ISSN 2354-9114 (online), ISSN 0024-9521 (print)
Indonesian Journal of Geography Vol 57, No.3 (2025): 628-636
DOI: 10.22146/ijg.10761 website: htps://jurnal.ugm.ac.id/ijg

INDONESIAN JOURNAL OF GEOGRAPHY

RESEARCH ARTICLE

Reducing the digital divide as a goal for a knowledge-based economy: Lessons learned from the European Union

Maria Tislenko[1], Marko D. Petrović[1,2,*], Alena Massarova[1], Milan M. Radovanović[2] and Maria Potapenko[1]

[1] Department of Regional Economics and Geography, Faculty of Economy, Peoples' Friendship University of Russia (RUDN University), Moscow, Russian Federation

[2] Geographical Institute "Jovan Cvijić", Serbian Academy of Sciences and Arts (SASA), Belgrade, Serbia

Received: 2025-06-06
Revised: 2025-12-16
Accepted: 2025-12-31
Published: 2025-12-31

Key words: digital transformation; EU; GKI; DESI; digitalization funding

Correspondent email:
m.petrovic@gi.sanu.ac.rs

Abstract

The research examines the European Union's (EU's) policy to boost digitalization and reduce the digital divide. It involves seven strategic documents and three funding programs to evaluate their impact on building a knowledge-based economy in EU member states. It aims to identify connections between the EU's digital divide reduction policy and the path toward a knowledge economy. The analysis includes comparative, correlation, and regression analyses of the strategic planning documents, funding, and statistical data. It reveals a discrepancy between the EU's digital divide reduction policy and the goals of a knowledge-based economy. The implementation is hindered by inadequate and uneven funding, as well as the declarative nature of the goals outlined in the strategic documents. Furthermore, the correlation analysis of the Digital Economy and Society Index (DESI), the Global Knowledge Index (GKI), and proxy variables reveals significant relationships between digital transformation, a knowledge-based economy, and overall socio-economic development. The outcome revealed that the EU's policy lacks synchronization in reducing digital divides using financial instruments, which hampers the efficiency of transitioning to a digital economy and impedes the potential for technological and socio-economic development in EU countries.

1. Introduction

Digital divide refers to the gap in access and use of ICTs across socio-economic levels. Scholars have studied this topic for over 30 years, transitioning from examining differences in internet/computer access to investigating differences in digital competencies and usage. Initially viewed positively, it became clear that the benefits of ICT were unevenly distributed, jeopardizing territorial justice and exacerbating inequality (Loginova et al., 2020). The pandemic intensified digital transformation, forcing industries and households to go digital, exposing many individuals' unpreparedness due to a lack of infrastructure and digital skills, especially among the vulnerable socio-economic groups (Gabryelczyk, 2020; Nagel, 2020).

There is a consensus nowadays that the principal difficulties of combating digital divide in the 21st century lie in the domain of digital competencies and levels of their command (Troshina et al., 2020). Significant attention of researchers was devoted to the digital divide factors. Its main determinants are age, education, gender, level of income, ethnic and racial indicators for several communities; however, the strongest relation is demonstrated by the age and education factors (Elena-Bucea et al., 2021). Considering that, the digital divide works according to the so-called Matthew Effect, i.e., reproduces itself. People with lower levels of education and income rarely use the Internet for education purposes—and consequently for increasing their income, even if they have access to it. This is how the digital divide feedback loop works (Volchenko, 2016).

The digital divide can be assessed through indicators like Internet access, broadband and 5G coverage, online SME sales, and e-governance usage. As this study is centered around the European Union (EU) countries, the EU's main benchmark is the Digital Economy and Society Index (DESI), which includes 33 indicators for 27 countries, covering aspects such as big data, cloud technologies, and women in ICT 14 (Eurostat, n.d.).

There is no unanimity of opinion in the academic literature on whether it constitutes a specific stage in the development of postindustrial society (Bekbergeneva, 2020) or a domain of human activity that generates knowledge to achieve the goals of cognition and creativity in society (Yamashkin et al., 2023). Nevertheless, there is a consensus that a knowledge-based economy is closely connected with human capital and its quality. Aganbegyan (2021) evaluated the knowledge economy through government spending on R&D, education, ICT, biotech, and healthcare. Apart from that, 11 composite indices and methodologies to assess the knowledge economy have been recognized so far (Ojanperä et al., 2019). Despite the diversity of the various approaches offered to assess the knowledge economy, one of the most widely used approaches belongs to the World Bank—the Knowledge Economy Index (KEI). However, the World Bank stopped publishing statistics on this index after 2012. Today, the most relevant and comprehensive, in terms of its selection of countries, is arguably the Global Knowledge Index (GKI) developed by the United Nations Development Program. It tracks 154 states across 232 indicators in various fields, including economy, higher and further professional education, science, and innovation.

Several key areas of digital technology's impact on the knowledge-based economy have been identified in the past few years. Firstly, research has shown that people with technological knowledge have a positive impact on regional digital economic activity (Syzdykova et al., 2023). Secondly, ICT has been found to play a role in forming the knowledge economy, with the development level of ICT use being a significant factor (Bilan et al., 2023). Thirdly, digital technology in higher education institutions can impact student skill development (Bejinaru, 2019). Fourthly, digital literacy is considered important in the context of a knowledge-based economy, with studies focusing on its role in community development (Amponsah et al., 2025).

