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THE ROLE OF DIGITALIZATION IN ECONOMIC INTEGRATION AND THE FORMATION OF THE EU DIGITAL SINGLE MARKET

ABSTRACT:

Purpose: To identify the key factors influencing the digital integration of European Union member states, with a focus on the development of the Digital Single Market (DSM) and the level of digital maturity as measured by the DESI index.

Methodology/approach: The study employs correlation analysis, multifactor regression modeling, and logical generalization. Official statistical data from Eurostat and DESI country reports were used to assess the influence of ICT sector share in GDP, the proportion of ICT specialists in employment, broadband internet coverage, and the level of e-commerce.

Findings: The results show that human capital indicators – particularly the share of ICT specialists and the population's basic digital skills – have the most significant impact on digital integration. Despite the harmonization of digital strategies, notable structural asymmetries persist across EU countries, stemming from unequal access to digital resources and varying levels of institutional

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preparedness. The study emphasizes that the success of the Digital Europe programme largely depends on its capacity to mobilize transnational investments and support cross-border digital cooperation.
Originality/value: This research provides an evidence-based understanding of the structural challenges within EU digital integration. It offers policy-relevant insights into shifting from regulatory unification toward human capital development and institutional coordination, contributing to the design of more effective EU-wide digital strategies.

Keywords*: digital integration, Digital Single Market, DESI index, human capital, ICT professionals, digital skills, EU digital policy*

1. INTRODUCTION

As a result of the transformation of the modern paradigm of economic development – driven by the intense influence of technological progress on the global economic system – digitalization is gaining particular significance. It is no longer perceived as a specific tool for modernizing individual sectors, but rather as an independent, system-forming factor that is radically reshaping existing models of economic integration and market interaction. In this context, the European Union, as one of the world's largest integration projects, views digital transformation not only as a functional means of enhancing competitiveness, but also as the foundation for building the Digital Single Market (DSM). In the short term, such a market has the potential to generate synergy between innovation and new forms of consumer behavior, thus shaping a new framework known as the digital economy.

At present, the formation of the EU Digital Single Market is characterized by a high level of institutional and regulatory complexity. This necessitates a thorough analysis of the interrelations between digitalization and economic convergence. The urgency of such analysis stems from the fact that digital infrastructure – including cloud services, e-commerce platforms, and large-scale data repositories – is already creating fundamentally new opportunities for deeper integration of goods and financial markets not only within Europe, but also across the global economy. At the same time, this transformation gives rise to risks of fragmentation and increased technological asymmetry among EU member states. As M. Kenney emphasizes, "the digital economy is transforming the foundations of economic geography, redefining the scale and scope of markets and production systems" (Kenney, 2016).

In analyzing the role of digitalization in the development of the Digital Single Market, it is essential to account not only for the economic benefits associated with stimulating investment and increasing the productivity of the real sector, but also for structural constraints arising from heterogeneity in digital

capacity and national policy disparities. Accordingly, the formation of the DSM is not a linear process of implementing successive standards, but rather a complex, multi-vector strategy. It combines the dynamics of technological innovation with the specific interests of market participants operating within the European economic space. As L. Floridi aptly notes, "the digital revolution is not merely a continuation of the industrial revolution, but an epochal transformation of human reality itself" (Floridi, 2014).

Thus, the outlined issues underscore the relevance of researching the impact of digitalization on sustainable economic development and the strengthening of the EU's integration architecture in the near future.

2. LITERATURE REVIEW

Modern research on the digitalization of the European Union's economy and the development of the Digital Single Market is characterized not only by its functional complexity but also by the rapid evolution of conceptual approaches to the issue. For instance, L. Floridi (2014) and S. Richmond (2016) argue that the digital revolution constitutes a profound transformation of socio-economic reality, wherein information technologies become the core foundation of business interaction. Meanwhile, M. Kenney and J. Zysman (2016) highlight the rising importance of platforms as a new organizational principle of the digital economy, shaping both the architecture of contemporary markets and the mechanisms of integrating new actors into them. Similarly, Z. Wysokińska (2021) and L. Mićić (2017) emphasize the need for EU policy to adapt effectively to emerging digital business models. In their view, this should involve rethinking approaches to market supervision and consumer protection within the digital environment. Thus, it can be argued that the current academic discourse increasingly focuses not only on technological factors but also on the institutional and behavioral dimensions of digitalization as a defining vector of economic integration.

