knowledge that can be gathered through experiences in the working environment, as well as any kind of training or education offered by companies to cultivate the skills of their personnel (OECD, 2016).

To be able to analyze the projected results in the best way, an index that expresses the percentage of employed persons with ICT Specialist Skills was used, which was calculated through the following formula:

$$\frac{Employed\ p.with\ ICT\ Sp.Skills}{Employed\ persons} \times 100 = \%Employed\ persons\ with\ ICT\ Sp.Skills$$

First, it should be noted that the term ICT Education in this paper refers to the knowledge that is provided only by the certified educational institutions of the countries in question.

However, the comparison and analysis of the average of the twenty-seven countries is not considered to be trustworthy due to the uneven fluctuation of the unemployment rate from 2010 onwards in countries such as Greece, which alters the average. Therefore, it is considered fair to analyze the way that these indexes evolve over time for each country or group of countries, and to compare them to assess the status of the educated persons of these economies.

Since these indexes concern employment and unemployment, it is natural for them to be negatively correlated as employment and unemployment are considered opposite phenomena. This means that the interpretation of the minimum and the maximum score for each index is different, as for employment the minimum is the least desirable score, while for unemployment the minimum is the most desirable score. Likewise, a maximum score for employment produces a strongly positive effect for a country, whereas a maximum score for unemployment is a worst-case scenario.

In recent years, a very popular tool among researchers of countries' digital efficiency has been the Digital Economy and Society Index (DESI), which is a complex summary of basic indicators depicting the digital performance of every EU member state and how highly they score in digital competitiveness when compared to another member state. The DESI measures the performance indicators of five main categories (Eurostat, 2021a):

- Connectivity – which measures broadband network coverage within the region of each member state (25% weight).
- Human capital – regarding the people equipped with proper digital skills (25% weight).
- Use of the internet – by citizens and to what extent (15% weight).
- Integration of Digital Technology – industries and business sectors (20% weight).
- Digital public services – measuring the number of public services that can be conducted online by each member state (15% weight).

These categories are further analyzed in various sub-categories. The DESI index concerning the EU27 countries was first published in 2014, and this is the reason for the limitation of the chronological span of data.

Figure 2 shows the ranking of Member States in the Digital Economy and Society Index in 2020 based on 2019 data. Finland, Sweden, Denmark, and the Netherlands had the most advanced digital economies in the EU, followed by Malta, Ireland, and Estonia. Bulgaria, Greece, Romania, and Italy had the lowest scores on the index.

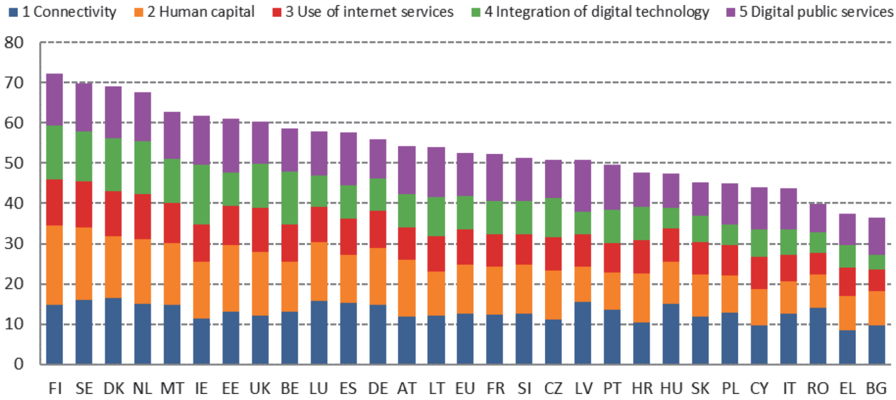

Figure 2. *The Digital Economy and Society Index 2020 ranking.*
Source: *European Commission (2020)*

Figure 3 depicts the progress of Member States as regards the overall level of digitization of the economy and society over the last 5 years. This is measured in terms of the progression of their DESI scores over that period.