However, there are also areas where research is still ongoing or where more research is needed. For example, the impact of digital technology on the knowledge economy in different regions and industries may vary (Ding et al., 2021; Zhang et al., 2022), and further research is needed to understand these differences. Additionally, the role of digital technology in promoting social inclusion and reducing economic inequality remains an area that necessitates additional study to grasp its full impact (Bejinaru, 2019; Nosratabadi et al., 2023). Therefore, it is important to consider the digital divide as a potential impeding factor for the knowledge economy, and it seems reasonable to look at particular cases to establish the connections between the concepts of digital inequality and the knowledge economy.

The choice of the EU case is not random. First, the European Union has a long-standing history of pursuing a targeted policy of digital transformation and transition to the knowledge-based economy and implements a set of measures to that end. Second, the EU is one of the pioneers of digital development. According to the data of the World Digital Competitiveness (WDC) ranking in 2022 (Business School, 2025), the world's top 20 countries included seven EU member countries, including Denmark (1st place) and Sweden (3rd place) in 2022. The experience of the European Union in boosting digital competitiveness and bridging the digital divide poses a special interest, since the EU, as an economic and political integrational association, is distinct in its sufficient connectivity and provides the financial and instrumental framework for the tangible support of initiatives related to digital transformation of its member countries' national economies. It is noteworthy that due to strong federalist traditions, subsidiarity, and decentralization, the EU has no superior body or framework that would consolidate all digital transformation projects, yet various initiatives in individual directions were adopted (Tislenko, 2024).

The study aims to identify spatial connections between EU policy initiatives targeted at reducing the digital divide as part of advancing digital transformation and the transition towards a knowledge-based economy. The authors contend that while the European Union has declared the goal of reducing the digital divide at a strategic level, the effectiveness of its implementation has been hampered by inadequate funding, resulting in a limited role in fostering a knowledge-based economy. The assessment of effectiveness is carried out to advocate for the adoption of more appropriate measures by supranational and national authorities, supported by adequate budgets. The synchronization of efforts to advance digitalization, bridge digital divides, and cultivate a knowledge economy is posited to yield more tangible results in socio-economic and technological development, given the sustainable connections between these processes.

The objectives of this research are the spatial distribution of the digital divide within the European Union, contextualized within the shift toward a knowledge-based economy. The subject of investigation encompasses EU measures aimed at mitigating the digital divide. Through regression analysis utilizing Ordinary Least Squares (OLS), Spatial Auto-regressive (SAR), and Structural Equation Modeling (SEM) models, the study compares and evaluates the robustness and reliability of these models, with a focus on spatial disparities, to discern the interrelation among digital transformation, the digital divide, and parameters indicative of a knowledge economy. The model selection process prioritizes models with statistically significant results (p-values < 0.05) to provide insights into the spatial dynamics influencing the cohesion between digital transformation, the digital divide, and the advancement of a knowledge-based economy within the EU.

2. Methods

The chosen methodological framework is the comparative analysis of government strategic planning through the lens of EU supranational documents aimed at promoting digital transformation across the EU. To that end, seven major EU strategic planning documents related to digital transformation were selected, starting from the 2000 eEurope program and finishing with the large-scale program NextGenerationEU adopted in 2020 for the period until 2026 (NextGenerationEU, 2025). The texts of the documents were analyzed for content markers of digital divide, digital divides, and digital inclusion. This enabled us to identify if the digital divide is indicated as a challenge in the documents studied. Next, we determined the context of marker use, focusing on the proposed methods of bridging digital divides. That procedure allowed formulating the priorities that were set by the EU for bridging the digital divides, as well as the target audiences and policies singled out by the EU officials to deliver on the intended outcomes.

The second stage of the research involved an analysis of digital transformation funding and an assessment of its efficiency. Based on the open public data on EU budgeting, specific digital transformation funding programs were identified. Due to the availability of complete data on funding, three ICT and digital transformation boosting programs were singled out that were consistently implemented from 2007 to 2026. These programs offered the most comprehensive information on the funding as broken down by countries: The Information and Communication Technologies Policy Support Program (ICT-PSP, 2007–2013); Connecting Europe Facility (CEF-Telecom, 2014–2020); NextGenerationEU (NGEU, 2021–2026). In addition, the map of fund distribution was created. The software and hardware complex GeoDA was applied.

The third stage of the research involved collecting a database of EU countries capturing the following indicators: funding in the previous period (2007-2020, the amount collected under ICT-PSP и CEF-Telecom programs), funding in the current period (2021-2026, NGEU program), values of Digital Economy and Society Index (DESI), Global Knowledge

Index (GKI) as well as proxy variables as Human Development Index (HDI) and per capita GDP based on purchasing power parity (PPP). That database was used to match the data and identify connections between funding of digitalization in the EU, digital divide, and knowledge-based economy. The authors calculated the Pearson correlation coefficient of the selected indicators among themselves. This statistic is used to measure the strength and direction of a linear relationship between two variables, providing a numerical value, known as the correlation coefficient, which ranges from -1 to 1. To characterize the results of Pearson's correlation, the authors used the following degrees of determination (Gao, 2021) (Table 1).

This allowed identifying the nature of relations between EU funding of digital transformation/combating digital divide and the positions of EU countries in the digitalization and knowledge-based economy rankings. Moreover, the calculations enable us to assess the degree of interrelatedness of a knowledge economy and digital divide and to identify the variables that may influence GKI more than others.

