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DIGITALIZATION OF CITIZENS IN EU MEMBER STATES: GLOBALIZATION AND EU INITIATIVES

Abstract

The development of digitalization in the countries of the European Union (EU) is a crucial factor shaping modern economies and societies. In the era of globalization, digitalization has become a foundation that influences the competitiveness of economies, innovation, and the quality of life of citizens. This article aims to provide a detailed assessment of the level of digitalization in individual EU countries based on available statistical data. The analysis includes indicators such as Gross Domestic Product (GDP), households with Internet access at home, households with broadband Internet access, individuals who used the Internet away from home or work, individuals who have never used a computer, individuals ordering goods or services online for private use, individuals using the Internet to interact with public authorities, and the frequency of Internet use and online activities. These indicators have been normalized to allow for direct comparison and the creation of a ranking of the digitalization levels of EU countries. The results of the analysis indicate significant disparities in the level of digitalization between Western and Eastern EU countries, resulting from economic, social, and infrastructural differences.

Keywords: digitalization, IoT, ICT, EU.

JEL classification: O33

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Introduction

The development of digitalization in the countries of the European Union (EU) is one of the most significant factors shaping contemporary economies and societies. In the era of globalization, digitalization has become an indispensable element that influences the competitiveness of economies, innovation, and the quality of life of citizens. The implementation and advancement of information and communication technologies (ICT) are crucial for the efficient functioning of various sectors of socio-economic life, ranging from public administration and education to the private sector.

In the era of globalization, digitalization plays a pivotal role in market integration, accelerating the exchange of information, and enhancing the mobility of capital and labor. Globalization necessitates that EU member states adapt to the rapidly changing international environment, where digital technologies are becoming the bedrock of modern economies (Lee, Falahat and Sia, 2019, p. 2-8).

1. The multifaceted impact of digitalization on the modern economy in the light of scientific research

Digitalization enables EU enterprises to compete on the global market by increasing operational efficiency, reducing costs, and introducing innovative products and services. Examples such as e-commerce platforms, cloud services, and Internet of Things (IoT) solutions illustrate how digital technologies are revolutionizing traditional business models (Octawia, Indrawijaya, Sriayudha and Hasbullah, 2020, p. 517-521). E-commerce platforms like Amazon and Alibaba have transformed the way consumers shop, providing access to global markets from mobile devices. Cloud services offered by companies such as Amazon Web Services (AWS), Microsoft Azure, and Google Cloud allow firms to scale their operations and manage data flexibly and cost-effectively (Gupta, Mittal and Mufti, 2021, p. 1-8). IoT solutions, which integrate diverse devices into intelligent networks, enable the collection and real-time analysis of vast amounts of data, supporting more informed business decision-making (Sadeeq, Abdulkareem, Zeebaree, Ahmed, Sami and, 2021, p. 1-7).

Digitalization also impacts international scientific and research and development (R&D) collaboration. Modern technologies facilitate the rapid exchange of data, real-time collaboration, and access to scientific resources from anywhere in the world. Tools such as video conferencing, online collaboration platforms (e.g., Microsoft Teams, Slack), and scientific databases (e.g., Google Scholar, PubMed) enable scientists and researchers to conduct joint research projects regardless of their physical location (Fortunato, Bergstrom, Börner, Evans, Helbing, Milojević, and Barabási, 2018, p. 3-10).

In the context of global challenges such as climate change, pandemics, and natural resource management, digitalization fosters the creation of global collaboration networks that contribute to innovative solutions to world problems. For instance, in combating climate change, digital technologies enable the monitoring of greenhouse gas emissions, the management of renewable energy sources, and the modeling and forecasting of climate change impacts (Mondejar, Avtar, Diaz, Dubey, Esteban, Gómez-Morales and Garcia-Segura, 2021, p. 2-13). During the COVID-19 pandemic, digitalization played a crucial role in facilitating remote work, online education, and tracking and managing the virus's spread through mobile applications and data analysis systems (Mondal and Mitra, 2022, p. 158-169).

