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THE IMPACT OF DIGITALIZATION ON UNEMPLOYMENT OF THE POPULATION IN THE EUROPEAN UNION

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Abstract

The paper examines the current state of the digitalization in the European Union (EU) with an emphasis on Slovakia. We analyzed impact of digitalization on the unemployment of the population by educational attainment. The paper identifies and distinguishes the population groups that are affected by digitalization. We analyzed the data by correlation and regression analysis. The analyzed data are secondary, from Eurostat and the European Commission. The output of the paper is a comparison of the current state of digitization in Slovakia and the average of the EU and the identification of population groups that are disadvantaged, advantaged, and not influenced by digitization on the labour market. The results show that Slovakia ranks last in the DESI index within the EU. At the labour market the digitalization disadvantages people with a high education level. Conversely, digitalization favors individuals with secondary education.

Keywords

Digitalization, Digital Economy and Society Index, Unemployment, Education, Slovakia

I. Introduction

Digitization is an important phenomenon of the present time, which has seen significant development, especially in the last decade. This process has a global impact and fundamentally transforms social structures and the daily life of individuals. It brings with it a wide range of opportunities and advantages, but also challenges and risks, especially in connection with changes in the labour market. The main goal of this paper is to analyze the current state of digitization within the European Union, with a specific focus on the Slovak Republic, and to examine its impact on the unemployment rate depending on the level of education achieved. In the paper, the population is categorized based on the ISCED international classification of education, which allows a detailed division according to different types of completed education. The partial goal of the paper is to identify specific population groups affected by digitization in the labour market and to distinguish those who are disadvantaged or advantaged because of this phenomenon.

II. Digitalization

In the Slovak language, the terms are not distinguished, there is only one category „digitalizácia“. The term “digitization” represents the initial phase of digitalization, where it involves the conversion of data and information from analogy to digital form (Morháč, 2022). This level focuses on the digitization of the information itself, while not yet interfering with the automation of business processes. The second level of digitization is expressed by the English term “digitalization”, which

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includes the automation of business operations and processes through digital technologies (Savić, 2019). According to Gartner (2023), "digitization" is defined as "the use of digital technologies to change the business model and provide new opportunities for revenue and value creation," representing the transition to digital business. Closely related to digitization is the term "digital transformation", but it is often confused with the term digitalization. Digital transformation means a fundamental and complex change in the functioning of the organization through the use of digital technologies, including changes in the culture and strategy of the organization. An example of digital transformation is Netflix, which has transformed from a traditional DVD-by-mail provider to a global digital streaming platform (Dieffenbacher, 2023).

Digitization brings many advantages and opportunities that positively affect individuals, businesses and society as a whole. Digital records, such as text, audio, and video files, require significantly less storage space compared to analogue records and allow for faster, easier information retrieval, processing, and sharing (Veber et al., 2018). Digital technologies also enable the involvement of multiple participants in networks where they can simultaneously share various records and information without significant restrictions, while these networks can operate continuously, 24 hours a day, 365 days a year (Veber et al., 2018). A secondary benefit of digitization and digital transformation is environmental protection. Digitization contributes to reducing the consumption of paper and other materials, eliminates the need for large storage spaces, and thus contributes to reducing the carbon footprint, thereby supporting environmental sustainability (Dieffenbacher, 2023).

Digitization also brings with it various risks that can threaten its positive benefits. With the growing trend of digital transformation of businesses, the issue of information security is increasingly coming to the fore. Information and data represent key and valuable assets of organizations, but due to their intangible nature, in the context of digitization, ensuring their protection is increasingly difficult (Veber et al., 2018).