The last step of this research was to conduct a regression analysis of the funding with the selected indicators. As the authors focus on spatial aspects of the digital divide, geographically weighted regression (GWR) was selected, besides the conventional OLS model. GWR considers the spatial effect, or, in other words, shows to what extent the spatial effect strengthens or weakens the regression dependence. SEM and SAR were used as two types of geographically weighted regressions. It means that only neighboring observations are taken to run the regression, while the spatial error type, on the other hand, excludes the neighborhood factor from the regression. The authors compared the results of three models (OLS, SAR, and SEM) and based on their robustness and statistical significance (p-values less than 0.05) chose

Table 1. Degrees of determination of correlations (Pearson's coefficient) and spatial autocorrelations (Moran's I)

Degree	Interval
Absolute positive	1
Strong positive	[0,6; 1)
Medium positive	[0,4; 0,6)
Moderate positive	[0,2; 0,4)
Weak positive	(0; 0,2)
No association	0
Weak negative	(-0,2; 0)
Moderate negative	(-0,4; -0,2]
Medium negative	(-0,6; -0,4]
Strong negative	(-1; -0,6]
Absolute negative	-1

Source: adapted from (Gao, 2021).

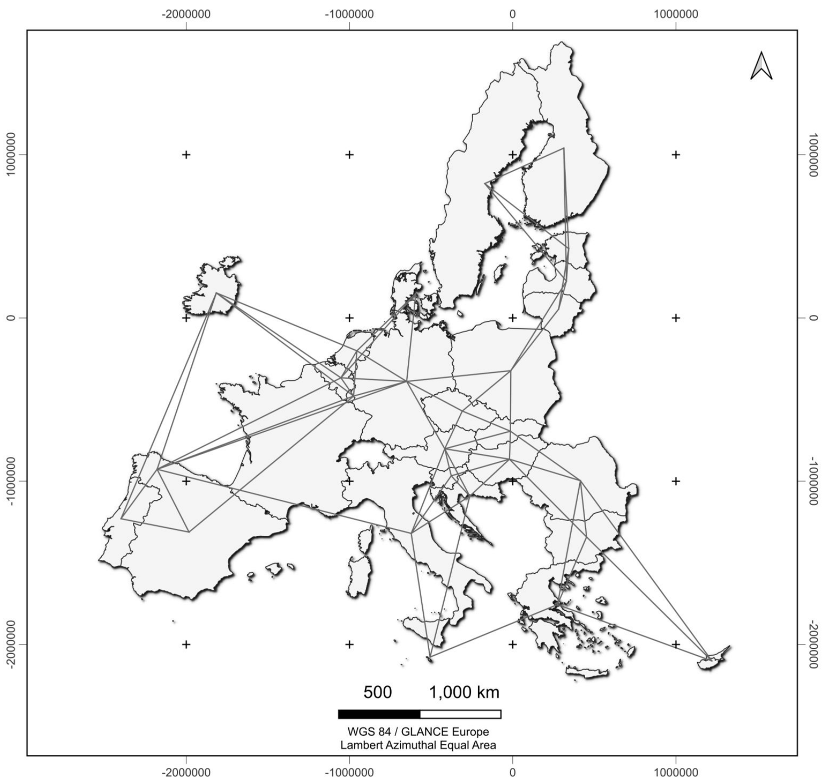


Figure 1. Connectivity graph for EU member states
Source: compiled by the authors using GeoDa software.

the best among them to describe the relation among digital transformation, digital divide and knowledge economy parameters.

To calculate the GWR, the authors used the matrix of spatial neighborhood weights based on the intersection of two matrices, by the "queen rule" and the k-nearest neighbors' method, where k=3 to avoid isolated cases such as Malta, Cyprus and Ireland, i.e. they remain in the analysis and have three neighbors each. The connectivity graph is shown in the cartogram below (Figure 1).

3. Result and Discussion

1.1. EU supranational policy to reduce digital divide 2000-2021: key documents and priorities.

The subject of digital divide plays an essential role in the EU's strategic documents from 2000 to 2020. Figure 2 shows that the issues of introducing ICT and digital transformation have consistently been the focus of attention of EU policy, while the financial instruments were not necessarily synchronized with strategic planning documents.

The EU's supranational digitalization policy from 2010 to 2022 demonstrates that reducing the digital divide was a key direction of the EU's digitalization efforts. It included the improvement of ICT skills, digital literacy, and promotion of inclusive digital services (Table 2). An important landmark was the publication of the 2015 report titled "Bridging the Digital Divide in the EU", which presented a comprehensive review of the measures and progress in closing the digital gap in the EU.

Since 2020, the digital transformation priority focus has shifted from facilitating digital inclusion to the general intensification of the transition to digital technologies in the context of challenges facing the united Europe. The approach of the NextGenerationEU and the Recovery and Resilience Facility plans refines the traditional perceptions of digital divide adopted during the previous decade of combating the EU's digital divide [38-39]. EU's digital divide policy is getting more complex as managers shift from the traditional indicators of ICT—infrastructure availability and command of digital skills—to the problems of digital divide of enterprises, accessibility of interfaces, as well as the gender divide in IT professions. Nonetheless, we deem it important to not only consider the declared priorities and obtained results but also to assess the levels of funding those proclamations and deliverables were backed with.