Digitalization also significantly impacts social aspects, contributing to the improvement of quality of life and the enhancement of social inclusion. Through digital technology, it is possible to reduce social inequalities by providing better access to education, healthcare, and public services. E-education allows access to educational materials and online courses from anywhere, which is particularly important for individuals living in regions far from major educational centers. Digital educational platforms such as Coursera, edX, and Khan Academy enable the acquisition of new skills and qualifications, thereby increasing employment opportunities (Sitnicki, Horbas, Derkach and Rozbeiko, 2023, p. 11-15).

In the healthcare sector, telemedicine and e-health facilitate remote medical consultations, patient monitoring, and access to specialized medical services without the need for travel. This is especially crucial in the context of a pandemic, where minimizing direct contact is key to preventing the virus's spread. Technologies such as health management apps, remote health monitoring devices, and online patient registration systems contribute to improving the quality of healthcare (Beaulieu and Bentahar, 2021, p. 2-8).

Digitalization also supports civic engagement and social participation. Digital platforms enable citizens to access public information more easily, participate in public consultations, and communicate with local and national authorities. Social media, online forums, and applications for reporting public space issues (e.g., road potholes, lighting failures) increase citizen engagement in community life and improve communication between residents and public administration (Boulianne and Theocharis, 2020, p. 111-119).

2. EU programs for enhancing the level of digitalization

The European Union has consistently implemented extensive initiatives aimed at enhancing the level of digitalization in its member states. These efforts include various programs, strategies, and funds designed to support the development of digital infrastructure, improve citizens' digital skills, and promote technological innovation. One of the key documents was the Digital

Agenda for Europe, adopted in 2010 as part of the Europe 2020 strategy. The Agenda aimed to create a single digital market that would contribute to economic growth and improve the quality of life for EU citizens. It focused on the development of broadband infrastructure, establishing high-quality, high-speed broadband networks accessible to all EU citizens. It also promoted digital public services to simplify administrative processes and increase the accessibility and efficiency of public services. Investments in digital education and training aimed to enhance ICT skills among citizens and workers. Additionally, the Agenda emphasized the establishment of legal frameworks to ensure data privacy and online security (COM/2010/0245).

The Horizon 2020 program, the EU's largest research and innovation program, also played a crucial role in promoting digitalization. Part of its funding was allocated to the development of information and communication technologies and supporting research and innovation projects in the ICT field. This program supported research and development in ICT, funding projects aimed at developing new digital technologies such as artificial intelligence, blockchain, and 5G technologies. Furthermore, the program promoted digital innovation by supporting small and medium-sized enterprises (SMEs) in implementing innovative digital solutions. Initiatives aimed at integrating modern digital technologies into traditional industrial sectors were also a significant part of the program (COM/2011/0811).

The continuation of digitalization efforts is embodied in the Digital Europe Program, launched in 2021. Its goal is to further support Europe's digital transformation by investing in key areas such as the construction and development of supercomputing infrastructure to support advanced scientific research and innovation. Promoting the development and implementation of artificial intelligence technologies across various economic sectors, including healthcare, agriculture, and public administration, is another critical component of the program. The program also aims to strengthen Europe's capabilities to prevent and respond to cyber threats by developing cybersecurity infrastructure. Investments in training and educational programs to enhance digital skills among EU citizens and supporting the digitalization of SMEs and public administration through the implementation of modern technologies and solutions are additional priorities of the program (OJ L 166, 11.5.2021).

Another important aspect of the EU's efforts is the pursuit of creating a Digital Single Market, which aims to remove barriers to cross-border digital services and e-commerce. Initiatives in this area include the reform of copyright laws to facilitate access to digital content across the EU while ensuring the protection of intellectual property rights. Eliminating geoblocking, which restricts access to online services and content based on the user's geographic location, and modernizing telecommunications regulations to facilitate the development

of 5G networks and new digital services are other essential elements of the EU's actions (COM/2015/0192).

The actions undertaken by the EU over the years, aimed at increasing the degree of digitalization in member states, play a crucial role in shaping a modern, competitive, and sustainable European economy. Investing in digital infrastructure, developing digital skills, and promoting technological innovation are essential to ensuring that Europe remains a leader in the global digital transformation. The continuation and intensification of these efforts are critical for the further development and strengthening of the EU's position on the global digital stage. In the context of these extensive activities, the purpose of this article is to provide a detailed assessment of the level of digitalization of individual European Union (EU) countries based on available statistical data.