It is also worth noting that researchers such as Ł. D. Dąbrowski (2022) and I. Britchenko (2023) stress that modern digital innovations can serve as drivers for business adaptation to unstable environments, while also generating risks of resource imbalance, which may exacerbate regional disparities within the EU. Similarly, M. Dziamulych (2025) emphasizes quantitative approaches to assessing the digitalization level of regional business ecosystems, underlining the heterogeneity of digital maturity indicators as a key barrier to economic integration. This perspective is echoed by L. F. Rodríguez-Hevía (2022) and F. Palmisano (2024), who argue that digital transformation remains uneven across Europe, and that the success of integration initiatives depends on bridging the regional "digital divide" through targeted support for less-developed areas. Consequently, the formation of the Digital Single Market requires not only

technological renewal but also consideration of territorial imbalances, necessitating a differentiated digital policy that reflects the development levels of regional economic systems.

In light of current challenges, T. Gajewski (2023) draws attention to foreign policy and geoeconomic factors – particularly the risks of a "technological cold war" – which could hinder integration processes within the Digital Single Market and lead to the segmentation of innovation supply chains. This view aligns with the European Commission (2020), which positions the Digital Single Market as a tool for strengthening the EU's strategic sovereignty in the digital sphere. On the other hand, M. Dodgson (2021), based on his study of platformization and artificial intelligence, notes that regulating digital competition requires flexible and innovative approaches. In this context, R. A. Burgelman (2008) emphasizes that the effectiveness of digital integration in the long term will depend on the capacity of public policy to adapt to such structural shifts. Additionally, the McKinsey Global Institute (2016), in its "Digital Europe" report, underscores the potential of digitalization to generate over €415 billion in added value for the European economy, provided that common standards are consistently implemented. Hence, the effective combination of innovative regulation and digital standardization is a key prerequisite for unlocking the economic potential of Europe's Digital Single Market.

Attention should also be paid to the report by N. Kroes (2012), which stresses that critical conditions for successful digital integration include not only infrastructure investments but also the enhancement of digital skills among the population and the development of specialized solutions for both the public and private sectors. Furthermore, I. Graef and P. Valcke (2014), along with K. Rong (2022), point out that standardization of integration between digital products in the single market must be implemented through transparent marketing and licensing mechanisms while avoiding overly restrictive antitrust measures. Based on these insights, it can be concluded that the success of digital integration within the EU should be defined not only by technological readiness, but also by the institutional capacity to create a favorable environment for the development of digital competencies and transparent data governance rooted in common standards.

In summary, contemporary academic research on the digitalization of the common European market demonstrates a broad spectrum of approaches to understanding digital integration. These studies address both the refinement of regulatory integration frameworks and the empirical evaluation of its economic impact. Therefore, the systematization of this body of research contributes to a

deeper understanding of the prospects and risks involved in building the EU's Digital Single Market in the coming years.

3. MATERIAL AND METHODS

The research employed a combination of specialized scientific methods, integrating tools of descriptive statistics, correlation analysis, and multiple linear regression, aimed at identifying the determinants of digital integration across European Union member states. As an integral indicator of digital maturity, the DESI index was selected, as it aggregates five key dimensions related to human capital development, connectivity, internet usage, business digitalization, and digital public services. This ensured comprehensive coverage of the core domains of digital transformation.

To construct the model of DESI level dependence on key digital integration factors, a dataset was compiled using selected indicators of digital maturity in the EU for the most recent available period. As independent variables, the model incorporated the share of the ICT sector in gross value added, the percentage of ICT specialists in total employment, the scale of e-commerce, and broadband internet access. Data sources included official EU repositories such as Eurostat, the Digital Agenda Scoreboard, and annual DESI reports issued by the European Commission.

The regression model was built in the form of a linear equation, enabling estimation of the individual impact of each factor on the composite DESI indicator. To assess the model's statistical validity, Student's t-test was applied to each coefficient, along with the Fisher F-test for the overall significance of the regression. The confidence level was set at 0.05. The coefficient of determination (R^2) was calculated to indicate the proportion of variance in the dependent variable explained by the model.

A Pearson correlation matrix of pairwise coefficients was also constructed to initially detect relationships between variables. This facilitated refinement of predictor selection and minimized the effect of multicollinearity. The quality of the model was further validated through a graphical visualization of actual versus predicted DESI values, allowing for additional confirmation of forecasting accuracy.

Furthermore, the method of logical generalization was applied to interpret the results of the regression model. This approach made it possible to identify consistent patterns emerging across countries with differing institutional characteristics. It also enabled the translation of empirical findings into a strategic framework for understanding EU digital integration.