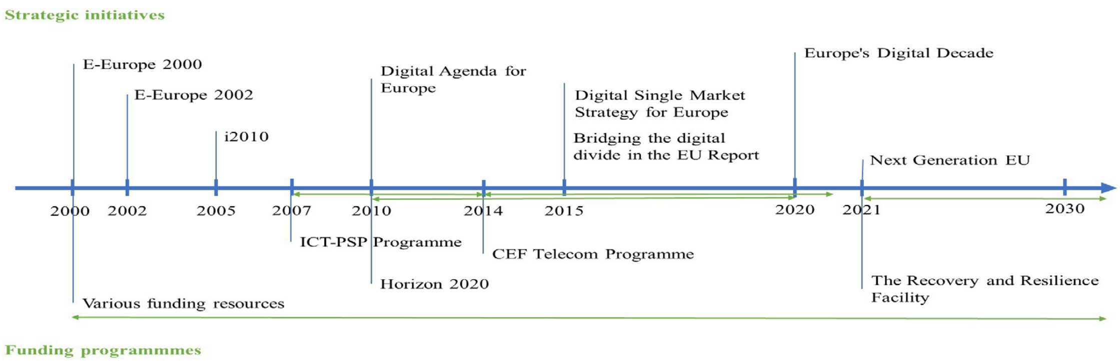


Figure 2. The timeline of strategic planning of digital transformation in the EU in 2000–2030, based on main documents and sources of funding. Source: compiled by the authors.

Table 2. Comparative analysis of the EU digital transformation institutional documents (2000-2022)

Document	Characteristics
eEurope (2000 and 2002)	Sets as one of its goals the building of information society for all; electronic inclusion is called a priority for combatting digital divide for the first time
i2010	Electronic inclusion as one of the key priorities; the program envisages incorporating a dedicated plan of action for electronic inclusion which registers digital divides and vulnerable population groups for the first time
A Digital Agenda for Europe	A separate chapter is devoted to bridging the digital divide through building up competence
A Digital Single Market Strategy for Europe	Creating inclusive digital society is one of the goals among others
Bridging the Digital Divide in the EU	Evaluation of inequality in the EU based on EUROSTAT statistics and Digital Economy and Society Index (DESI)
Europe's Digital Decade	- 8 out of 12 efficiency indicators work towards boosting digital equality among both people and enterprises including SMEs - The Digital Citizenship project for EU citizens based on inclusivity and broadening the possibilities for people
NextGenerationEU	- Digital transformation as a tool to recover and maintain sustainability in EU countries in the post-crisis world, - Funding the reduction of the digital divide in ICT skills of various population cohorts.

Source: compiled by the authors based on the cited documents.

1.2. Funding digital transformation and digital divide reduction in the EU, 2007-2027.

Narrowing the digital divide is one of the aspects of developing digital technology applications; hence, to assess how the EU members utilized the potential of combating the digital divide, we had to analyze the data related to the EU's funding of programs aimed at facilitating digital transformation. The EU budget funds digital transformation through various sources like the Cohesion Fund, Competitiveness and Innovation Framework Program, and European Regional Development Fund. There are dedicated programs for boosting ICT (e.g. Information and Communication Technologies Policy Support Program) as well as programs for other industries like transport and science that involve digital innovations spending. However, it is not always possible to isolate expenditures specifically for digital transformation from broader industrial programs. Similarly, funding for reducing the digital divide is difficult to differentiate. Since the EU aims to build a digital society and increase competitiveness through digitalization, the authors consider that funding such programs contributes to improving the digital position of all EU countries.

To conduct a quantitative evaluation in light of the mentioned singularities, the authors selected three ICT and digital transformation boosting programs that were consistently implemented from 2007 to 2026, offering the fullest possible information on countries' funding. The results are given in Figure 3.