The risks associated with digitization have a significant impact on the labour market. Digitization brings the threat of the disappearance of some jobs, which can lead to an increase in unemployment in certain sectors. On the other hand, the creation of new job positions that will require higher skills and knowledge is expected (Veber et al., 2018). At the same time, digital transformation accelerates technological unemployment and job polarization, which increases the need for a sophisticated education system and investments in retraining and increasing the qualifications of employees, that is essential for employment in the era of Industry 5.0 (Kolade & Owoseni, 2022). Digitization is changing the nature of work across all industries, and therefore employees must adapt to these changes. Creativity, flexibility and a willingness to learn throughout one's professional life is the key (Masárová, 2020). The growth of educational level and lifelong learning are important because people with low education and insufficient technological skills will be the most vulnerable in the labour market (Ivanová et al., 2021). Digitization also reduces the need for workers performing low-skilled routine work, while administrative positions are threatened by automated systems that can effectively replace this work (Veber et al., 2018). In the digitalization process, the digital literacy of employees is essential, while their skills, such as the use of cloud technologies, play a key role (Cetindamar, Abedin & Shirahada, 2021).

The level of digitization in individual countries can be measured through the Digital Economy and Society Index, known as DESI. This index, monitored annually by the European Commission, evaluates the development of digital competitiveness within Europe. DESI is composed of 33 indicators divided into four main areas according to the Digital Compass: human capital, connectivity, integration of digital technologies and digital public services (European Commission, 2023, 2024a). DESI provides a comprehensive assessment of the level of digitization of society in the countries of the European Union and enables the identification of problem areas that require increased attention from the state. On the basis of four main areas and their respective indicators, the index makes it

possible to analyze and compare the level of digital society and economy between individual EU countries (MIRRI SR, 2023).

According to the European Commission, the digital transformation should bring benefits for everyone, while it is necessary to emphasize people's needs, support the emergence of new opportunities for businesses, and at the same time actively contribute to the fight against climate change and ecological transformation (European Commission, 2023). As part of efforts to achieve a successful digital transformation by 2030, the European Commission presented in March 2021 the political program *Digital Decade of Europe*, which is based on the so-called Digital compass. This program sets objectives in four key areas: digital skills, digital transformation of businesses, secure and sustainable digital infrastructures and digitization of public services (European Commission, 2023).

The Government of the Slovak Republic is actively trying to support digitization in the country through various measures and strategies. In 2019, it approved the Strategy for the Digital Transformation of Slovakia 2030, which represents a framework supra-ministerial strategy with the aim of transforming Slovakia by 2030 into a modern country with an innovative and ecological industry based on the digital economy. This strategy, based on an analysis of the current state of Slovakia, focuses on five key areas where it is necessary to strengthen the potential in digital transformation: economy, society and education, public administration, territorial development, and science, research and innovation (MIRRI SR, 2024).

III. Methodology

When analysing the labour market and investigating unemployment, it primarily focuses on the population of productive age (15-64 years). From an economic point of view, this group is divided into two main categories: (1) the economically active population, i.e. the labour force, and (2) the economically inactive population, which is not part of the labour force (Mihaľová et al., 2022). The labour force consists of two groups: employed and unemployed. Employed are individuals who do any paid work, including those who are temporarily out of work due to illness, strike, or vacation. On the contrary, the unemployed are persons who are not currently performing paid work but are actively looking for it with the aim of returning to employment (Čaplanová et al., 2022). According to the methodology of the International Labour Organization (ILO), the activity of looking for work does not only refer to registration at the labour office, but also includes responding to job advertisements, updating public CVs, or obtaining business permits. The group of unemployed also includes those who have already found a job, but have not yet entered it (Mihaľová et al., 2022). The economically inactive population includes persons who are neither working nor actively looking for work. These include, for example, students preparing for a profession, persons on disability pension or individuals taking care of the household (Čaplanová et al., 2022).

We also focused on the analysis of the issue from the point of view of the achieved education. International Standard Classification of Education (ISCED) from 2011, which contains nine levels, is used to distinguish between different levels of education. To simplify statistics, these levels are usually grouped into three main categories: low, secondary and high education. The low education category covers grades 0 to 2, including early childhood education, primary education, and lower secondary education. Secondary education consists of levels 3 and 4, which represent upper secondary education and post-secondary non-tertiary education. The higher education category includes levels 5 to 8, which include short-term tertiary education, bachelor's, master's and doctoral education, as well as their equivalent levels (Eurostat Statistics Explained, 2023).