Overall, the adopted methodology provided a quantitative assessment of the contribution of specific factors to the digital integration process and revealed structural asymmetries among EU countries that possess comparable

levels of technical infrastructure but differ in institutional efficiency and the quality of human capital.

4. RESULTS AND DISCUSSION

At the current stage of global economic development, digitalization has ceased to be merely an auxiliary technological trend. Today, it acts as a structural foundation for economic transformation, shaping not only the nature of production and consumption processes but also the functional principles of international integration. Within the European Union, digitalization plays a system-forming role in the development of the Digital Single Market (DSM). Simultaneously, it serves as a catalyst for a new type of integration ties, based not on geographic proximity or customs harmonization, but on the fundamental ability of individual countries to interact effectively within a common informational, legal, and technological space of the EU.

It should be noted that, unlike classical industrial models of market integration, digitalization does not simply aim to eliminate barriers to trade in goods and services. Rather, it is functionally oriented toward creating the most favorable conditions for the digital transformation of the traditional economic order (Latoszek, 2021). In this context, digitalization alters the general logic of economic integration, transforming it from an institutional process into a dynamic technological ecosystem in which trust in data and the responsiveness of regulators to change become critically important. As noted by analysts at the JRC, “enhanced digital functionality of markets could bring the EU up to a 0.4% GDP increase and save billions of euros” (Ulrich et al., 2022). Thus, it can be argued that the creation of a unified digital technological ecosystem is beneficial from a macroeconomic perspective. According to expert estimates, these benefits are substantial in the context of DSM development (see Table 1).

Table 1

Expert Assessments of the Macroeconomic Impact of Digitalization in the EU

Impact Category	Expected Effect	Expert Source
GDP growth due to multifunctional services	Up to 0.4% of GDP annually	EU Joint Research Centre
Savings for businesses and citizens	€543 million (public services), €568 billion (regulatory sector)	EU Joint Research Centre
Potential annual additional GDP growth	€375–415 billion	McKinsey & Company
Potential GDP increase by 2030	Up to €2.5 trillion with doubled digital intensity	McKinsey & Company
Benefit from open data use	€45 billion/year by 2028	European Parliament

Economic potential of DSM and energy market	€1.28 trillion	Centre for European Policy Studies

Notes: Martens (2021), McKinsey (2016), Marcus et al. (2019), Pelkmans (2024)

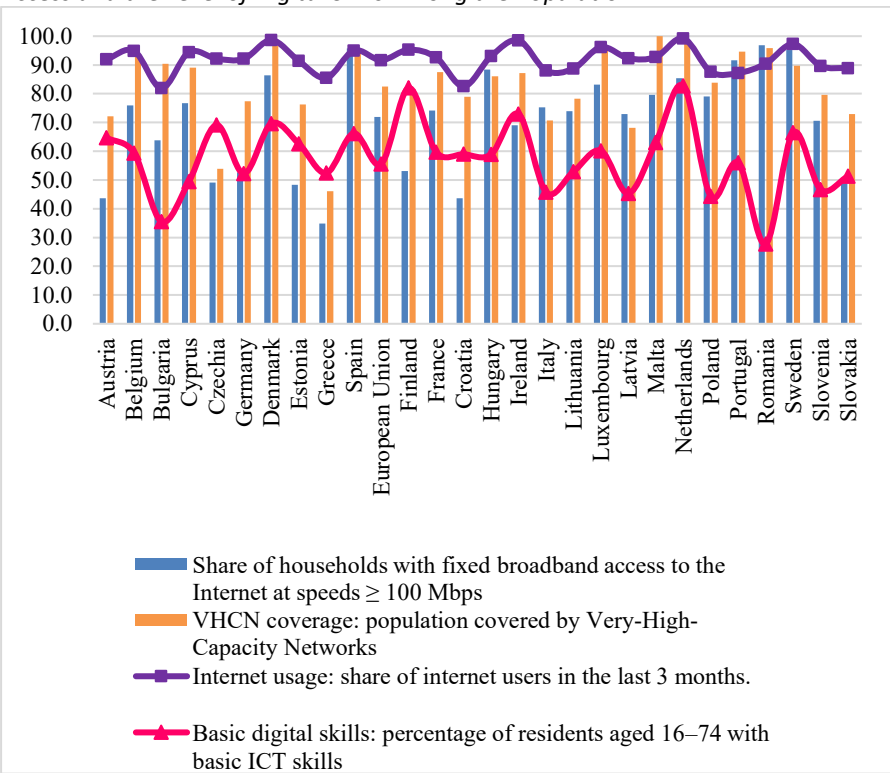
Thus, the European Union's Digital Single Market (DSM) can become a key instrument for strengthening the EU's sovereignty in the digital domain by protecting against external technological pressures and enhancing internal competitiveness. As B. Martens emphasizes, "digital sovereignty means the ability to control your own digital destiny – your data, the hardware and software you rely on and produce" (Martens, 2021). Moreover, technical harmonization and a pan-European digital infrastructure significantly contribute to the scalability of business innovation, especially in the domain of digital services (Małkowska et al., 2021). The most tangible benefit of the digital market's functioning lies in reduced transaction costs and expanded access to digital services. However, ensuring symmetrical access to these market advantages for countries at varying stages of development is a critical condition for leveling economic disparities within the DSM.