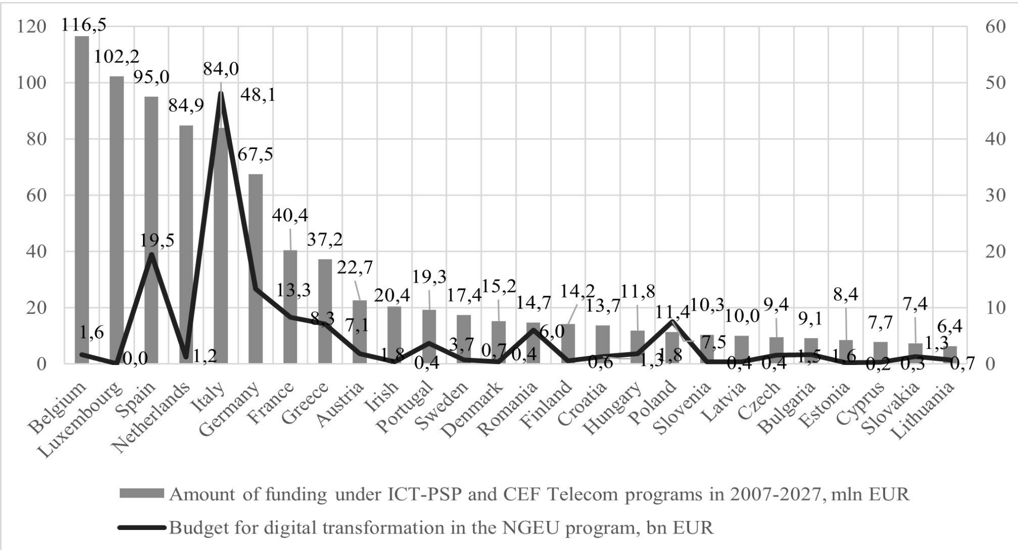
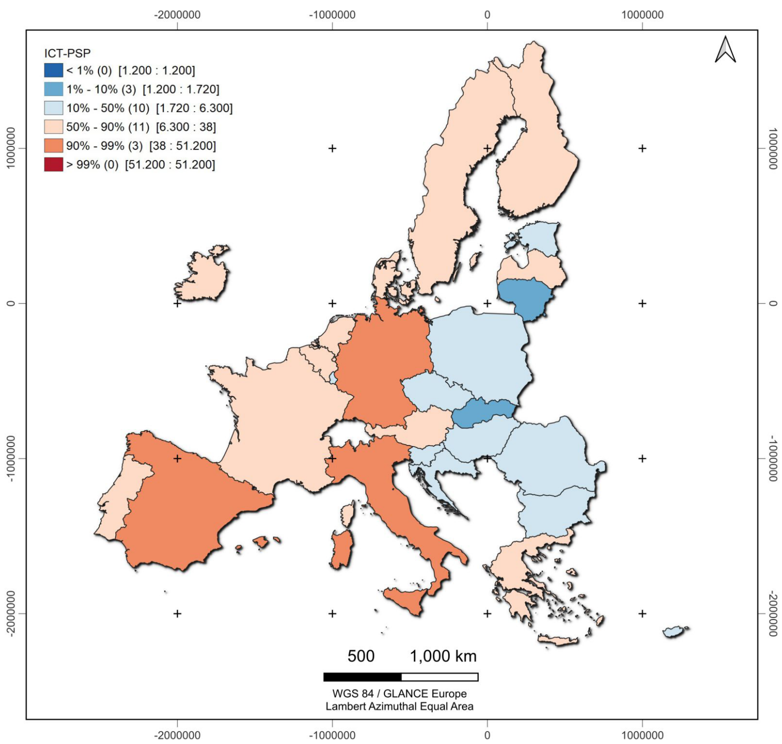
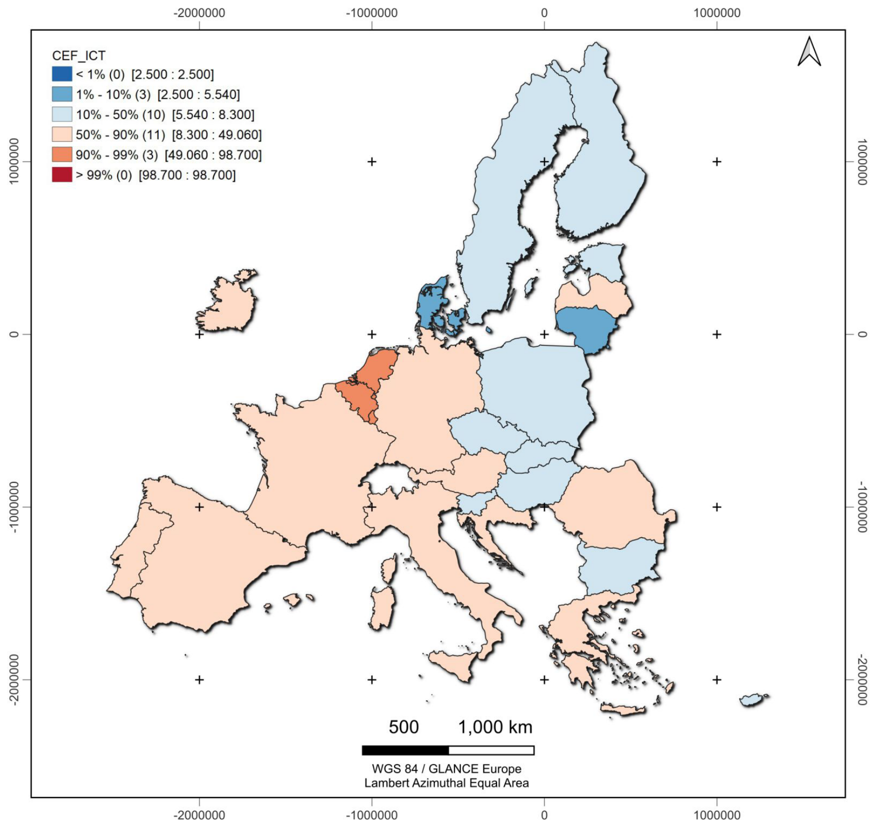


Figure 3. Funding of the digital transformation in the EU from 2007 to 2027 under ICT-PSP, CEF-Telecom, and NGEU by countries. Sources: compiled by the authors based on the data (Eurostat, n.d.)

a) Financing of the Information and Communication Technology Policy Support Program by country in 2007-2013, mln EUR



b) Financing of Connecting Europe Facility Telecom program by country in 2014-2020, mln EUR



c) Financing of Next Generation EU by country according to states' Recovery and Resilience Plans in 2021-2026, mln EUR