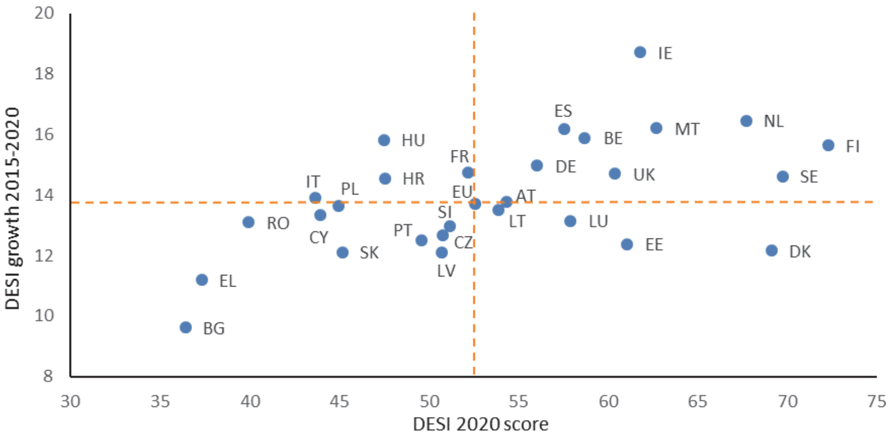

Figure 3. *Digital Economy and Society Index – progress of the Member States in 2015–2020*

The most significant progression was noted in Ireland, followed by the Netherlands, Malta, and Spain. These countries also performed well above the EU average, as measured by the DESI score. Common to these Member States are robust policies and targeted investment in all the areas measured by the DESI.

Finland and Sweden were amongst the leaders in overall performance in digitization, but in terms of progression over the last five years they were only slightly above average, together with Belgium and Germany.

3. Data and results

The data used in this study concern the following indexes: DESI, Employment, and ICT. DESI is a composite index that measures relevant digitalization and evolution indicators (Eurostat, 2021a); Employment is the employment rate for people aged 20 to 64 (Eurostat, 2021b); and ICT is the proportion of employed ICT specialists in total (Eurostat, 2021c). In Table 1, the averages of the above indexes in the 2015–2020 period are presented for all European Union countries in order of the highest to the lowest average DESI score. This period was used because the available data for the DESI index starts from the year 2014.

Table 1. *Average index values of the EU27 countries in the 2015–2020 period*

Index / Country	DESI	Employment	ICT
Finland	63.12	75.08	6.8
Denmark	62.4	76.93	5.08
Sweden	62.27	81.47	6.72
Netherlands	59.28	78.47	5.33
Estonia	54.73	78.38	5.58
Malta	52.82	73.8	4.3
Ireland	51.92	72.82	4.98
Luxembourg	51.02	71.68	5.6
Belgium	50	68.93	4.75
Spain	48.78	65.35	3.45
Germany	47.63	79.38	3.97
Austria	47.18	75.5	4.32
Lithuania	47.17	76.2	2.73
Latvia	45.4	75.28	2.97
France	44.77	70.73	3.9
Slovenia	44.77	73.33	3.87
Czechia	43.72	78.32	3.83
Portugal	43.58	73.22	3.28
Croatia	40.18	64.07	3.28
Slovakia	39.43	71.15	3.27
Hungary	38.68	73.07	3.62
Poland	38.23	71.13	2.93
Cyprus	37.78	71.98	2.88
Italy	36.27	62.25	3.43

Index / Country	DESI	Employment	ICT
Romania	33.33	68.78	2.15
Bulgaria	31.52	71.15	3.12
Greece	31.43	58.45	2.02

All indexes were studied in three distinct groups, which were compiled according to the DESI index: the group with the highest DESI values was labeled *H*; the group with intermediate DESI values was labeled *I*; and the group with the lowest DESI values was labeled *L*. Group H included Finland, Denmark, Sweden, the Netherlands, Estonia, Malta, Ireland, Luxembourg, and Belgium. Group I included Spain, Germany, Austria, Lithuania, Latvia, France, Slovenia, and Czechia. Group L included Croatia, Slovakia, Hungary, Poland, Cyprus, Italy, Romania, Bulgaria, and Greece. Statistical analysis was conducted with the Jamovi software.