Therefore, it can be argued that digitalization now functions as a distinct modernization tool for the European market. It constitutes a foundational infrastructure for a new form of integration – one that requires the EU to rethink its strategies in terms of cohesion, flexibility, and regulatory engineering. These dynamics underscore the role of digitalization in shaping the DSM as a cornerstone of an effective knowledge-based economy and a guarantor of the Union's technological sovereignty.

Nevertheless, digital transformation within the EU is currently hampered by significant disparities in digital maturity among member states. These imbalances reflect profound institutional and infrastructural asymmetries, which markedly influence the pace and quality of economic integration. While the EU has formally declared the creation of the Digital Single Market as a systemic prerequisite for achieving digital sovereignty, empirical data reveal that technological convergence remains highly fragmented. A closer look at basic DESI indicators – such as household broadband access and the population's digital skills – clearly illustrates this divergence (see Figure 1).

Figure 1

DESI Indicators Related to the Share of Households with High-Speed Internet Access and the Level of Digital Skills Among the Population



Notes: Digital Decade DESI Visualisation Tool (2025), Digital Agenda Scoreboard Key Indicators (2025)

As illustrated, the DESI indicators not only highlight the presence of a digital divide among EU member states but also reflect its systemic nature, rooted in disparities in infrastructural development, socio-educational characteristics of the population, and varying levels of digital integration within national economies. For example, the share of households with access to fixed broadband at speeds ≥ 100 Mbps reveals a gap of over 50% between leading countries (Romania, Spain, Sweden) and laggards (Croatia, Austria, Greece). This disparity directly impacts the potential for digital transformation in sectors heavily dependent on high-speed data access, such as financial services and cloud infrastructure serving the service economy. A striking contrast is also evident in the coverage of Very High-Capacity Networks (VHCN), ranging from 46.1% in Greece to 100% in Malta. These figures confirm the notion that, even within a

politically integrated union, the capacity to deploy next-generation infrastructure varies considerably. Similarly, internet usage within the last three months ranges from 81.9% in Bulgaria to 99.2% in the Netherlands. Although the gap is narrower here, it still reflects deep social differences in digital lifestyles across the EU.

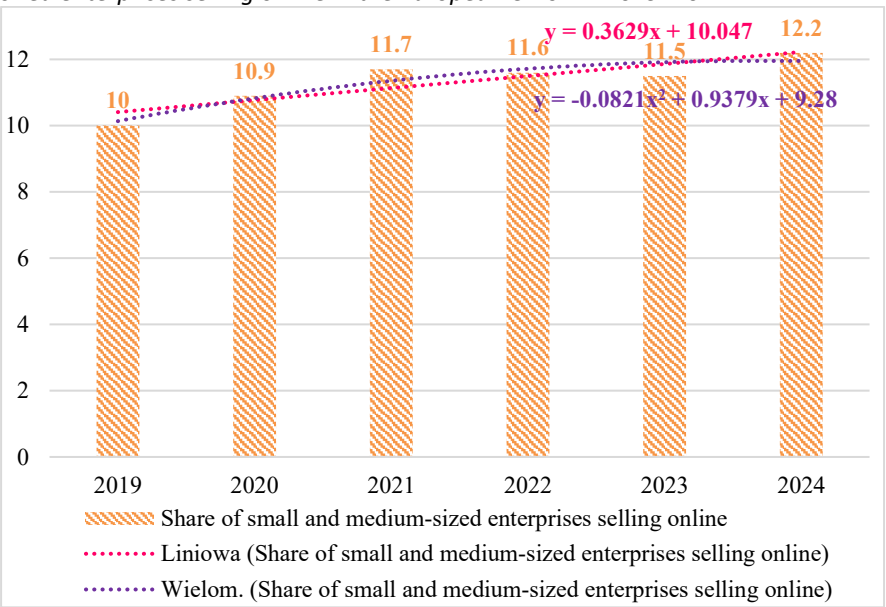
However, the sharpest asymmetry appears in the indicator of basic digital skills. Only 27.7% of Romania's population possesses the minimum ICT competencies, compared to 82.7% in the Netherlands and 82.0% in Finland. This greatly limits not only the demand for digital services but also the functional capacity of local businesses to integrate into the Digital Single Market. As a result, in underperforming countries, digital transformation is not an endogenous engine of development but rather an external adaptation problem to standards set by more technologically and economically advanced nations.