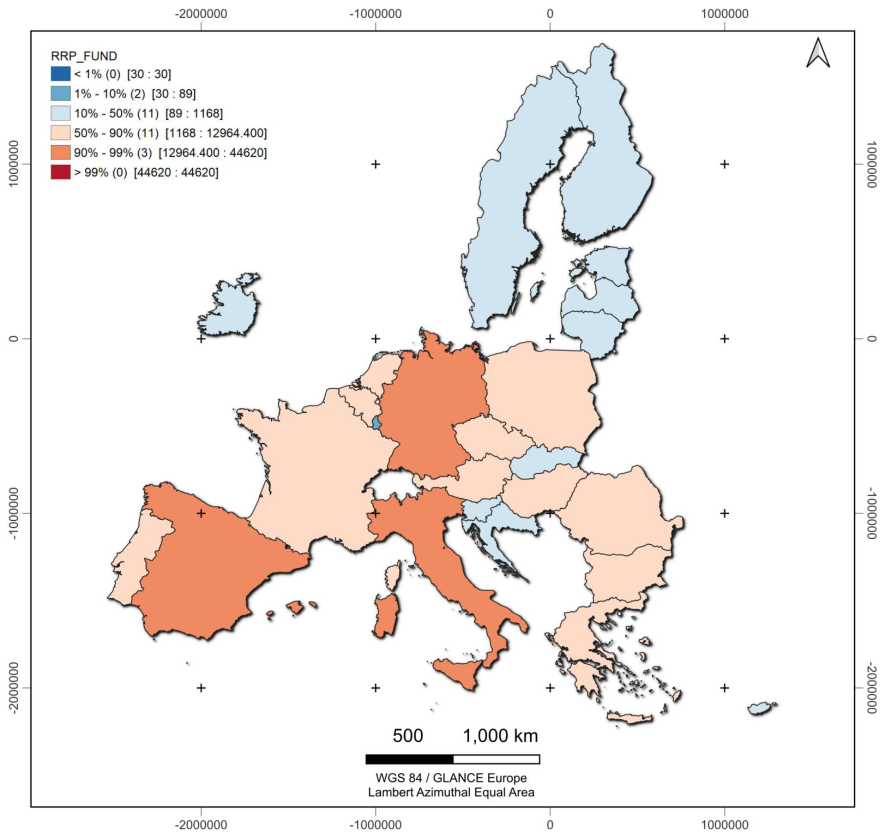


Figure 4a/b/c. Maps of fund distribution percentiles for digital transformation programs in EU countries
Map legend: in parentheses is the number of countries in the percentile group; in square brackets is the range of funding values corresponding to the percentile group. Blue color corresponds to below-average funding values; orange color corresponds to above-average values. Sources: compiled by the authors based on the data (Eurostat, n.d.).

The analysis of funding revealed that in 2007-2013, the EU spent approximately 1.2 billion euros on digital transformation projects under funding programs, which may be viewed as a very modest amount. By contrast, Horizon 2020, which is the EU's largest research and innovation funding program, supported projects worth over 80 billion euros in 2014-2020 (Eurostat, n.d.). For comparative purposes, the authors then presented the funding distribution on percentile maps. The results obtained (Figure 4a/b/c) reveal the disproportions of digitalization funding in the EU for Western and Eastern Europe, which proves our hypothesis.

The budgeting of digital transformation in Northern European countries turned out to be lower than average, while EU members in Southern Europe received funding under ICT-PSP, CEF Telecom, and NGEU, which was sufficient to narrow the ICT gap gradually. EU funds distribution policy in the given period looks inconsistent: South European countries received in 2014–2020 less funding in relative terms under the CEF-Telecom program than under the ICT-PSP and NGEU programs. It was only at the present stage that Eastern Europe received a digitalization budget above the EU average despite chronically lagging behind. The EU funds earmarked for digital transformation only benefit EU members with initially average or above average positions in terms of digitalization, while less competitive EU members, particularly in Eastern Europe, receive less funding and spend it less efficiently, without improving competitiveness in any significant way.

1.3. Interconnections between EU digital divide reduction policy and knowledge-based economy.

Thus, we can state that the political course towards digital transformation and combating the digital divide was not backed by substantial funding from 2007 to 2020. Besides, those funds were distributed too unevenly and inconsistently to be able to produce a tangible effect on the levels of digitalization and digital divide, with a subsequent impact on the establishment of a knowledge-based economy. To verify this hypothesis, the authors conducted a correlation analysis (Table 3) of the amounts of funding in the previous and present periods, as well as the positions of the countries by the Digital Economy and Society Index (DESI) and Global Knowledge Index (GKI) considered above. On top of that, proxy variables (Human Development Index and per capita GDP based on PPP) were added that may serve to characterize the overall level of socio-economic development, based on the analysis of the literature on the subject.

The correlation analysis of statistical arrays demonstrates diverse relations between the variables selected. The highest correlation is the Global Knowledge Index with DESI and HDI. The correlation coefficient of digital transformation funding in 2007-2020 reaches its highest values for Human Development Index and GDP per capita, which proves the previously proposed hypothesis that the digital transformation budgets were primarily allocated to EU members with a high level of socio-economic development. The future period's funding of digital transformation for EU countries has near-zero correlation coefficients, which is positive evidence that the allocated funds for the future period will not statistically work to perpetuate the current state of digital inequality in the EU, i.e., underfunded Eastern European EU members have received a chance to improve their digital competitiveness and position in terms of spatial digital inequality. This proves the authors' initial hypothesis that the goals of boosting digital transformation and reducing digital divide are inextricably connected with knowledge economy formation and socio-economic progress. It is also worth noting that the medium correlation for HDI and GDP per capita (0.629) should be disregarded, because the second indicator is a part of calculating HDI.

The next step is to estimate the indicators that showed the highest correlation with the Global Knowledge Index using regression analysis. The dependent variable is GKI, the covariates are DESI and HDI. For this purpose, not only was the OLS model created, but also geographically weighted regression (GWR) was used with its SEM and SAR models. Table 4 shows the findings.