Figure 4 presents the average values of the three indexes grouped as mentioned above. It is evident that all indexes follow similar behaviors throughout each group.

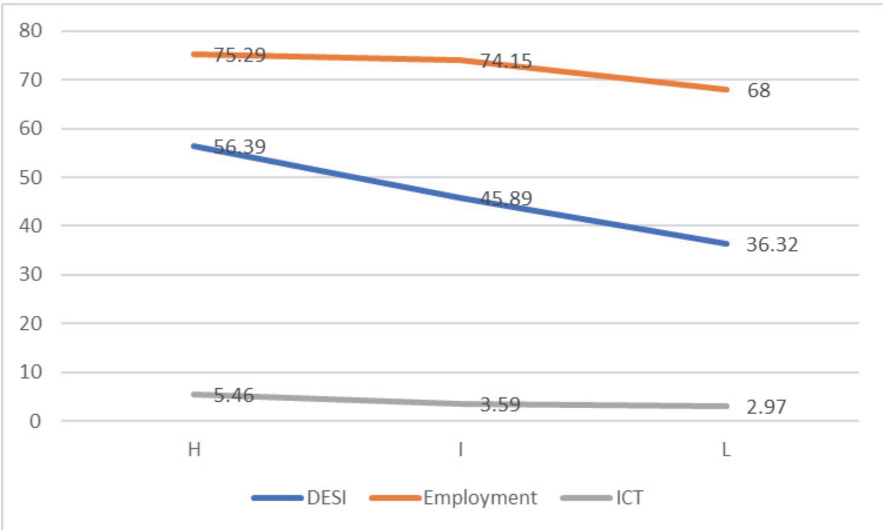

Figure 4. *The average index values of the groups*

Figure 5 presents the average values of the DESI index in all three groups throughout the period studied. All three groups' DESI indexes increased over time, and there is a clear distinction among groups.

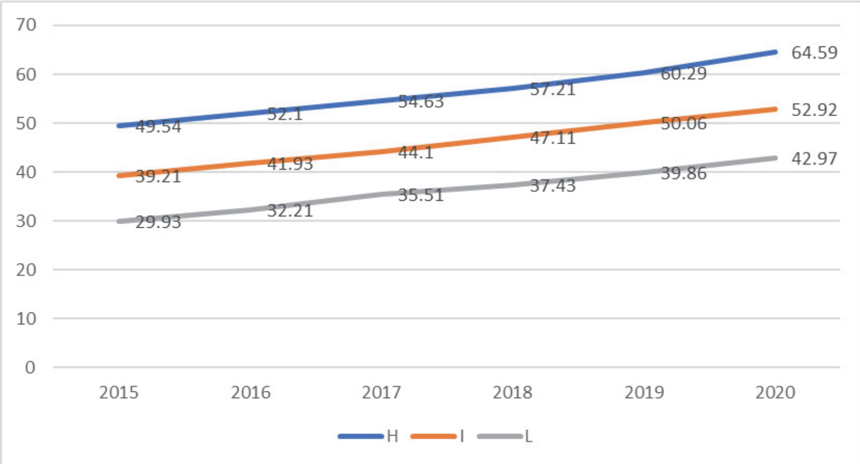

Figure 5. *The DESI indexes of the three groups over the 2015–2020 period*

However, if we calculate the change in the average DESI index for all three groups as the value of the current year minus that of the previous year (Figure 6), then the change experienced by Group H in 2020 was the largest of any throughout the entire period. Group L also experienced a large change in 2017, mainly because of Poland (a change of 9.70) and Slovakia (3.70); and Group I did so in 2018 mainly because of Lithuania (4.40) and Spain (4.10).

