Digitalization and Employment Trends in the European Union

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Abstract

The article examines the impact of digitalization on the labor market in European countries, with a focus on cluster analysis, which allows for the identification of groups of countries with similar characteristics. Using a multifactor regression analysis, it was found that digital technologies, such as e-commerce, broadband internet access, and financial services, have a significant influence on employment. The results show that countries with active implementation of electronic services can have a positive impact on the labor market, while less developed countries face challenges due to insufficient digital infrastructure. Adapting policies aimed at increasing digitalization is an important step for employment growth in each cluster. Based on the obtained data, recommendations for countries are proposed, including improving access to digital technologies, promoting e-commerce, and developing skills in the ICT sector.

This article makes some contribution to understanding the relationship between digitalization and employment, offering new perspectives for shaping effective policies in this area.

Keywords

digitalization, employment, e-commerce, regression analysis, cluster analysis, digital technologies, broadband access, financial services, employment policies, European Union

1. Introduction

The beginning of the 21st century was marked by the emergence of a new global phenomenon – digitalization of the economy, driven by the rapid spread of the Internet. The World Telecommunication Standardization Assembly provides the following statistics: in 2021, 63% of the world's population were active users of the World Wide Web [1]. According to Cloudflare, global Internet traffic in 2023 increased by 25% compared to the previous year, and the traffic of satellite provider SpaceX Starlink tripled, while in some countries that had only recently begun using this operator's services, growth was recorded in multiples [2]. Digital innovations not only affect employment levels but also change the forms of employment and the skills required of workers. According to estimates by the World Economic Forum, by 2025, due to shifts in the distribution of labor between humans and machines, 85 million jobs could be displaced, while 97 million new jobs, better adapted to this new distribution, may emerge [3]. Economically developed countries are rapidly implementing digital technologies, which are primarily transforming the labor market. The countries of the European Community have their own digitalization strategy, aimed at promoting economic growth for all members of this economic alliance, as well as increasing jobs, investments, innovations, etc. Analysts, scientists, and researchers emphasize that digital innovations integrated into the economy of any country can pose threats and challenges to existing labor markets and impact employment. D. Acemoglu and R. Restrepo (2020) note that significant progress in the fields of artificial intelligence, machine learning, communication technologies, its consequences, and their impact on employment is an open and important issue that needs to be thoroughly researched [4].

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2. Literature review

W. P. Groen, K. Lenaerts, R. Bosc, and F. Paguier (2017) state that the consequences of digitalization of the economy can be very serious in the context of job creation/job reduction. However, they also note that there is no consensus on how much the Fourth Industrial Revolution, which involves the widespread adoption of digital innovations and information computer technologies, will impact employment [5]. A study conducted by the Organisation for Economic Co-operation and Development indicates that previous industrial revolutions led to an increase in jobs after a certain period, but initially, there was a reduction in jobs. New technologies will boost productivity, thus reducing the need for jobs; on the other hand, they will lead to lower prices, and consequently, an increase in demand. Therefore, it is difficult to determine how strongly both effects will differ across economic sectors, regions, and time [6]. A. Smith and J. Anderson (2014) also highlight the uncertainty of the impact of digital transformations on employment, based on the results of a Pew Research Center survey [7]. The research by R. Pena-Casas, D. Ghailani, and S. Coster (2018) shows that digitalization processes affect both employment levels and its quality, with the consequences depending on sectors and professions [8]. S. Sandri, N. Alshyab, and M. Shaban (2022) emphasize that digital transformation can be a source of competitive advantage and a driver of economic growth in any country, helping to reduce unemployment if effective government policies are in place [9]. A. Kolot et al. (2022), after substantiating current trends in employment in the context of the digital economy, confirmed the hypothesis regarding both the constructive and destructive impacts of digitalization on employment structure. In examining the interaction between these processes in the Ukrainian context, the authors concluded that the introduction of digital technologies had the greatest impact on high-tech sectors, while no such connection was observed in industrial sectors [10]. D. Lederman and M. Zouaidi (2022), analyzing the relationship between digital economy development and unemployment levels in countries with different levels of economic development, found a negative correlation between these indicators, with the relationship being stronger in developing countries than in highly developed ones. To mitigate such an impact, the authors propose introducing control over the prevalence of informal employment [11]. A. M. Santos, J. Barbero, S. Salotti, and A. Conte (2023), in their comprehensive study of ICT investments across EU countries during 1995–2019, simultaneously concluded that the impact of digitalization on employment is heterogeneous across different countries [12]. N. Dziubanovska et al. (2023) identified a significant impact of digital economy indicators, particularly e-banking, on the volumes of international trade in goods and services [13]. W. Yunxia, H. Neng, and M. Yechi (2023) analyzed the impact of digital economy development on the scale of employment in China and concluded that digitalization positively affects employment levels by increasing the share of high- and medium-skilled labor while reducing the share of low-skilled labor. They explain this effect through scale and productivity expansion effects [14]. The results of the study conducted by E. Prytkova et al. (2024) showed that there is a direct link between the introduction of digital technologies and employment in European countries during 2012–2019, contributing to the emergence of three types of effects: substitution, productivity, and recovery [15].