The aim of the paper is to examine the current state of digitization in the European Union and Slovakia and to analyze its impact on the unemployment of the population regarding the level of education. It also focuses on identifying population groups that may be at risk or disadvantaged in the labour market because of digitization, as well as identifying those groups that are advantaged by digitization on the labour market.

For a deeper analysis, we established 3 hypotheses:
H_{1A}: The DESI index has no effect on the share of unemployed people with low education in a country.
H_{1B}: The DESI index has no effect on the share of unemployed people with secondary education in the country.
H_{1C}: The DESI index has no effect on the share of unemployed people with high education in a country.

For the purposes of this paper, we focused on the individual states of the European Union, which includes 27 countries. Within these countries, we analyzed two main indicators: the Digital Economy and Society Index (DESI) and the number of unemployed in thousands, with data referring to the year 2022. Our analysis specifically focused on the percentages of unemployed population groups by educational attainment compared to the total by the number of unemployed persons aged 20-64 in the given country. We examined the number of unemployed based on selected educational groups of the population aged 20-64. Due to the significant differences in the total population between individual countries, we used a relative expression of the number of unemployed, which enabled an effective comparison of the situation between different countries.

In individual EU countries, we specifically examined the percentage of unemployed people with low education (ISCED 0-2), the percentage of unemployed people with medium education (ISCED 3-4) and the percentage of unemployed people with high education (ISCED 5-8) on the total the number of unemployed people aged 20-64. When dividing into specific groups, we followed the internationally recognized ISCED classification of education from 2011 (Eurostat Statistics Explained, 2023).

We searched for data on the number of unemployed people in thousands by educational attainment for the year 2022 on the website of the Statistical office of the European Union, Eurostat, and downloaded them from the data set entitled Unemployment by sex, age, and educational attainment – annual data (Eurostat, 2024). After obtaining data on the number of unemployed in thousands for individual population groups in the EU countries, due to the different number of the total population in the countries, it was necessary to express them relatively (in percentages) in order to be able to compare the situation between countries. To evaluate the current state of digitization in Slovakia, we used the comparison method.

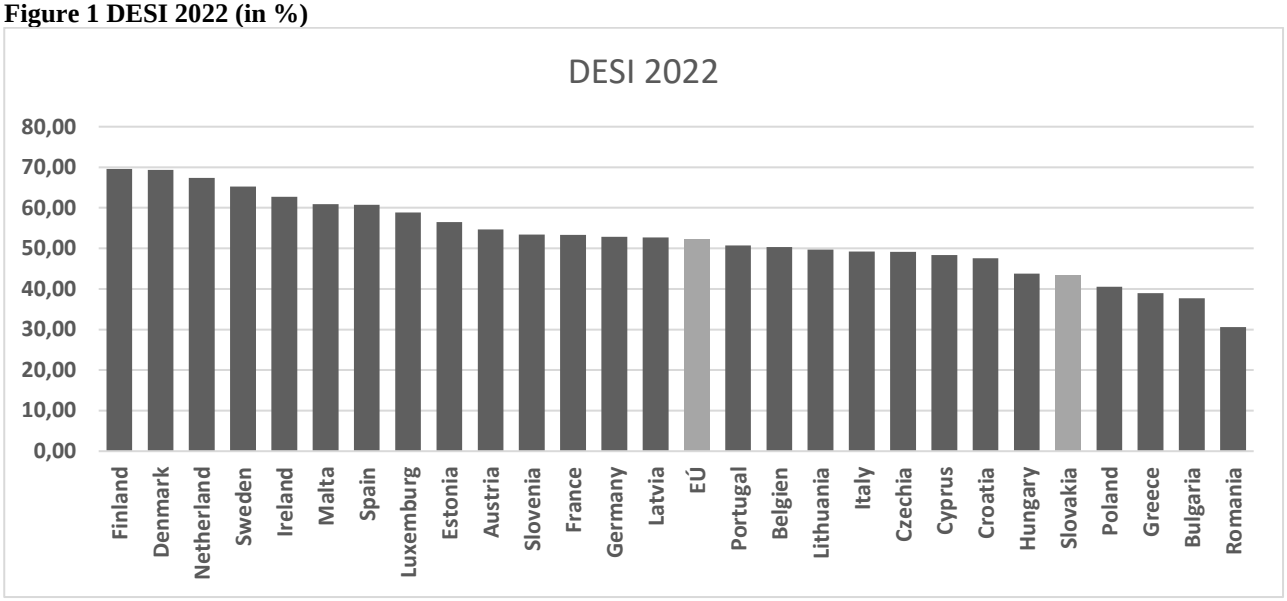
To investigate the relationship between digitization and unemployment of specific population groups, we performed a correlation analysis using the SPSS program. In the analysis, we focused on Spearman's correlation coefficient. Based on the value of the correlation coefficient, we determined whether it is a direct relationship (positive value of the coefficient) or an indirect relationship (negative value of the coefficient) (Pivovarniček, 2021). We interpreted the results of the correlation analysis verbally and using a table. To analyze the impact of digitization on the unemployment of individual population groups, we performed a simple regression analysis using the SPSS program. The independent (explanatory) variable was the DESI index, and the dependent (explanatory) variable was the share of the unemployed of a particular group. We examined the coefficient of determination R^2. As part of the regression analysis, we used the ANOVA test to determine whether the regression model is statistically significant at the $\alpha = 0.05$ significance level. Based on the p-value of the test, we accepted or rejected the established hypotheses. Based on the results of the regression analysis, we identified population groups that are affected by digitization.