These disparities show that the EU does not face a linear issue of digital lag but a multifaceted challenge, where institutional inertia, unequal access to investment, and weak human capital dynamics form significant barriers to the true unification of the digital space. In practice, this gap represents more than just a statistical phenomenon – it translates into structural constraints on the EU's digital sovereignty. As Martens rightly points out, "the success of the Digital Single Market depends not only on harmonised rules but also on the equal ability of member states to adopt and implement them" (Martens, 2021). Therefore, digital maturity should not be seen merely as a technical parameter, but as a structural determinant of the European Union's overall competitiveness.

Another critical indicator of digital maturity that directly impacts economic integration and the functioning of the Digital Single Market is the level of digital commercial activity among small and medium-sized enterprises (SMEs). Currently, the share of SMEs engaged in online sales ranges from 3.4% in Bulgaria to 21.1% in Ireland, clearly indicating the uneven pace of e-commerce adoption. As we can see, the EU digital market is forming unevenly – countries with high levels of SME online sales are more deeply integrated into the cross-border economy, while laggards remain limited to regional or local digital ecosystems. As M. Cini notes, "the ability of SMEs to sell online is not only an indicator of digital maturity but also a critical factor in determining their cross-border integration and competitiveness in the Digital Single Market" (Cini & Czulno, 2022). At present, when in some countries nearly one-third of SMEs are active in online sales and in others fewer than one in twenty, the DSM risks losing its status as a unified market and instead resembles a conglomerate of fragmented digital economies with varying trajectories of development. When assessing the overall trend of this indicator across the EU, the picture unfolds as follows (Figure 2).

Figure 2

Correlational assessment of the trend change in the share of small and medium-sized enterprises selling online in the European Union in 2019–2024.



Note: calculated by the author based on data from the Digital Decade DESI Visualisation Tool (2025)

From the trend analysis, it is evident that the growth in the share of small and medium-sized enterprises (SMEs) operating online has been moderate – from 10.0% in 2019 to 12.2% in 2024. The constructed trend curves (linear and polynomial regressions) confirm the presence of a positive dynamic; however, its slope remains modest. Specifically, the linear equation y = 0.3629x + 10.047 indicates that the annual growth rate is less than half a percent. Overall, the defined parameters of the linear trend demonstrate a consistent upward trajectory in the SME share during the analyzed period, with an absolute increase of 0.3629%. On the other hand, analysis of the polynomial trend shows that the actual annual change during the observed period was 0.9379%, with an initial reduction of 0.0821%.

It is worth noting that the slowdown observed during 2022–2023 suggests a short-term exhaustion of the adaptive capacity of SMEs – most likely due to exogenous shocks such as rising global economic instability and war-related risks. This inertial growth dynamic does not support rapid digital convergence. At the current pace, reaching an average level of 25–30%, typical of countries with high digital business density, may take decades. Consequently,

despite the political rhetoric around the Digital Single Market (DSM), the actual participation of SMEs remains limited – transforming the DSM from an integration tool into a space of structural segmentation. Supporting this, G. Soava notes that "the share of SMEs engaging in e-commerce and their e-sales turnover vary significantly depending on size and country, indicating a fragmented model of digital integration" (Soava et al., 2022). Thus, countries with low SME digital activity lose access to large-scale online markets and miss out on the growth catalyzed by the DSM.

Clearly, these existing issues present substantial obstacles to effective economic integration and the establishment of a fully functional DSM. Achieving this goal requires coordinated action across five interrelated strategic directions:

1. Infrastructure convergence, ensuring equal access to high-speed Internet (VHCN, 5G) across all countries and regions, including rural areas. This demands a reorientation of funding toward lagging member states, potentially via the Digital Europe Programme and the Connecting Europe Facility.
2. Enhancing digital skills, necessitating greater investment in digital education and workforce reskilling, especially among the 45+ age group and microenterprises. This is essential not only to close skill gaps but also to stimulate demand for digital services.
3. Digital transformation of SMEs, through expanding support for e-commerce, cloud adoption, and digital marketplaces to enable small businesses to internationalize more effectively.
4. Legal and institutional harmonization, aimed at reducing regulatory fragmentation in data protection, cybersecurity, and taxation of digital services.
5. Integrated strategy for digital sovereignty, focused on establishing a common framework for supporting European digital technologies and standards, as the foundation of a resilient and autonomous EU digital economy.