3. Methodology

To assess the level of digitalization of the economies of EU member states, the European Commission uses the Digital Economy and Society Index. It has been calculated since 2014 and consisted of the following components: connectivity, human capital, use of the Internet, integration of digital technologies, and digital public services. In 2021, taking into account the EU's political initiatives in the context of digital transformation, namely the creation of the Recovery and Resilience Facility and the adoption of the Digital Decade Compass policy program, the structure of the index was transformed into a four-dimensional one (Table 1).

Table 1
The Specific Weight of the Main Components of DESI

Component	Specific weight, %	
	2014 – 2020	2021 to present
Connectivity	25	25
Human Capital	25	25
Internet Usage	15	–
Integration of Digital Technologies	20	25
Digital Public Services	15	25

Given the data for the period from 2017 to 2022 [16], we will analyze the dynamics of DESI growth to gain a deeper understanding of the pace of digital transformation in EU countries. This will allow for a comparison of their achievements in implementing digital technologies and an assessment of the effectiveness of national strategies in this area. This analysis will help identify countries with the most significant changes in indicators, indicating their progress in adopting digital technologies, as well as highlight areas where improvements are still needed (Figure 1).

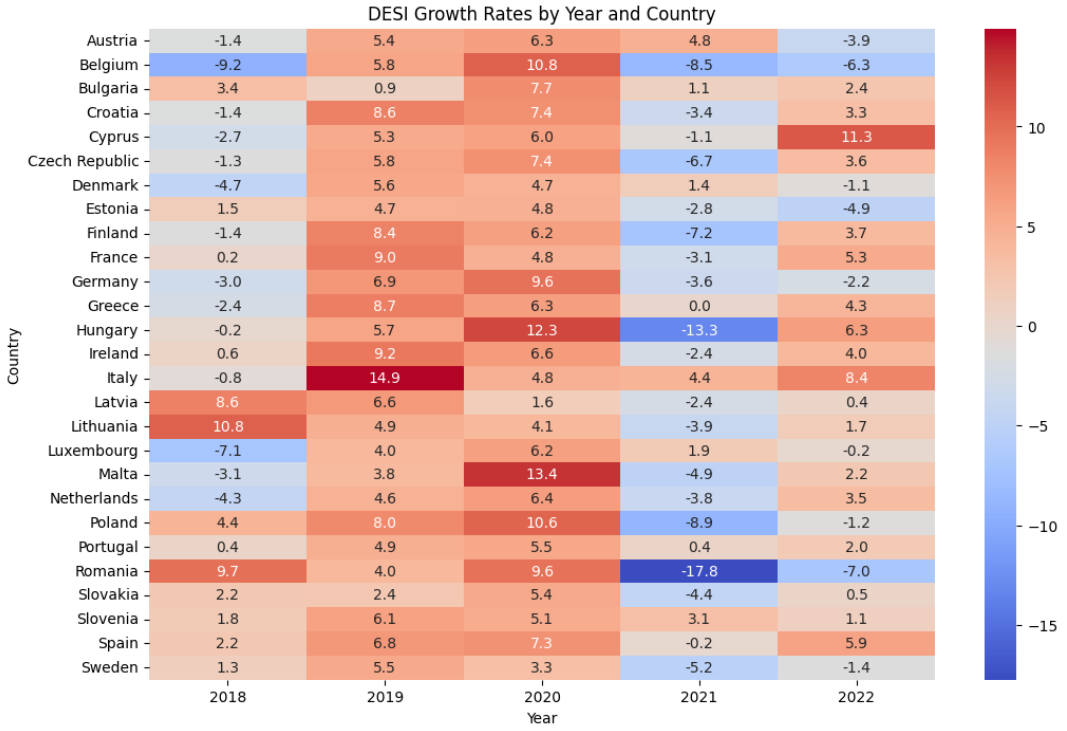

Figure 1: DESI Growth Rates by Year and Country

During the studied period, there was a general improvement in digital indicators in most European countries, indicating active implementation of digital technologies. However, in 2021, many countries experienced a slowdown in growth, which could be a result of economic challenges related to the COVID-19 pandemic and geopolitical changes. Lithuania, Italy, and Bulgaria showed the highest average growth rates over five years, reflecting steady progress in the development of digital technologies. Belgium, Hungary, and Romania displayed unstable results, with periodic declines, indicating challenges in adapting to digital changes.