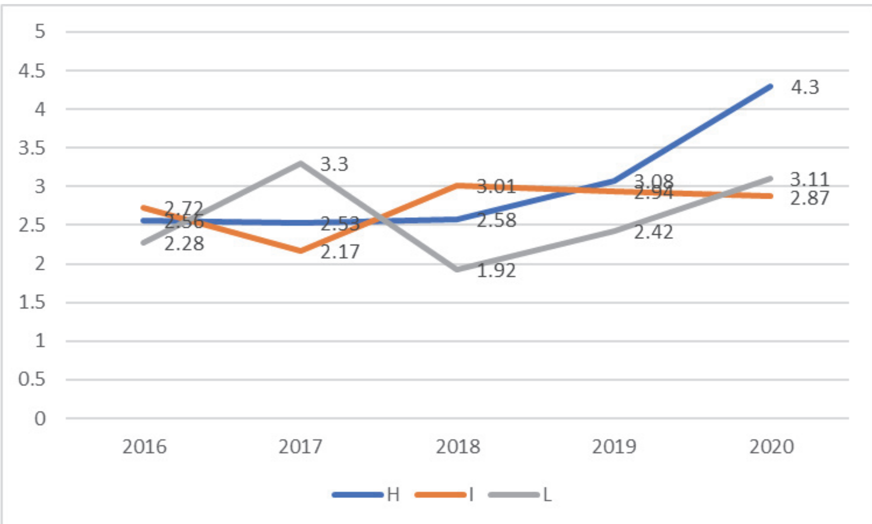

Figure 6. *Changes in the DESI rate of each group for the 2015–2020 period*

Figure 7 presents the average values of the employment index in each group. It is clear that all three groups increased over time – except in 2020, which was the year in which the COVID-19 pandemic affected the employment rate in all countries. The distinction among groups is again clearly indicated, with Group I being very close to Group H.

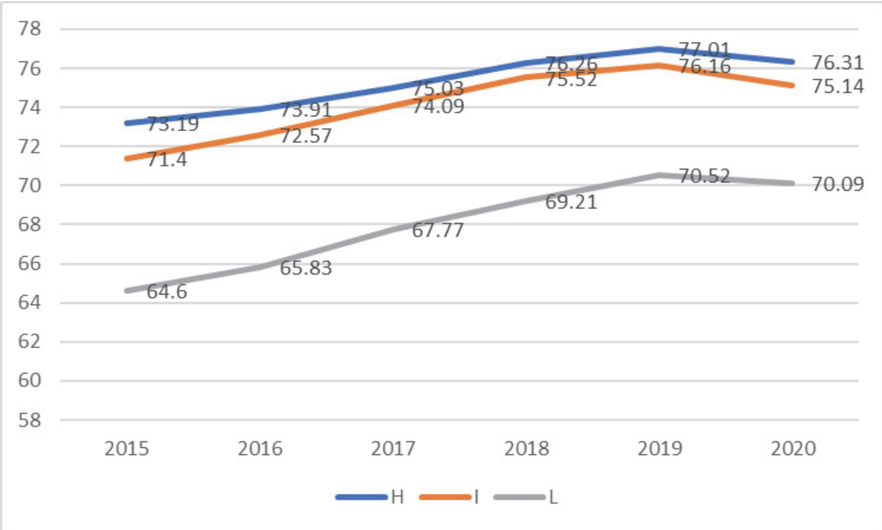

Figure 7. *The Employment index in the groups for the 2015–2020 period*

Moreover, if we calculate the average change in the Employment index for all three groups (Figure 8), then it is evident that in 2017 Group L had the largest change throughout the entire period due to Bulgaria (a change of 3.60), Romania (2.50), Croatia (2.20), and Cyprus (2.10).