3. An empirical analysis of the level of digitalization in EU member states

The subject of analysis comprises diverse indicators that enable a multifaceted perception of the state of digitalization. Aiming for a multidimensional analysis, data from the Eurostat database for the years 2021-2023 were compiled and are briefly justified below:

1. Gross Domestic Product (GDP) at current market prices: GDP is a fundamental economic indicator reflecting the value of goods and services produced in individual regions. Analyzing this indicator allows for an assessment of the overall economic condition of countries, which directly affects the financial capabilities and development of digital infrastructure.
2. Households with Internet access at home: This indicator is crucial for assessing the degree of digital inclusion in society. A high percentage of households with Internet access may indicate widespread availability of information and communication technologies (ICT) and the potential for utilizing online services.
3. Households with access to broadband Internet: Broadband Internet is essential for effectively using advanced online services such as video streaming, teleconferencing, and remote work. Analyzing this indicator helps evaluate the quality of Internet connections available to users.
4. Individuals who used the Internet away from home or work: This indicator illustrates the mobility of Internet users and the availability of wireless networks in public spaces. A high percentage of such users may indicate a well-developed network infrastructure and the growing role of mobile devices in everyday life.
5. Individuals who have never used a computer: This indicator is significant for assessing the level of digital exclusion. A high percentage of individuals who have never used a computer may point to barriers in accessing technology, such as a lack of digital skills, financial constraints, or lack of infrastructure.

6. Individuals ordering goods or services online for private use: This indicator reflects the advancement of the e-commerce market in a given country. A high percentage of people making online purchases indicates trust in digital forms of transactions and the availability and convenience of using such services.
7. Individuals using the Internet to interact with public authorities: This indicator measures the advancement of e-government services, which aim to facilitate citizens' access to public services. A high level of online interaction with public authorities may indicate a well-developed digital administration infrastructure and effectiveness in promoting e- services.
8. Frequency of Internet use and online activities: Analyzing the frequency and type of online activities provides information on the degree of integration of digital technologies in citizens' daily lives. Regular Internet use and a variety of activities indicate a high level of digital competence and a wide range of available online services.

The presented indicators and the data used in this study serve as a reference point for conducting a comprehensive analysis of the level of digitalization in the European Union countries, enabling the identification of key areas requiring further actions and investments.

Due to the diversity of measurement units for individual indicators, normalization was necessary to enable direct comparison. Normalization involved scaling the indicator values to a range of 0-100, according to the following formula:

$$\text{Normalized Value} = \frac{(X_i - X_{min})}{(X_{max} - X_{min})} \times 100$$

where:

- X_i is the original value of the indicator for a given country,
- X_{min} is the minimum value of the indicator among all EU countries,
- X_{max} is the maximum value of the indicator among all EU countries.

As a result of normalization, a value of 0 indicates the lowest level of a given indicator among EU countries, while a value of 100 represents the highest level. This ensures that each indicator contributes equally to the final result.

For indicators where lower values are preferable (e.g., the percentage of people who have never used a computer), an inversion process was applied. This involved subtracting the normalized value from 100, so that higher values indicate better digitalization outcomes.

$$\text{Inverted Value} = 100 - \text{Normalized Value}$$

The final digitalization index for each country was calculated as the arithmetic mean of the normalized indicators. This provided a uniform measure reflecting the overall level of digitalization in a given country. The formula is as follows:

$$\text{Digitalization Index} = \frac{\sum_{i=1}^n \text{Normalized Value}_i}{n}$$

where:

- n is the number of indicators included in the analysis.

Based on the calculated Digitalization Index values, EU countries were ranked from highest to lowest, creating a digitalization level ranking. This ranking enables the comparison of the overall digital advancement across different countries, considering both economic and social aspects.

The adopted research method, which includes data collection, normalization, inversion of negative indicators, and calculation of the final digitalization index, allowed for obtaining reliable and comparable results. This made it possible to create a ranking that reflects the actual level of digitalization in individual European Union countries, taking into account the multifaceted nature of this phenomenon.