The analysis of DESI growth for the period 2017–2022 suggests that digital transformation in Europe is occurring unevenly. To gain a deeper understanding of digitalization processes in European countries and to identify groups of countries showing similar trends in digital transformation, cluster analysis of countries based on DESI growth was conducted.

In the first stage of cluster analysis, the "elbow" method was used to determine the optimal number of clusters. This approach involves constructing a graph of the sum of squared distances within clusters (WCSS) for different values of the number of clusters. The goal is to identify the point of inflection, or "elbow," on the graph (Figure 2), after which further increases in the number of clusters only slightly reduce the WCSS. This point indicates the optimal number of clusters.

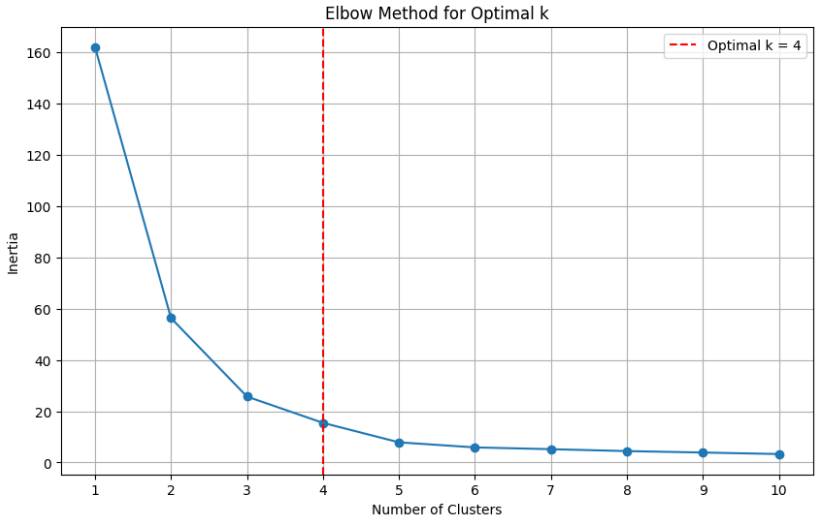

Figure 2: The "Elbow" Method for Determining the Number of Clusters Based on the Growth of the DESI

In the next stage, clustering was performed using the k-means method, which divides the data into clusters by minimizing the within-cluster sum of squares. As a result, all EU member states were grouped into four clusters based on the pace of digital technology adoption (Table 2).

Table 2
EU Member States by Clusters

Cluster	EU member states
0	Croatia, Cyprus, Czech Republic, France, Hungary, Italy, Latvia, Portugal, Slovakia, Slovenia
1	Austria, Belgium, Estonia, Germany, Ireland, Lithuania, Luxembourg, Malta, Spain
2	Denmark, Finland, Netherlands, Sweden
3	Bulgaria, Greece, Poland, Romania

The cluster analysis based on DESI growth indicators identified four main groups of countries that differ in their pace of digital transformation. The first cluster (Cluster 0) includes countries that show moderate growth in DESI indicators, with periodic fluctuations. Some of them, such as Croatia and Hungary, exhibit significant positive changes, but there are also negative values in 2021, indicating instability in their digital transformation. The second cluster (Cluster 1) comprises countries with high DESI growth rates, but they also experience some fluctuations. Overall, these countries hold strong positions in digitalization, which may suggest significant investments in digital technologies. The third cluster (Cluster 2) is characterized by high DESI growth rates and stable performance, indicating a certain maturity in the digitalization processes. Countries in this cluster demonstrate the best results in this area, highlighting the effectiveness of national strategies. Lastly, the fourth cluster (Cluster 3) consists of countries with low DESI growth rates, suggesting the need for more intensive efforts to improve their digital indicators. It can be assumed that these countries face challenges related to economic development and adaptation to new technologies.

Thus, the results of the cluster analysis indicate different stages of digital transformation development across European countries, which can aid in designing targeted strategies for each cluster, considering their specific needs and challenges.

To visualize the clustering results, the Principal Component Analysis (PCA) method was applied, reducing the multidimensional data to two components for easier visualization. PCA reduces the number of dimensions while preserving the maximum data variance, allowing for a clear representation of the data structure and relationships between clusters (Figure 3).