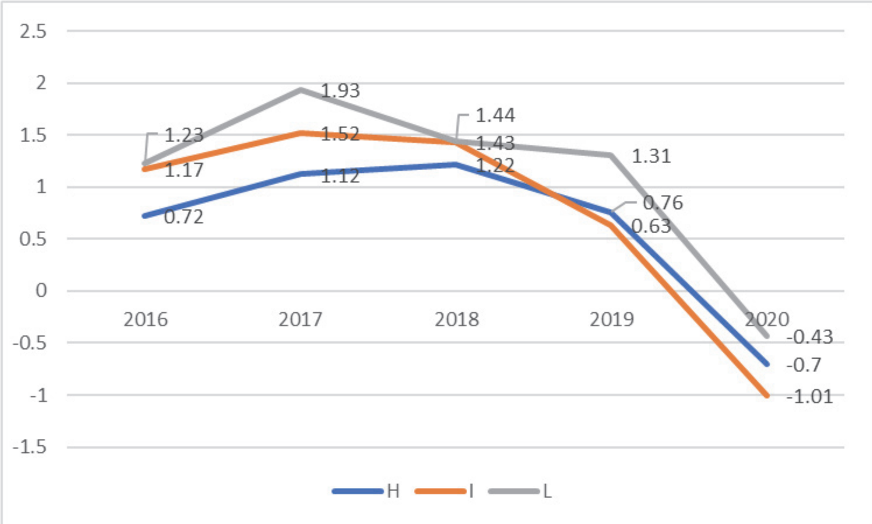

Figure 8. *Changes in the Employment rate of the groups for the 2015–2020 period*

Figure 9 presents the average values of the ICT index for the groups of countries. It is clear that all three groups increased over time, and the distinction among groups is again clearly indicated.

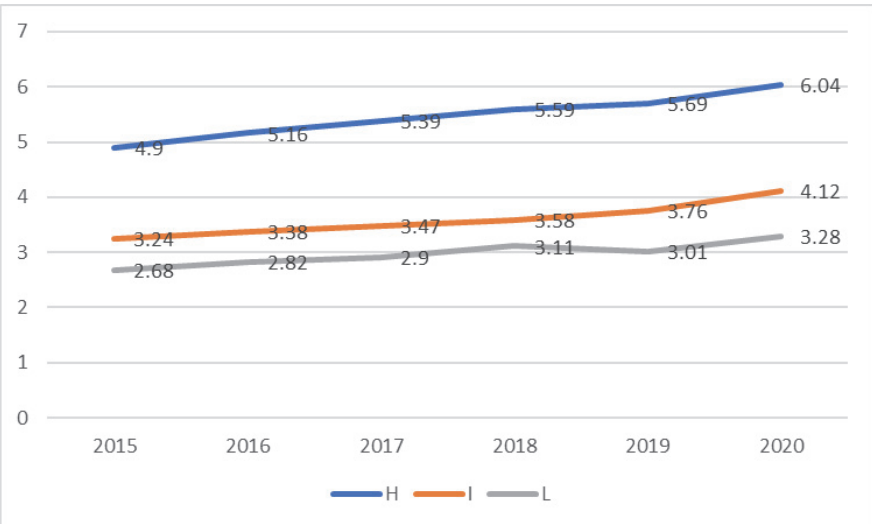

Figure 9. *The ICT index in the groups for the 2015–2020 period*

Additionally, if we calculate the average change of the ICT index for all three groups (Figure 10), then Group I followed the most consistently increasing course among all groups, and also experienced the largest overall change throughout the entire period – except in the year 2017, during which a slight reduction in the rate of growth occurred. The largest single-year change occurred 2020, and was mainly due to Germany (a change of 0.70), Latvia (0.60), Slovenia (0.50), and Portugal (0.40). The change experienced by Group H was very close to that of Group I due to Finland and Ireland (0.80), and Sweden and Estonia (0.50).