In our view, without the fulfillment of these conditions, the DSM will remain a declarative construct, lacking real integrative capacity. While initiatives like Digital Europe may promote gradual progress, the absence of large-scale targeted investment means the intended outcomes can only be achieved in the long term. Thus, investment becomes a critical enabler of DSM success, yet also its most vulnerable point – since without adequate and targeted financing, digital integration cannot bridge the structural divides among EU members.

At present, the gaps in VHCN and broadband access call for prioritization through programmes such as the Connecting Europe Facility – Digital and the Recovery and Resilience Facility. According to the European Commission, achieving full EU gigabit network coverage by 2030 will require more than €174 billion in investment (González, 2023).

One of the most effective ways to attract additional investment is through the creation of public-private investment alliances. Cooperation among member states, financial institutions (EIB, InvestEU), and tech businesses could mobilize capital toward digitalization initiatives like cloud infrastructure and data processing centers. At the same time, expanding grants and credit programs for SME digitalization – especially in countries where SME e-commerce participation is below 10% – would lower entry barriers and accelerate national economic transformations. Therefore, we conclude that effective integration under the DSM is unattainable without a strategic investment framework. Its absence or uneven execution exacerbates fragmentation and undermines the EU's digital sovereignty potential.

It is also essential to identify the priority domain for investment to accelerate digital transformation across the EU. Given the uneven digital development revealed through earlier analysis – and the multifactorial nature of the drivers influencing DESI dynamics – there is a need for a formalized statistical analysis. Since DESI is the key indicator reflecting national readiness for digital transition, identifying the most influential determinants of its variation will help define priority investment directions for successful transformation.

To assess such influence, we apply correlation analysis to identify the most significant relationships between digital development levels and key digital economy parameters – especially investment-related, human capital, and technological penetration indicators, which together form the institutional and infrastructural foundation for digital integration. This approach not only clarifies linear relationships between DESI and selected variables but also highlights the most relevant ones for EU-level policy intervention.

To empirically test the hypothesis of a dependency between a country's digital maturity (based on DESI) and economic/infrastructure factors, we developed and constructed a correlation-regression model. Annual statistical data for 2017–2024 covering four independent variables relevant to digital transformation and contributing to the base DESI index were used (see Table 2).

Table 2

Dynamics of the studied indicators for EU countries in 2017–2024.

Indicator	2017	2018	2019	2020	2021	2022	2023	2024
DESI (y)	33,71	35,92	38,64	41,67	46,2	52,28	53,84	57,33
Percentage of the ICT sector in gross value added (x_1)	4,45	4,64	4,86	5,19	5,46	5,46	5,78	6,09
Share of ICT specialists in the employment structure (x_2)	3,6	3,7	3,8	3,9	4,3	4,5	4,6	4,8

Share of turnover of enterprises in e-commerce (x_3)	18,48	17,17	18,06	19,83	19,77	17,62	18,29	19,12
Share of users using fixed high-speed internet (x_4)	14,98	15,49	20,72	27,99	33,42	40,61	55,08	58,47

* Taking into account the change in the DESI calculation methodology after 2022, we recalculated its values for 2023 and 2024 using the previous methodology

Note: Digital Decade DESI visualisation tool (2025), Eurostat Database (2025)

Table 3 presents the key parameters of the regression model that describes the influence of factors on the DESI index level.

Table 3

Parameters of the developed correlation-regression model for determining the influence of factors on the DESI index (y)

Factor	Coefficient (B)	Standard error	t-statistic
DESI (y)	-19.156	16.614	-1.153
Percentage of the ICT sector in gross value added (x_1)	4.571	5.344	0.855
Share of ICT specialists in the employment structure (x_2)	11.83	5.594	2.115
Share of turnover of enterprises in e-commerce (x_3)	-0.59	0.692	-0.853
Share of users using fixed high-speed internet (x_4)	0.06	0.128	0.466

Note: own collaboration

The equation of the correlation-regression model obtained as a result of the analysis describes the dependence of the Digital Economy and Society Index (DESI) on four key factors:

$$y = -19.156 + 4.571x_1 + 11.830x_2 - 0.590x_3 + 0.060x_4$$

From this equation, it can be seen that the coefficient for the share of the ICT sector in gross value added (4.571) indicates that a 1% increase in the ICT sector share is accompanied by an average DESI increase of 4.571 points. At the same time, the coefficient for the share of ICT specialists in the employment structure (11.830) is the highest, indicating the most significant impact of this factor. Therefore, a 1% increase in ICT specialists yields a DESI index growth of nearly 11.83 points.