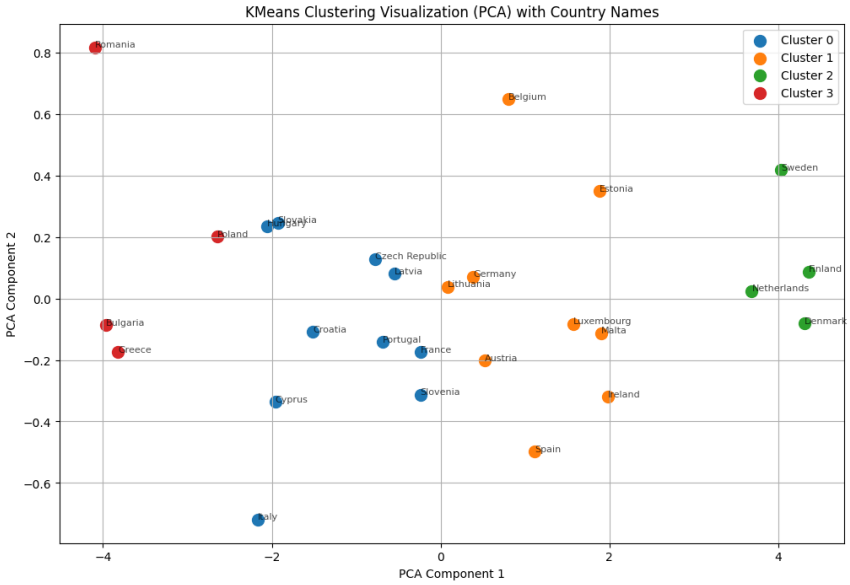

Figure 3: Visualization of Clusters in the Two-Dimensional Principal Component Space

The resulting visualized image highlights the differences between the data clusters, emphasizing their unique characteristics. This analysis not only facilitates the understanding of key patterns but also helps identify potential areas for further research and the implementation of targeted actions within the digital economy.

4. Results

In today's world, digitalization has become a key factor shaping the socio-economic development of countries. Understanding the impact of digital technologies on employment is crucial for developing effective labor market policies. The primary goal of this study is to identify the influence of various aspects of digitalization on the overall employment levels in EU countries, according to Eurostat data [17].

The selection of independent variables for analysis was based on key aspects that determine a country's level of digital transformation, which are included in the DESI (Table 3).

Table 3
Representation of Digital Economy Factors

Sub-Index DESI	Factor Variables and Description
Connectivity	*Broadband internet coverage by speed (More than 100 megabits per second (Mbps) (Percentage of households))* (X_1) *High-speed internet is essential for supporting remote work and digital employment opportunities.*
	Broadband internet coverage by technology (Percentage of households) (X_2) *Access to various technologies ensures that all demographics can connect to the internet, facilitating job opportunities.*
	Level of internet access (Percentage of households) (X_3) *Access to the internet at home enables job seekers to search for opportunities and enhances employability.*

Human Capital	*Employed ICT specialists (Percentage of total employment)* (X_4) *A higher percentage of ICT specialists indicates a skilled workforce capable of driving digital economy growth and innovation.*
Use of Internet Services	*Internet purchases by individuals* (X_5) *Online shopping habits reflect consumer behavior and adaptability to digital employment trends.*
	Individuals – internet use (Percentage of individuals who used Internet within the last year) (X_6) *The level of internet use indicates how well-prepared individuals are for remote job opportunities.*
	Promoting e-commerce for individuals (X_7) *Encouraging online commerce suggests readiness to engage in digital job markets, enhancing employment opportunities.*
	Financial activities over the internet (X_8) *Engagement in online financial services can increase job opportunities in the financial technology sector.*
Integration of Digital Technology	*E-commerce* (X_9) *The presence of e-commerce platforms enhances job opportunities by connecting buyers and sellers in a digital marketplace.*
	Selling goods or services (X_{10}) *The ability to sell online demonstrates entrepreneurial spirit and potential for job creation in the digital economy.*
	Promoting e-commerce for business (X_{11}) *Support for e-commerce in business reflects job growth potential in digital sectors, attracting talent and investment.*
Digital Public Services	*E-government activities of individuals via websites* (X_{12}) *Participation in e-government services can lead to job creation in public sector services and improve civic engagement.*
	E-banking (X_{13}) *The growth of e-banking indicates a comfort with digital transactions, which can facilitate job creation in fintech and related sectors.*

The dependent variable chosen for the analysis was Total employment (Percentage of total population from 20 to 64 years) (Y). Regression models were built for each of the four clusters, allowing for a detailed examination of the relationship between the independent digitalization factors and the dependent variable – total employment. This study aims to uncover not only correlations between digital indicators and employment levels but also to understand which factors play the most significant role in these processes. The results of the analysis may serve as a basis for further policy recommendations and strategies for the development of digital technologies in different countries.

The results of the multivariate regression analysis for the first cluster (Figure 4) show that digital innovations have a significant impact on overall employment levels.

The model that assesses the impact of various factors on the overall level of employment is quite effective. An R-squared value of 0.820 indicates that 82% of the variation in total employment is explained by the independent variables, demonstrating a high quality of the model. The adjusted R-squared value of 0.772 further confirms this, taking into account the number of predictors in the model.