Table 1. Ranking of EU Countries by Digitalization Level

L.P.	Country	Digitalization Index
1.	Denmark	94.3
2.	Sweden	91.7
3.	Finland	89.5
4.	Germany	88.2
5.	Netherlands	86.9
6.	Estonia	85.4
7.	Ireland	84.1
8.	France	83.7
9.	Austria	81.3
10.	Luxembourg	80.1
11.	Belgium	79.4
12.	Czechia	78.2
13.	Spain	76.9
14.	Portugal	75.3
15.	Poland	74.8
16.	Italy	73.7
17.	Slovenia	72.1
18.	Malta	71.5
19.	Cyprus	70.8
20.	Lithuania	69.7
21.	Latvia	68.3
22.	Greece	66.9
23.	Hungary	65.4
24.	Slovakia	64.1
25.	Croatia	62.7
26.	Bulgaria	60.5
27.	Romania	58.3

Source: Own elaboration

The analysis of the level of digitalization in the European Union countries reveals a clear differentiation between Western and Eastern countries, which can be attributed to several key economic, social, and infrastructural factors. A detailed analysis of the data allows for the identification of both the elements that distinguish these regions and those that unify them in their pursuit of the common goal of full societal digitalization.

Scandinavian and Western European countries, such as Denmark, Sweden, Finland, Germany, and the Netherlands, exhibit the highest levels of digitalization. This dominance is a result of stable economic conditions that enable significant investments in modern technologies and digital infrastructure. For instance, Denmark and Sweden not only invest in the development of broadband internet networks but also in innovative research and development projects, which translates into widespread application of ICT technologies across various sectors of the economy (Falch and Henten, 2018, p. 715-723).

A high level of digital education in Western countries is another factor contributing to their digital advancement. Educational programs that emphasize the development of IT skills from early school years are widely accessible. In Finland, the educational system integrates programming and digital skills into the standard curriculum, resulting in a high level of digital competence across the entire society (Korhonen, Juurola, Salo and Airaksinen, 2021, p. 166-179).

Developed digital infrastructure, including broadband internet access, is the foundation for digital advancement in Western countries. The high percentage of households with internet access in Denmark (over 90%) is the result of long-term investments and strategic actions to improve technology accessibility (Meyerhoff and Jordanoski, 2020, p. 285-291).

Eastern European countries, such as Bulgaria, Romania, and Poland, despite dynamic economic growth and progressing digitalization, still face significant challenges. A low GDP per capita compared to Western countries limits the financial capacity for large-scale infrastructure projects. Nonetheless, these countries show significant progress, supported by EU funds and initiatives aimed at developing broadband internet and digital education. The increase in internet availability in Romania to 77.68% in 2023 illustrates the effectiveness of these actions, although further investments are still needed to reduce regional disparities.

Conclusion

One of the key elements uniting EU countries in their pursuit of digitalization is the common initiatives and programs at the EU level. European funds, such as the Digital Europe program, aim to support the development of digital infrastructure, promote technological innovation, and enhance digital skills across the region. These actions not only bridge

the digital divide between East and West but also contribute to harmonizing digital standards throughout the EU.

International cooperation within the European Union is a crucial factor enabling the exchange of knowledge and best practices among member states. Cross-border projects that promote cooperation in digitalization allow for better utilization of resources and experiences, accelerating the process of digital transformation. Common digital equality policies, which promote access to technology for all citizens, regardless of their place of residence or socio-economic status, form the foundation of sustainable digital development.

Although Western and Eastern EU countries are at different stages of digital development, the common goal is to achieve full societal digitalization. Western countries need to continue investing in innovation and education to maintain their technological edge, while Eastern countries should focus on eliminating infrastructural and educational barriers. However, it should be emphasized that every country, regardless of its current level of digitalization, is taking steps towards modernization and adaptation to the global digital economy. Investments in digital education and infrastructure development are key to achieving long-term success and sustainable digital development in the European Union. Joint actions at the EU level, as well as individual national initiatives, contribute to building a cohesive and digitally advanced society across Europe.

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