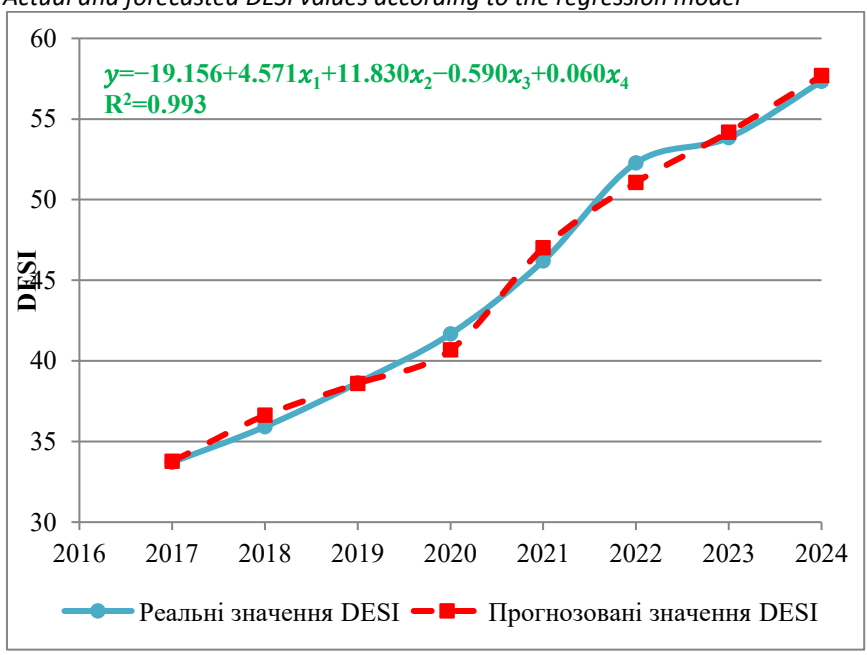
On the other hand, the coefficient representing the share of enterprise turnover in e-commerce (-0.590) has a negative value, indicating an inverse

relationship. A possible explanation is that the growth in e-commerce volume without appropriate digital skills or infrastructure may not contribute to an overall increase in digitalization. Additionally, the coefficient for the share of users accessing fixed high-speed internet (0.060) is small but positive, indicating a weak yet positive effect of growth in high-speed internet access on DESI.

Overall, based on the visualization of the correlation-regression model, a clear upward trend of the DESI index with increases in factor values is observed, especially regarding the share of ICT specialists in employment. To visualize the calculations, a comparison of actual and predicted DESI index values using the developed model is presented in Figure 3.

Figure 3

Actual and forecasted DESI values according to the regression model



Note: own collaboration

From the figure, it can be observed that the model adequately describes the dynamics of the indicator during the period from 2017 to 2024. The graph demonstrates a high correspondence between the actual and predicted DESI values for 2017–2024. This confirms that the constructed model closely approximates the real dynamics, which is also supported by the high coefficient of determination (R^2 = 0.993). Thus, the model serves as a reliable tool for

analyzing the influence of digital factors on the development of the digital economy in the EU.

I also present the final results of the correlation-regression analysis of the relationship between the DESI index and the factor variables. In particular, the main coefficients of the developed correlation-regression model indicate the following:

Coefficient of determination (R^2): 0.993 – the model explains the variation in the DESI index very well.

Adjusted R^2: 0.984 – indicates high accuracy of the model, accounting for the number of variables.

Fisher's F-test: 106.06 (p = 0.0015) – the model we propose is statistically significant.

Student's t-statistics show that at least one variable (x_2) is statistically significant.

Additionally, I present the evaluation of the correlation matrix (Table 4).