Results for Cluster 0:

OLS Regression Results

Dep. Variable:	Total employment	R-squared:	0.820
Model:	OLS	Adj. R-squared:	0.772
Method:	Least Squares	F-statistic:	17.13
Date:	Mon, 30 Sep 2024	Prob (F-statistic):	6.28e-14
Time:	11:11:00	Log-Likelihood:	-135.99
No. Observations:	63	AIC:	300.0
Df Residuals:	49	BIC:	330.0
Df Model:	13		
Covariance Type:	nonrobust		

	coef	std err	t	P>|t|	[0.025	0.975]
const	58.1581	8.683	6.698	0.000	40.708	75.608
e-banking	-0.0620	0.063	-0.987	0.329	-0.188	0.064
e-commerce	-0.2085	0.205	-1.017	0.314	-0.620	0.204
selling goods or services	-0.0445	0.119	-0.375	0.709	-0.283	0.194
promoting e-commerce for individuals	0.4598	0.193	2.380	0.021	0.072	0.848
promoting e-commerce for business	0.0630	0.036	1.736	0.089	-0.010	0.136
Financial activities over the internet	-0.1421	0.077	-1.839	0.072	-0.297	0.013
Internet purchases by individuals	-0.1929	0.086	-2.237	0.030	-0.366	-0.020
Broadband internet coverage by technology	0.0674	0.056	1.196	0.238	-0.046	0.181
Broadband internet coverage by speed	0.1126	0.032	3.570	0.001	0.049	0.176
Individuals - internet use	-0.2324	0.487	-0.477	0.635	-1.210	0.746
Level of internet access	-0.1569	0.140	-1.120	0.268	-0.439	0.125
E-government activities of individuals via websites	0.2104	0.050	4.230	0.000	0.110	0.310
Employed ICT specialists	-0.0634	1.028	-0.062	0.951	-2.129	2.002

Omnibus:	6.265	Durbin-Watson:	2.000
Prob(Omnibus):	0.044	Jarque-Bera (JB):	5.993
Skew:	-0.755	Prob(JB):	0.0500
Kurtosis:	3.041	Cond. No.	5.39e+03

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

Figure 4: Regression Analysis Results for Cluster 0

The regression equation for Cluster 0:

$$Y = 58.1581 + 0.1126X_1 - 0.1929X_5 + 0.4598X_7 + 0.2104X_{12}. \quad (1)$$

The constant coefficient is 58.1581, indicating the expected value of the overall level of employment when all independent variables are equal to zero. This coefficient is statistically significant (p = 0.000).

Among the key independent variables that have a statistically significant impact on employment, the promotion of e-commerce for individuals stands out, with a positive coefficient of 0.4598 (p = 0.021). This means that increasing initiatives aimed at popularizing e-commerce positively affects employment. E-government services for individuals via websites have also proven to be important, with a positive coefficient of 0.2104 and p = 0.000. This suggests that the availability of digital government services can improve the labor market situation by simplifying employment-related processes. In contrast, Internet purchases by individuals has a negative coefficient of –0.1929 with p = 0.030. This may indicate that an increase in online shopping is associated with a decrease in employment in the traditional sector, suggesting a displacement of jobs in retail. The results of the study also confirm that broadband internet coverage by speed has a positive impact on overall employment (coefficient of 0.1126, p = 0.001), demonstrating the importance of infrastructure development to ensure internet access, as it can contribute to creating new job opportunities.

Overall, the results indicate that countries in this cluster have the potential for further development, considering the positive impact of digital technologies on employment. However, they also emphasize the need for a strategic approach to implementing digitalization, taking into account the specifics of each country. This can serve as a basis for developing policies aimed at increasing employment levels in the context of the rapid development of the digital economy.

For Cluster 1, the resulting equation for the multiple regression analysis is as follows:

$$Y = 107.2753 - 0.2576X_2 + 0.1909X_5 + 0.1961X_6 + 0.2594X_{10}. \quad (2)$$

The *R*-squared value is 0.716, indicating that approximately 71.6% of the variation in the overall level of employment can be explained by the selected variables, showing a moderate correlation between digital technologies and employment levels.

It is worth noting that the constant (107.2753) represents the baseline level of employment in these countries in the absence of other influencing factors. A significant positive correlation with "sales of goods and services" (coefficient 0.2594, p = 0.004) suggests that an increase in sales contributes to job creation. There is also a positive impact from online financial activities (coefficient 0.1961, p = 0.001), highlighting the importance of digital financial services in this group of countries.

Additionally, the positive relationship with Internet purchases by individuals (coefficient 0.1909, p = 0.048) reflects the growing significance of e-commerce for the economy of Cluster 1. However, the negative impact of "broadband internet coverage by technology" may indicate that insufficient broadband Internet development is a limiting factor for employment growth (coefficient −0.2576, p = 0.023).