IV. Research about DESI

The Digital Economy and Society Index is a quantitative ordinal variable and can range from 1 to 100, with 1 representing the lowest level of digitization in a country and 100 the highest. Variables expressing the percentage share of unemployed population groups on the total number of unemployed are also quantitative ordinal variables and reach values from 0 to 100%. All the data we have collected for the purposes of this paper are secondary, i.e. taken from another source. We downloaded the data

on the digital economy and society index for individual countries for the year 2022 from the website of the European Commission, and it was a data set called Digital Economy and Society Index (until 2022) (European Commission, 2024a). We also found data on the individual components of the DESI index for Slovakia and the average values of the given indicators for the European Union on the website of the European Commission in the document entitled Digital Economy and Society Index (DESI) 2022 Slovakia (European Commission, 2024b).

Figure 1 DESI 2022 (in %)



Source: Own processing according to: European Commission, 2024a

After identifying the population groups affected by digitization on the labour market, it was necessary to determine which groups digitization favours and which groups it disadvantages. We determined this based on the sign of the correlation coefficient between the DESI index and the share of unemployed population groups affected by digitization. If the value of the correlation coefficient between the DESI index and the share of the unemployed of a specific group is positive, these are groups disadvantaged on the labour market due to digitization. If the value of the correlation coefficient is negative, these are population groups that are favoured by digitization on the labour market.

Table 1 shows the level of Slovakia in individual areas of the DESI index compared to the EU average for the year 2022, as well as the position of Slovakia in the given area within the EU states.

Table 1 Components of DESI for EU and Slovakia

Components:	Slovakia	Average EU	Rank Slovakia
Total DESI	43.4	52.3	23.
Human Capital	44.1	45.7	19.
Connectivity	49.8	59.9	21.
Integration of digital technologies	27.8	36.1	21.
Digital public services	52.0	67.3	24.

Source: Custom processed according to: European Commission, 2024b

Slovakia ranked best in the area of human capital, in 19th place. It scored 44.1, which is only 1.6 points below the EU average. In the area of connectivity, Slovakia received a score of 49.8 in 2022, while the EU average was 59.9. Slovakia was thus ranked 21st among individual countries in this area. Slovakia was also placed in the same place in the field of integration of digital technologies and achieved a score of only 27.8, which was almost 10 points lower than the EU average. Slovakia ranked worst in the area of digital public services, while only 3 EU countries – Bulgaria, Greece

and Romania - achieved worse results in this area. Slovakia, with a score of 52.0, was more than 15 points worse than the EU average.