Table 4

Matrix of mutual correlation of factor and dependent variables

Indicators	DESI	Percentage of the ICT sector in gross value added (x_1)	Share of ICT specialists in the employment structure (x_2)	Share of turnover of enterprises in e-commerce (x_3)	Share of users using fixed high-speed internet (x_4)
DESI (y)	1	X	X	X	X
Percentage of the ICT sector in gross value added (x_1)	0,973779	1	X	X	X
Share of ICT specialists in the employment structure (x_2)	0,994313	0,970326	1	X	X
Share of turnover of enterprises in e-commerce (x_3)	0,194131	0,369335	0,201397	1	X
Share of users using fixed high-speed internet (x_4)	0,978295	0,970487	0,972501	0,238465	1

Source: own collaboration

As can be seen from the calculations, the highest correlation with DESI is observed for the share of ICT specialists (0.994) and the indicator of fixed high-

speed internet access (0.978). At the same time, the share of e-commerce has a low correlation with the index (0.194), which may indicate the weakest influence of this factor.

Thus, the conducted correlation-regression analysis empirically confirmed the hypothesis of a significant influence of human capital and institutional-infrastructure factors on the level of digital maturity of EU countries. The highest correlations were demonstrated by the share of ICT specialists in employment and the level of fixed high-speed internet use, highlighting the crucial role of qualified personnel and broadband infrastructure in digital integration. Meanwhile, the unexpectedly low coefficient for e-commerce suggests that the growth of its volume, without supporting institutional and educational changes, may be ineffective. This indicates the complex nature of digital transformation, where some elements may act as drivers while others become barriers to integration.

The model's reliability is supported by a high coefficient of determination ($R^2 = 0.993$) and statistical significance according to the F-test ($p = 0.0015$), making it suitable for forecasting DESI dynamics under changing conditions. However, t-statistics show that only one variable – the share of ICT specialists – is statistically significant at the $p<0.05$ level. This underscores the importance of investing in human capital during digital integration and the development of the EU Digital Single Market. Consequently, digital transformation policy should be adjusted toward greater investment in education and ICT workforce reskilling. The model's results not only confirm the significance of certain factors but also offer a basis for informed EU digital policy planning.

In summary, it is important to view digital integration in the EU not as a function of technical modernization alone, but as the result of a choice between institutional inertia and strategic initiative. The results show that simply having fast internet or growing e-commerce turnover does not guarantee future economic breakthroughs. The weak correlation of e-commerce with digital maturity (DESI) challenges the notion of its universal benefit and contradicts the assumption that economic factors dominate integration processes. Businesses may sell online, but without digital culture, infrastructure, and policy, such activity remains only statistical. In this context, human capital becomes the true driver of integration. An additional 1% of ICT specialists in employment yields a system-wide increase of over 11 points in DESI. This effect cannot be attributed to chance, as knowledge now defines the capacity of national economies to operate within the digital market.

This conclusion aligns with a core principle of modern financial analysis: capital includes not only financial resources but also skills and data trust. Ignoring this leads to information asymmetry, where digitally competent countries disproportionately benefit from integration. This is likely the root cause of the

current fragmentation of the Digital Single Market, undermining the idea of a unified platform. The weak correlation of some factors with DESI does not diminish their importance, but highlights the need for real institutional support, educational programs, and protection of digital rights. Analytically, digital integration success results from the interaction of many weighted variables – not merely accumulated investments. Therefore, digital maturity, both at the EU level and within member states, should be seen as a long-term asset requiring not only funding but also strategic and systematic attention.

5. CONCLUSIONS

Thus, we come to the conclusion that digital integration is a complex and interconnected system with many variables. Strategies focused solely on technical modernization or expanding Internet access may fail precisely due to a lack of systemic approach. As the developed model demonstrates, the key variable that truly influences the level of digital maturity is not infrastructure investment alone, but consistent work on human capital. In today's world, where hyper-competition exists in global value chains, what matters most is not the quantity of equipment but the quality of those who operate it. Accordingly, if states do not invest in digital education, they risk leaving their citizens behind in the new economic order. In that case, no digital strategy will be able to save them from chronic underdevelopment.

The model we built clearly explains why some countries, despite having similar starting conditions, show drastically different results. The hypothetical growth of the DESI index depends on the availability of specialists who can not only service technology but also build new business models around it. That is why the regression variable describing the share of ICT specialists turned out to be the most stable and significant. In contrast, variables related to e-commerce or added value in the ICT sector, when detached from human capital, produce a vague picture. All this underscores the fact that the digital economy is based on a complex decision-making architecture, where each individual indicator functions effectively only in combination with others. Therefore, to ensure the success of digital transformation and the development of the Digital Single Market, it is essential to increase investment in the training of specialists with strong digital skills, as the human factor is what can truly accelerate digitalization.

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