Countries in Cluster 1 show a diversity in the use of digital technologies, underscoring the importance of considering the specific contexts of each country. This indicates a need for policies aimed at promoting e-commerce and financial technologies as crucial factors that can contribute to job creation in these countries.

Based on the results of the multiple regression analysis for Cluster 2, the model equation is as follows:

$$Y = 22.3702 + 0.1335X_1 + 1.8001X_4 - 0.1680X_5 + 2.2338X_6 + 0.6404X_7. \quad (3)$$

The *R*-squared value is 0.975, indicating that 97.5% of the variation in the overall level of employment can be explained by the use of digital technologies. This suggests that the countries with high employment levels demonstrate a very strong correlation between employment and digital technologies.

The constant (22.3702) represents the baseline level of employment in these countries in the absence of other factors. A significant positive correlation with "promotion of e-commerce for individuals" (coefficient 0.6404, p = 0.003) indicates a positive impact of such activities on job creation. This suggests that promoting e-commerce stimulates consumer demand and leads to increased employment.

It is also important to note that "broadband internet coverage by speed" (coefficient 0.1335, p = 0.001) has a significant positive effect, highlighting the importance of high-quality internet connectivity for supporting employment in these countries. Additionally, the indicator "individuals – internet use" also has a high positive coefficient (coefficient 2.2338, p = 0.001), indicating the significance of actively utilizing internet technologies for job creation.

The number of ICT specialists also has a significant positive impact on employment (coefficient 1.8001, p = 0.000). This confirms that the development of information technology and related employment in this sector contributes to overall employment growth.

However, the negative impact of "internet purchases by individuals" (coefficient −0.1680, p = 0.005) suggests potential problems in this area, possibly due to decreased demand for traditional services or goods. Other variables, such as e-government activities and online financial activities, did not show statistically significant effects on employment, indicating a need to improve these services.

Countries in Cluster 2 likely have strong prerequisites for the development of the digital economy; however, it is essential to pay attention to the specifics of each country and consider their unique contexts when developing policies that will promote employment growth through digitalization.

The results of the regression analysis for Cluster 3 demonstrate an extraordinarily high level of explanatory power for the model, with an *R*-squared value of 0.982:

$$Y = 45.4069 + 0.082X_1 + 8.6569X_4. \quad (4)$$

This means that 98.2% of the variation in the overall level of employment in these countries can be explained by the use of digital technologies and related factors. The constant (45.4069) indicates the baseline level of employment in the absence of other influencing factors.

A key indicator is the "employed ICT specialists" (coefficient 8.6569, p = 0.000), which has a significant positive impact on the overall level of employment. This demonstrates that an increase in the number of ICT specialists directly contributes to employment growth in the region, highlighting the importance of skilled personnel in the digital economy.

Broadband internet coverage by speed (coefficient 0.0820, p = 0.050) also shows a positive effect on employment, albeit at the edge of statistical significance. This suggests that improving internet connection speeds may contribute to economic growth and job creation.

However, other factors did not show statistically significant effects on employment. These results indicate that for countries in Cluster 3, it is essential to develop not only broadband infrastructure but also to focus on training and attracting ICT specialists to support employment growth. At the same time, policymakers should consider changes in consumer preferences related to e-commerce to balance traditional and digital markets.

To visualize and assess the quality of the models, graphs of the actual and predicted values were constructed (Figure 5). These allow for the comparison of actual total employment values with calculated ones, helping to identify systematic deviations or trends.

The line of ideal fit provides a convenient reference point for evaluating the accuracy of the models, allowing for easy identification of areas that may require improvement. These visualizations also highlight the effectiveness of different clusters, which may be useful for further analysis and decision-making.