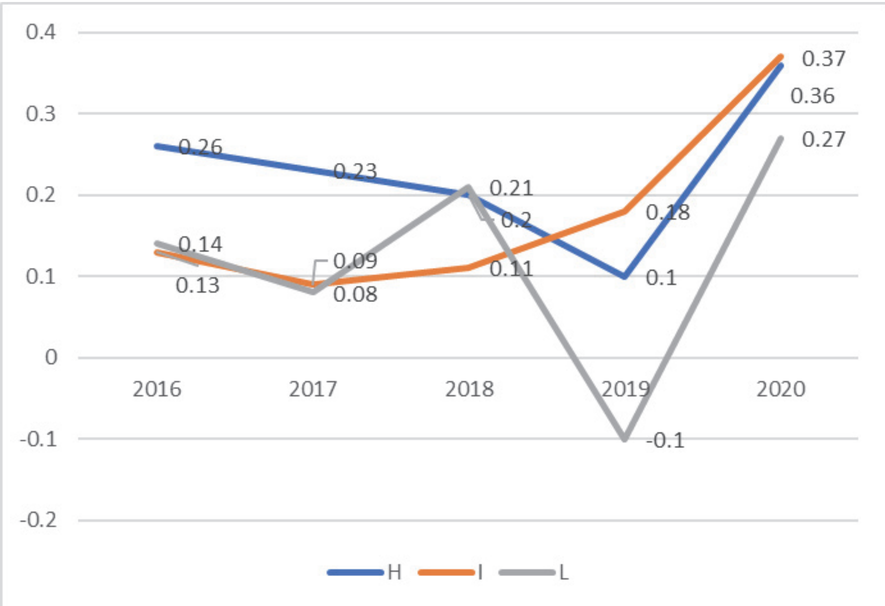

Figure 10. *Change in ICT rate for the period 2015–2020*

Furthermore, the correlation between the average values of all indexes was studied, and is presented in Table 2. All indexes were highly correlated in pairs, with the highest correlation observed between DESI and ICT.

Table 2. *Correlation matrix*

		DESI	Employment
Employment	Pearson's *r*	0.634	—
	p-value	< .001	—
ICT	Pearson's *r*	0.879	0.553
	p-value	< .001	0.003

Additionally, multivariate regression analysis was used to further analyze the correlation of these indexes (Field, 2018). Employment rate was used as the dependent variable and DESI and ICT as independent variables. The equation of the model was:

$$Employment = 55.079 + 0.3834^{*} DESI - 0.0787^{*} ICT$$

This model performed well (F(2.24) = 49.4, $p = 0.05$), and the adjusted R^2 of 0.552 indicated that the regression model accounted for 55.2% of the variability in the outcome measure. The statistical significance of each independent variable was measured with t-tests. Both variables were significant at a marginal level ($p = 0.05$). The variance inflation factor (VIF) of 2.44 indicated that there was no problem of collinearity between independent variables. The Durbin-Watson statistic of 1.89 indicated that there was no autocorrelation in the model, and a Cook's distance value of 0.0237 revealed that there was no problem with outliers.

5. Discussion and Conclusions

The main purpose of this paper was to investigate labor job digitalization processes, ICT skills, and employment rates in European countries in order to assess the problem of the labor deficit.

Regression analysis revealed the dependence of the employment rate on DESI and ICT skills. The accountability of the model was high, and can explain 55.2% of the variability in the outcome measure. All three indexes were highly correlated between each other, and the grouping of EU27 countries revealed that the employment rate of each country is affected by the performance of the DESI index and ICT skills.

These findings may be used as a starting point for the discussion on digitalization. Progress in digitalization, apart from the expected benefits for productivity and competitiveness (Fossen & Sorgner, 2019), may save jobs and preserve economic activities in a situation of high contagion (Carbonero & Scicchitano, 2021). Digitalization will increase the importance given to the digital channels of marketing and the sales of companies. It will also foster teleworking and the consumption of technological products as more people will interact using hybrid communication mechanisms accessible from anywhere, and not exclusively in the physical environments of companies and their homes (Almeida et al., 2020).

The repercussions and the pace of technological disruption in organizations are increasing and have been accelerated by the COVID-19 pandemic. Companies need to be prepared for this challenge, and to this end they need to foster a culture of innovation that involves the company's employees in this process. In fact, COVID-19 has accelerated the processes of digital transformation not only in companies but also in individuals and public entities. The enormous challenge for managers is to get involved in this change while trying to keep the business running in the face of a different and uncertain future.

Technological change has always had a decisive impact on the labor market. The COVID-19 pandemic is seen as an automation-forcing event, and its effects on technology and work are destined to last over time (Autor & Reynolds, 2020; Autor et al., 2020). Further research may test this hypothesis and investigate whether COVID-19 will have a persistent effect on technological change and further consequences on income inequality.

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