Table 2 presents selected indicators from individual areas of the DESI index for Slovakia compared to the EU average. For the calculation of the DESI index for 2022, data from 2021 was used for most indicators and data from 2020 was used for some indicators.

Table 2 Selected indicators of DESI

Indicator	SK	EU
At least basic digital skills (% of the population)	55.0 %	54.0 %
More than basic digital skills (% of the population)	21.0 %	26.0 %
ICT experts (% of employed persons aged 15-74)	4.3 %	4.5 %
Share of women in ICT (% of ICT professionals)	15.0 %	19.0 %
Total rate of use of fixed broadband (% of households)	81.0 %	78.0 %
Rate of use of mobile broadband (% of the population)	86.0 %	87.0 %
SMEs with at least a basic level of digital intensity (% of SMEs)	43.0 %	55.0 %
Use of social media (% of businesses)	21.0 %	29.0 %
Use of artificial intelligence (% of companies)	5.0%	8.0 %
Use of electronic invoices (% of companies)	16.0 %	32.0 %
Users of electronic public administration (% of Internet users)	62.0 %	65.0 %
Digital public services for citizens (score from 1 to 100)	65	75
Digital public services for businesses (score from 1 to 100)	75	82

Source: Custom processed according to: European Commission, 2024b

In 2021, up to 55% of the Slovak population had basic digital skills, which is just above the EU average. However, only a fifth (21%) of people in Slovakia had advanced digital skills, the EU average was 26%. The share of experts in the field of information and communication technologies in the total number of employees aged 15-74 was 4.3% in Slovakia in 2021, which is only two-tenths of a percent less than the EU average. It is interesting that only 15% of the total number of experts in this field in Slovakia were women. In the European Union, this figure was also relatively low, reaching 19%.

In 2021, up to 81% of Slovak households used a fixed broadband connection, which is 3% more than the EU average. 86% of the population used mobile broadband in Slovakia, which is just below the EU average.

Less than half, specifically 43%, of small and medium-sized enterprises in Slovakia have at least a basic level of digital intensity, which is a relatively bad result compared to the EU average, which reaches 55%. Regarding the use of social media and artificial intelligence by companies in 2021, Slovakia is below the European Union average. 21% of Slovak businesses used social media, and only 5% of businesses used artificial intelligence. Only 16% of businesses in Slovakia used electronic invoices, which is half as much as the EU average. This indicator was monitored for 2020.

Electronic public administration was used by 62% of internet users in Slovakia, which is 3% below the EU average. For the indicators of digital public services for residents and digital public services for businesses, scores were awarded from 1 to 100. In 2021, Slovakia achieved a score of 65 in the indicator of digital public services for citizens, which is 10 points lower than the EU average and in the indicator of digital public services for businesses it scored 75, which is 7 points below the EU average.

The Slovak Republic is working on various measures that should ensure the improvement of its position in individual areas of the DESI index and reach at least the average values of the European Union.

V. Analysis of the impact of digitization

Table 3 shows the values f the Spearman correlation coefficient, which describe the relationship between the DESI index and the shares of unemployed population groups.

Table 3 Results of correlation analysis

Variable 1	Variable 2	Coefficient	Relationship	Addiction
DESI	Low Education	-0,01	X	insignificant
DESI	Secondary Education	-0,562	undirect	strong
DESI	High Education	0,575	direct	strong

Source: Own processing according to results from SPSS

The correlation coefficient between the DESI index and the share of unemployed people with low education is almost zero. Thus, the level of digitization in a country does not affect the share of unemployed people with low education in that country.

The DESI index and the share of unemployed with secondary education show a correlation of -0.562. This is an indirect relationship with strong dependence, and this relationship indicates that the higher the level of digitization in a country, the lower the proportion of unemployed people with secondary education in that country.