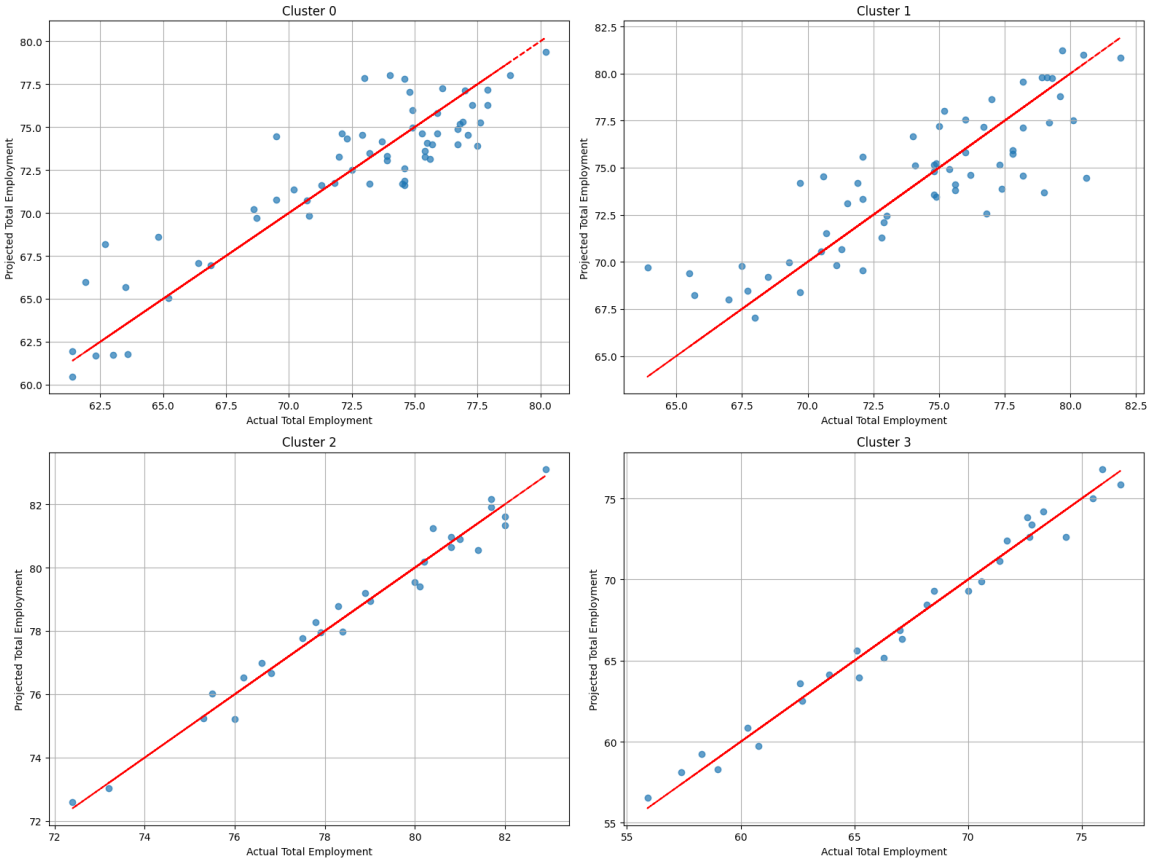

Figure 5: Plots of Actual vs. Projected Values

Multifactor regression analysis is an extremely important tool as it allows for the identification of significant factors that influence employment in the context of digitalization. This method enables the assessment of the contribution of each variable to the overall picture, highlighting those with the most substantial impact. Identifying such variables creates a solid foundation for further impact

analysis, which can be used to build development scenarios and forecast potential labor market outcomes. This approach allows for the development of more accurate strategies and their adaptation to real-world conditions. With clear relationships among variables, analysts and policymakers can more accurately predict which measures will yield the greatest benefits for employment growth in each country or region. This facilitates the formulation of targeted strategies for optimizing digital initiatives and enhancing management efficiency at the national level.

5. Conclusions

According to the results of the regression analysis across all clusters, there is an observed influence of digital transformation development on employment in European countries, but with varying aspects depending on the specifics of each cluster. Countries grouped in Cluster 0, such as France and Italy, demonstrate active implementation of e-services and a high level of digitalization, which can positively impact the labor market and serve as examples of effective use of e-commerce to stimulate it. However, less developed countries, such as Latvia and Hungary, may face challenges due to underdeveloped digital infrastructure, particularly limited access to the internet. Cyprus and the Czech Republic illustrate the importance of broadband access for increasing employment. The analysis results for this cluster demonstrate that there is potential for development, but also underscore the need for a strategic approach to the implementation of digital technologies.

Cluster 1 consists of countries where a lower level of correlation between digital technologies and overall employment has been detected compared to Cluster 0. They show diversity in the use of digital technologies, indicating the need to consider the specific contexts of each country in developing effective policies aimed at increasing employment through digitalization.

Countries in Cluster 2 have strong prerequisites for developing a digital economy; however, considering the specifics of each one when developing policies will promote employment growth through digitalization.

Countries in Cluster 3 should focus on training and attracting IT specialists as well as on developing broadband infrastructure. Policymakers must take into account changes in consumer preferences related to e-commerce to balance traditional and digital markets.

The analysis results show that digitalization has a significant impact on employment across all clusters; however, the specific contexts and challenges in each country require individualized policy approaches. Countries should focus on developing digital technologies, e-commerce, and infrastructure to enhance employment while considering their unique characteristics and needs.

Thus, the impact of digital technologies on employment largely depends on the level of their integration into the economy and incorporation into business processes. When countries actively stimulate the development of e-commerce and increase the share of internet activities among the population, it leads to the creation of new jobs and improved conditions in the labor market. Conversely, if digital technologies do not receive sufficient attention from governments or are under-invested in infrastructure, employment may remain low or even decline.