The models reveal that all three methods (OLS, SAR, and SEM) produce similar results and share the same problems with reliability and robustness. The coefficients for DESI can be interpreted in the following way: for a one-unit increase in DESI score, the Global Knowledge Index is expected to increase by approximately 0.3 units, holding other variables constant, across all three models. The p-value for the Breusch-Pagan test of heteroskedasticity is 0.65900; therefore, there is no strong evidence to suggest heteroskedasticity in the model. The p-value for the Jarque-Bera test of normality of errors is 0.23319, which also suggests that a departure from normality in the model's errors is unlikely to be present. The Akaike information criterion (AIC) value is the minimum in the spatial error model (122.069), which implies that the SEM model explains the relation better than the two other models. However, the p-value for HDI is 0.11266. With a p-value

Table 3. Correlation analysis of digital transformation funding, digital divide, and knowledge-based economy in EU countries

-	Global Knowledge Index (GKI), 2022, score	ICT & CEF Funding in 2007–2020, million euro	NGEU Funding in 2020–2027, billion euro	Digital Economy and Society Index (DESI), 2022, score	Human Development Index, 2021, score	GDP per capita - PPP, US dollars, 2022
GKI	1					
ICT & CEF Funding	0.242	1				
NGEU Funding	-0.234	0.452	1			
DESI	0.874	0.205	-0.129	1		
HDI	0.809	0.411	-0.012	0.825	1	
GDP per capita	0.547	0.402	-0.129	0.536	0.629	1

Source: authors' calculations based on (United Nations, n.d.).

Table 4. Regression models for Global Knowledge Index with DESI and HDI as covariates.

-	OLS	Spatial lag model (SAR)	Spatial error model (SEM)
Constant	17.3168 *(0.21656)*	13.8602 *(0.32420)*	15.739 *(0.20809)*
Digital Economy and Society Index (DESI), 2022, score	0.301251 *(0.00070)*	0.286706 *(0,00015)*	0.303715 *(0.00002)*
Human Development Index (HDI), 2021, score	30.8696 *(0.11266)*	28.500 *(0.10697)*	*32.5138* *(0.06013)*
Heteroskedasticity (Breusch-Pagan test)	0.1947 *(0.65900)*	1.5386 *(0.46333)*	1.7446 *(0.41799)*
Normality of errors (Jarque-Bera test)	2.9118 *(0.23319)*	–	–
Spatial dependence (Likelihood Ratio test)	–	0.4543 *(0.50032)*	0.3165 *(0.57371)*
Akaike info criterion	122.069	123.615	121.753
Schwarz criterion	125.957	128.798	125.64
R-squared	0.787422	0.791487	0.791145

Note: P-value is given in the brackets. Source: authors' calculations based on (United Nations, n.d.).

Table 5. Regression models for Global Knowledge Index with DESI as a covariate

-	OLS	Spatial lag model (SAR)	Spatial error model (SEM)
Constant	39.4519 *(0.00000)*	32.0388 *(0.00010)*	39.2826 *(0.00000)*
Digital Economy and Society Index (DESI), 2022, score	0.406479 *(0.00000)*	0.286706 *(0,00015)*	0.409916 *(0.00000)*
Heteroskedasticity (Breusch-Pagan test)	0.2064 *(0.64961)*	0.1947 *(0.65900)*	0.2055 *(0.65030)*
Normality of errors (Jarque-Bera test)	0.5538 *(0.75815)*	–	–
Spatial dependence (Likelihood Ratio test)	–	0.9012 *(0.34245)*	0.0276 *(0.86813)*
Akaike info criterion	122.959	124.058	122.932
Schwarz criterion	125.551	127.946	125.524
R-squared	0.763405	0.772363	0.763781

Note: P-value is given in the brackets. Source: authors' calculations based on (United Nations, n.d.).

greater than 0.05, we cannot conclude that HDI is statistically significant in predicting the Global Knowledge Index at the conventional significance level of 0.05. This suggests that the relationship between HDI and the Global Knowledge Index may not be statistically significant in this model, or it may be weaker compared to the DESI score. This is also relevant for the constant. Considering the high p-values of HDI and the constant, the authors tested the OLS/SAR/SEM models for GKI using the Digital Economy and Society Index as the only covariate. The results are presented in Table 5.

The models with DESI as the only covariate prove to be more reliable in terms of probability tests. The R-squared values indicate that approximately 76% of the variation in the Global Knowledge Index can be explained by the variation in the DESI scores in all three models. The remaining 24% of the variation is unexplained by the models. Despite the Akaike information criterion being at its lowest in the SEM model, the likelihood ratio test statistic for spatial dependence is almost zero (0.0276), and the associated p-value is 0.868, which is greater than 0.05, suggesting no significant evidence of spatial dependence. Thus, the OLS model describes the best relation between digital transformation/digital inequality and knowledge-based economy: for a one-unit increase in DESI score, the Global Knowledge Index is expected to increase by approximately 0.4 units, holding other variables constant.

4. Conclusion

Combating the digital divide is a critical task of a knowledge-based economy, which secures consistent and even digital development and the fulfillment of technological and socio-economic potential for territories and population groups. Our analysis, using OLS regression, reveals a significant positive correlation between the DESI score and GKI. However, SAR and SEM did not yield significant results, suggesting that the spatial distribution of digital divide indicators may have a less direct impact.

Future research could expand on this research in several directions. Analyzing the digital divide reduction policies and knowledge economy initiatives of other regions beyond the EU, such as North America or Asia, would provide valuable comparative insights.

While this study provides a useful high-level perspective, it does have some limitations. The scope is focused solely on EU countries, so the findings may not generalize to other global contexts. Much of the analysis relies on indices like DESI and GKI, which condense a lot of complexity into single measures and may obscure some nuanced dynamics.

Nevertheless, this research makes several important contributions to the academic discourse in this space. It highlights some of the disconnects between stated policy goals and actual implementation and outcomes when it comes to building an inclusive knowledge economy, underscoring the need for more intentional, integrated, and well-funded initiatives.