The last relationship examined was between the DESI index and the proportion of unemployed with high education. The correlation coefficient of this relationship was at the level of 0.575, which indicates a direct relationship with strong dependence. Based on this value, we can conclude that the higher the level of digitization in the country, the more unemployed people there are with high education.

In Table 4, we can see the results of the regression analysis of the effect of the DESI index on the share of unemployed population groups.

Table 4 Results of regression analysis

Variable X	Variable Y	R	R^2	Adj. R^2	The prescription of the regression line
DESI	Low Education	0.051	0.003	-0.037	y = 28,06-0,05x
DESI	Secondary Education	0.532	0.283	0.255	y = 81,28-0,62x
DESI	High Education	0.622	0.386	0.363	y = -9,33+0,68x

Source: Own processing according to results from SPSS

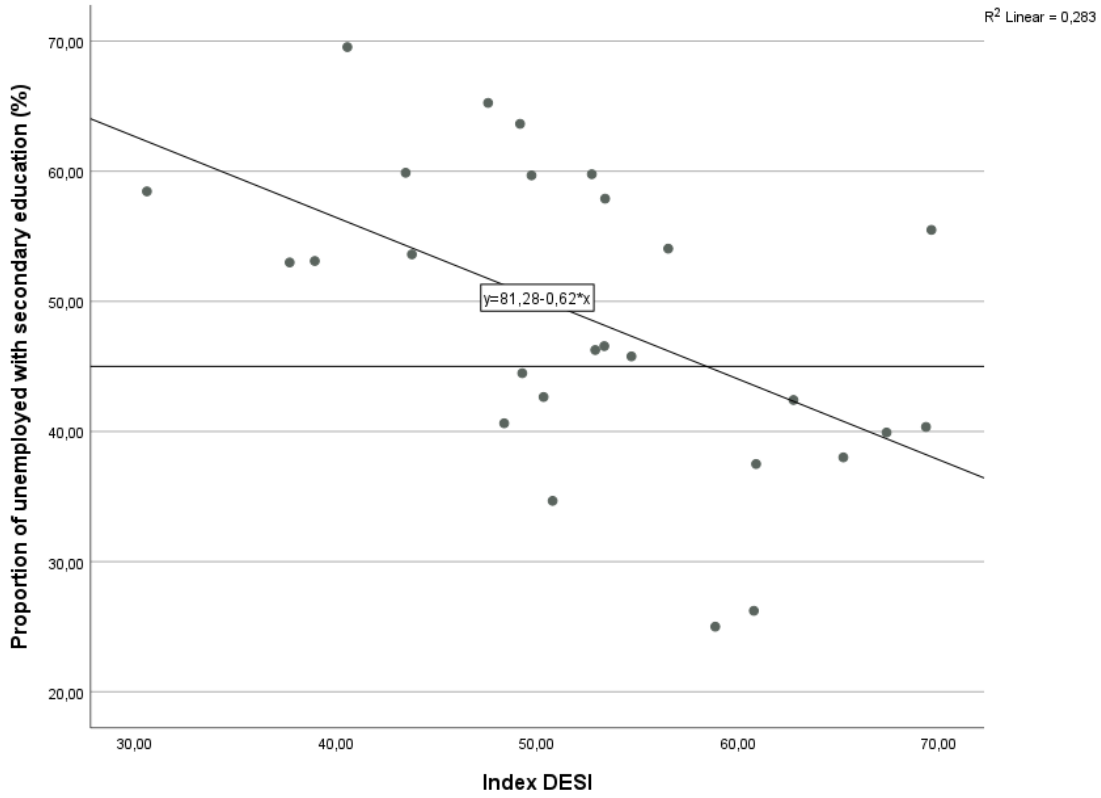
The linear regression model with the explanatory variable DESI can explain 25.3% of the variability in the share of unemployed people with secondary education.

The linear regression model with the explanatory variable DESI can explain 36.3% of the variability in the share of unemployed people with high education.

Almost 0% of the variability of the share of unemployed people with low education can be explained by a linear regression model with the explanatory variable DESI.