In this context, countries with developed digital infrastructures should continue to invest in technologies, particularly in the development of e-commerce, digital financial services, and access to high-speed internet, which can enhance competitiveness in international markets and ensure stable employment growth. Less developed countries need to focus on developing basic digital infrastructure, including expanding access to broadband internet and improving the digital skills of the population to maximize the potential of the digital economy for stimulating the labor market.

Additionally, upskilling and training ICT specialists should become a priority for all countries, as attracting highly qualified personnel in the ICT sector will strengthen the impact of digitalization on economic development and employment. Strategic regulation and support for small and medium-sized enterprises in the digital economy through state support programs and grant initiatives will help bridge the digital divide between countries and accelerate the integration of digital technologies into the business environment. These measures will enable countries to optimally leverage the opportunities provided by digitalization to stimulate employment and sustainable economic growth.

Declaration on Generative AI

The authors have not employed any Generative AI tools.

References

[1] International Telecommunication Union, Statistics, (2021). URI: https://www.itu.int/en/ITU-D/Statistics/Pages/stat/default.aspx.

[2] Cloudflare 2023 Year in Review. (2023). URI: https://blog.cloudfare.com/radar-2023-year-in-review/.

[3] The Future of Jobs Report 2020. (2020). World Economic Forum. URI: https://www.weforum.org/publications/the-future-of-jobs-report-2020/.

[4] Acemoglu, D., Restrepo, P. (2020). Robots and Jobs: Evidence from US Labor Markets. Journal of Political Economy. 128:6, 2188–2244. https://doi.org/10.1086/705716.

[5] Groen, W. P., Lenaerts, K., Bosc, R., Paguier, F. (2017). Impact of digitalization and the on-demand economy on labour markets and the consequences for employment and industrial relations. European Economic and Social Committee. URI: https://www.eesc.europa.eu/sites/default/files/resources/docs/qe-02-17-763-en-n.pdf.

[6] OECD Digital Economy Outlook 2015. (2015). OECD Publishing, Paris, 15 July. URI: https://www.ecd.org/en/publications/oecd-digital-economy-outlook-2015_9789264232440-en.html.

[7] Smith, A., Anderson, J. (2014). AI, robotics, and the future of jobs. Pew Research Center, Washington, D.C. URI: https://www.pewresearch.org/internet/2014/08/06/future-of-jobs/.

[8] Pena-Casas, R., Ghailani, D., Coster, S. (2018). The impact of digitalization on job quality in European public services. The case of homecare and employment service workers. Final report EPSU. URI: https://www.epsu.org/sites/default/files/article/files/FINAL%20REPORT%20EPSU%20DIGITALISATION%20-%20OSE%20June%202018.pdf.

[9] Sandri, S., Alshyab, N., Shaban, M. (2022). The Effect of Digitalization on Unemployment Reduction. New Medit. 21 (4). https://doi.org/10.30682/nm2204.

[10] Kolot, A., Herasymenko, O., Shevchenko, A., & Ryabokon, I. (2022). Employment in the coordinates of digital economy: current trends and foresight trajectories. Neuro-Fuzzy Modeling Techniques in Economics, 11, 78-123. http://doi.org/10.33111/nfmte.2022.078.

[11] Lederman, D., Zouaidi, M. (2022). Incidence of the Digital Economy and Frictional Unemployment: International Evidence. Applied Economics. 54 (51): 1-16. https://doi.org/10.1080/00036846.2022.2054927.

[12] Santos, A. M., Barbero, J., Salotti, S., Conte, A. (2023). Job creation and destruction in the digital age: Assessing heterogeneous effects across European Union countries. (2023). Economic Modelling. 126. https://doi.org/10.1016/j.econmod.2023.106405.

[13] Dziubanovska, N., Maslii, V., Krysovatyy, A., Desyatnyuk, O, Drelich-Skulska, B. (2023). The Effects of Digital Economy on International Trade: An Empirical Analysis of EU Countries Panel Data. 2023 13th International Conference on Advanced Computer Information Technologies (ACIT), Wrocław, Poland, 2023, 216-219. doi: 10.1109/ACIT58437.2023.10275723.

[14] Yunxia, W., Neng, H., Yechi, M. (2023). The Effect of Digital Economy Development on Labor Employment. Journal of Global Information Management. 31 (6). https://doi.org/10.4018/JGIM.321180.

[15] Prytkova, E., Petit, F., Li, D., Chaturvedi, S., Ciarli, T. (2024). The Employment Impact of Emerging Digital Technologies. CESifo Working Paper № 10955. URI: https://www.cesifo.org/en/publications/2024/working-paper/employment-impact-emerging-digital-technologies.

[16] The Digital Economy and Society Index (DESI). European Commission. URI: https://digital-strategy.ec.europa.eu/en/policies/desi.

[17] Eurostat. URI: http://www.ec.europa.eu/.