Acknowledgement

This research was supported by RUDN University Scientific Projects Grant System (Grant number 060509-0-000).

References

Aganbegyan, A. (2021). On priority development of knowledge economy. *Economic Revival of Russia, 1*(67), 15–22. https://doi.org/10.37930/1990-9780-2021-1-67-15-22

Amponsah, M., Enok, M., & Nandi, N. (2025). Bibliometric analysis of developing sustainable cities by enforcement of environmental policies. *Indonesian Journal of Geography, 57*(1), 180–190. https://doi.org/10.22146/ijg.94243

Bejinaru, R. (2019). Impact of digitalization on education in the knowledge economy. *Management Dynamics in the Knowledge Economy, 7*(3), 367–380. https://doi.org/10.25019/MDKE/7.3.06

Bekbergeneva, D.E. (2020). Approaches to the content and growth points of knowledge economy in the digitalization of regional economy. *Economy and Business: Theory and Practice, 3*(1), 27–29. https://doi.org/10.24411/2411-0450-2020-10161

Bilan, Y., Oliinyk, O., Mishchuk, H., & Skare, M. (2023). Impact of information and communications technology on the development and use of knowledge. *Technological Forecasting and Social Change, 191*, 122519. https://doi.org/10.1016/j.techfore.2023.122519

Ding, C., Liu, C., Zheng, C., & Li, F. (2021). Digital Economy, Technological Innovation and High-Quality Economic Development: Based on Spatial effect and Mediation effect. *Sustainability, 14*(1), 216. https://doi.org/10.3390/su14010216

Elena-Bucea, A., Cruz-Jesus, F., Oliveira, T., & Coelho, P. (2021). Assessing the role of age, education, gender and income on the digital divide: Evidence for the European Union. *Information Systems Frontiers, 23*(4), 1007–1021. https://doi.org/10.3390/fi6040673

Eurostat (n.d.). [Database] *Digital economy and society*. Retrieved from https://ec.europa.eu/eurostat/web/digital-economy-and-society/database

Gabryelczyk, R. (2020). Has COVID-19 accelerated digital transformation? Initial lessons learned for public administrations. *Information Systems Management, 37*(4), 303–309. https://doi.org/10.1080/10580530.2020.1820633

Gao, J. (2021). *Fundamentals of spatial analysis and modelling*. https://doi.org/10.1201/9781003220527

IMD Business School (2025). *World Digital Competitiveness Ranking*. Retrieved from https://www.imd.org/centers/wcc/world-competitiveness-center/rankings/world-digital-competitiveness-ranking/

Loginova, N. N., Radovanović, M. M., Yamashkin, A. A., Vasin, G., Petrović, M. D., & Demirović Bajrami, D. (2020). Analysis of the population dynamics in the "Slavic World" with a special focus on Russia. *Indonesian Journal of Geography, 52*(3), 317–326. https://doi.org/10.22146/ijg.51202

Nagel, L. (2020). The influence of the COVID-19 pandemic on the digital transformation of work. *International Journal of Sociology and Social Policy, 40*(9/10), 861–875. https://doi.org/10.1108/ijssp-07-2020-0323

NextGenerationEU Program. (2025). Retrieved from https://next-generation-eu.europa.eu/index_en

Nosratabadi, S., Atobishi, T., & Hegedűs, S. (2023). Social Sustainability of Digital Transformation: Empirical Evidence from EU-27 Countries. *Administrative Sciences, 13*(5), 126. https://doi.org/10.3390/admsci13050126

Ojanperä, S., Graham, M., & Zook, M. (2019). The digital knowledge economy index: mapping content production. *The Journal of Development Studies, 55*(12), 2626–2643. https://doi.org/10.1080/00220388.2018.1554208

Syzdykova, Z., Koblandin, K., & Medvedev, N. (2023). Migration Practices in Europe: Economic and Cultural Factors. *Indonesian Journal of Geography, 55*(2), 370–377. https://doi.org/10.22146/ijg.82169

Tislenko, M. (2024). Digital divide in the European Union: assessing spatial disparities and neighborhood effects. *Journal of the Geographical Institute "Jovan Cvijić" SASA, 74*(2), 181–194. https://doi.org/10.2298/ijgi2402181t

Troshina, E. P., Levashova, Y. V., & Mantulenko, V. V. (2020). Ways to improve the company competitiveness in the conditions of economy digitalization. *The European Proceedings of Social & Behavioural Sciences*, 1468–1473. https://doi.org/10.15405/epsbs.2020.03.211

United Nations (n.d.). Human Development Index. Retrieved from https://hdr.undp.org/data-center/human-development-index#/indicies/HDI

Volchenko, O. V. (2016). Dynamics of the digital inequality in Russia. *Monitoring Obŝestvennogo Mneniâ: Èkonomičeskie I Social' nye Peremeny*. *5,* 163–182. https://doi.org/10.14515/monitoring.2016.5.10

Yamashkin, A. A., Radovanović, M. M., Yamashkin, S. A., Zhulina, M. A., & Petrović, M. D. (2023). Development of Meta-Geosystems for Tourist and Recreational Clusters. *Indonesian Journal of Geography, 55*(2), 190–196. https://doi.org/10.22146/ijg.74615

Zhang, J., Zhao, W., Cheng, B., Li, A., Wang, Y., Yang, N., & Tian, Y. (2022). The impact of digital economy on the economic growth and the development strategies in the post-COVID-19 era: Evidence from countries along the "Belt and Road." *Frontiers in Public Health, 10*, 856142. https://doi.org/10.3389/fpubh.2022.856142