Figure 2 shows a scatter plot with a regression line that explains the relationship between the DESI index and the proportion of unemployed people with secondary education. A descending straight line proves that there is an inverse relationship between the variables.

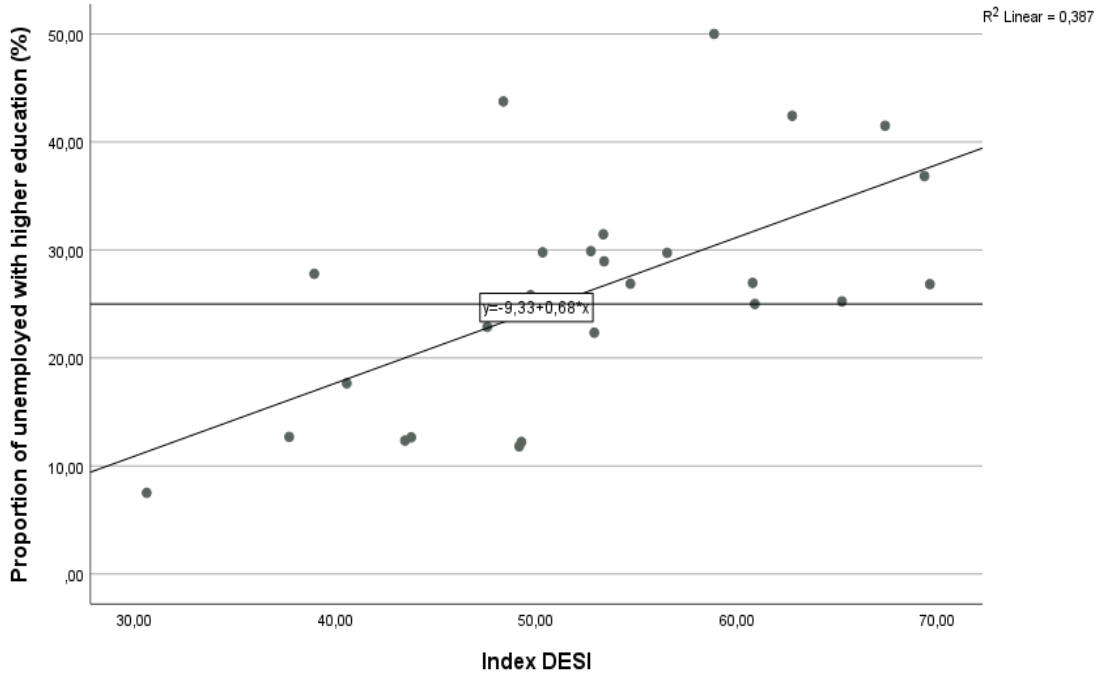
Figure 2 Regression line for the secondary education group (R2=0,283)



Source: Own processing according to z European Commission, 2024a a Eurostat, 2024

Figure 3 shows a scatter plot with a regression line that expresses the relationship between the DESI index and the proportion of unemployed people with a high education. The upward slope of the straight line confirms the direct relationship between the variables.

Figure 3 Regression line for the higher education group (R2=0,387)



Source: Own processing according to z European Commission, 2024a a Eurostat, 2024

Table 5 shows the results of the ANOVA test for individual hypotheses.

Table 5 Results of ANOVA

Hypothesis	p-value	Result
H_{1A}	0.800	Hypothesis H_{1A} **is accepted**
H_{1B}	0.004	Hypothesis H_{1B} **is rejected**
H_{1C}	<0,001	Hypothesis H_{1C} **is rejected**

Source: Own processing according to results from SPSS

We accept hypothesis H_{1A} at the significance level of 0.05 and thus the DESI index does not have a statistically significant effect on the share of unemployed people with low education in the country. At the significance level of 0.05, we reject hypothesis H_{1B}, which means that the DESI index has a statistically significant effect on the share of unemployed people with secondary education. We also reject the H_{1C} hypothesis at the significance level of 0.05. The DESI index has a statistically significant effect on the share of unemployed people with high education.

Based on the results of the regression analysis, we identified 2 population groups that are affected by digitization in the labour market and 1 group that is not affected by digitization in the labour market. Digitization affects people with medium education and people with high education. On the other hand, digitization does not affect people with low education.

Based on the positive or negative value of the correlation coefficient between the DESI index and the share of unemployed population groups that are affected by digitization, we identified 1 population group that is disadvantaged on the labour market due to digitization (positive value of the correlation coefficient) and 1 population group that digitization on the market work favours (negative value of the correlation coefficient). Digitization puts people with higher education at a disadvantage. On the contrary, digitization favours individuals with secondary education.

Given the assumption that highly educated individuals have the most developed digital skills, these findings were surprising. We expected that this group of the population is the best able to adapt to the digital transformation. As a result, it is not easy to identify the causes that would explain the disadvantage of this group in the labour market.

The disadvantage of highly educated individuals confirms the importance of lifelong learning in the age of digitalization. It is essential that people with higher education, in particular, quickly adapt to new technologies and learn new digital skills in order to be competitive in the labour market. Their disadvantage may also lie in insufficient education in the field of digital technologies at universities when they lack practical experience with various digital tools and software. At the same time, our research shows that digitization does not affect individuals with low education. This is probably because such people perform professions that do not change their nature due to the impact of digitization and do not require a high level of digital skills. In the future, however, there may be a situation where these professions will gradually disappear and be replaced by machines.

VI. Conclusion

The main goal of the paper was to examine the current state of digitization in the European Union with an emphasis on the Slovak Republic and to analyze its impact on the unemployment of the population according to educational attainment. Specifically, there were 3 population groups – individuals with low education (ISCED 0-2), medium education (ISCED 2-5) and high education (ISCED 6-8). The goal was to identify groups that are affected by digitization on the labour market, and subsequently to differentiate among the identified groups which are disadvantaged, and which are advantaged due to digitization on the labour market.

One of the sub-goals was also to analyze the individual components of the Digital Economy and Society Index in the Slovak Republic and compare them with the average values of the European Union. From the results, we found out that Slovakia is at the bottom of the DESI index within

the European Union. In 2022, it took 23rd place out of a possible 27 places. It was ranked worst in the area of digital public services, where it took up to 24th place, and Slovakia achieved the best results in the area of human capital, where it was ranked 21st within the EU. The level of digitization in Slovakia is therefore low compared to other EU countries. The Government of the Slovak Republic adopts various measures and plans with the aim of supporting digitization and improving Slovakia's position within the EU.

The main goal of the paper was fulfilled using correlation and regression analysis, which were used to examine the relationship between the DESI index and the percentage of unemployed according to education in EU countries. As part of the regression analysis, an ANOVA test was performed, which accepted the H_{1A} hypothesis and rejected the H_{1B} and H_{1C} hypotheses. By accepting the hypothesis, a population group was identified on which digitization in the labour market has no effect. These were individuals with a low level of education. By rejecting the hypotheses, the population groups affected by digitization on the labour market were identified. Specifically, they were individuals with secondary education and higher education. Based on the value of the correlation coefficient, the group of the population that is favoured by digitization on the labour market (negative value of the coefficient) and the group that is disadvantaged by digitization (positive value of the coefficient) were subsequently identified. From the results, we found that digitization favours individuals with a secondary education and disadvantages individuals with a high education.

We believe that the results of our research are beneficial for a better understanding of the current state of digitization and digital transformation in the European Union and Slovakia. At the same time, they approximate the current happenings on the labour market in connection with digitalization and can be beneficial for ensuring the employment of disadvantaged groups.

In the future, the research could be extended by a more detailed analysis of population groups on the labour market. It would be appropriate to monitor the impact of digitization on unemployment in individual sectors, or to analyze specific professions. Another extension could be the addition of qualitative research, as the research in this paper was exclusively quantitative. It would be interesting to conduct an interview with representatives of individual groups of the population or conduct a questionnaire and examine how specific groups perceive digitization.

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