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DIGITAL SKILLS IN SELECTED EUROPEAN UNION COUNTRIES IN THE CONTEXT OF DIGITAL EXCLUSION

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Purpose: The purpose of this paper is to analyse the key factors of the digital exclusion in selected European Union countries. Specifically, it examines the economic, social, and demographic determinants that shape digital accessibility and digital literacy in these nations.
Design/Methodology/Approach: This study analyses the factors associated with the level of digital skills, as measured by the DSI indicator, which is considered a key representation of digital exclusion. The analysis covers the 27 European Union countries from 2014 to 2023, enabling the identification of trends and changes over the examined period. Furthermore, correlations between the DSI levels and selected factors are investigated to determine the primary determinants of digital exclusion.
Findings: Significant variation in digital skill levels and the factors influencing them was observed across European Union countries. Strong correlations were identified between digital skills, GDP, and the level of education (both formal and informal). Additionally, the average age of the population was found to be a negative factor, which, in the context of aging societies, may play a crucial role in shaping future policies aimed at promoting digital inclusion for this demographic group.
Research Limitations/Implications: The conducted study provides a starting point for further analysis using a cross-sectional and temporal approach, focusing on digital exclusion in Europe.
Practical Implications: The results of the study have facilitated the identification of socio-economic factors associated with digital exclusion in European Union countries. These findings highlight key areas that require targeted action by policy-makers, particularly in addressing social inequalities and the digital marginalization of certain demographic groups.
Social Implications: The studies highlight the need for comprehensive education to develop key digital skills, enabling individuals to engage effectively and safely with the digital transformation of society and to prevent digital exclusion. They also indicate that, despite significant advancements in the availability of Internet technology over the years, digital exclusion remains unresolved, pointing to various underlying determinants of this issue.
Originality/Value: The paper identifies the factors associated with digital exclusion and provides recommendations for actions aimed at reducing digital inequality.
Keywords: sustainability, digital exclusion, digital transformation.
Category of the paper: Research paper.

1. Introduction

The dynamic development of information, communication, and digital technologies has driven the socio-economic transformation of the world, known as the digital transformation, and has contributed to the emergence of the so-called 'digital society.' This transformation affects all areas of life, and its potential for change appears to be unlimited. Technologies such as artificial intelligence (AI), robotics, the Internet of Things (IoT), autonomous vehicles, 3D printing, nanotechnology, biotechnology, and quantum information technology continue to advance (Balcewicz, 2019). Digitization has enabled the processing of and access to vast amounts of data, transforming the functioning of individuals, businesses, and institutions. While traditional technologies remain significant for knowledge, entertainment, and communication, digital media have become integral to nearly every action, purpose, and need in contemporary society (van Dijk, 2020). It is estimated that in 2023, 5.3 billion people worldwide used the Internet, accounting for approximately 66% of the global population (Petrosyan, 2024). In the European Union countries, the number of Internet users reached approximately 410 million, representing 91.43% of the population (Eurostat, 2023), and four out of five residents acknowledge that digital technologies will be significant in their lives by 2030 (European Commission, 2023).

Despite its numerous benefits, digital transformation brings a range of significant cyber risks. The rapid development of technology presents countries with the dilemma of accelerating digital transformation and developing a technology-driven economy, often at the cost of losing control over the security of the solutions used (Wrzosek, 2020). These dilemmas are crucial as they can impact the cybersecurity levels of both the country and its citizens. Three out of four residents of the European Union emphasised the need to enhance cybersecurity, improve connectivity, and strengthen data protection (European Commission, 2023). This is particularly relevant in light of the growing threats, such as the protection of citizens' data and privacy, the issue of online harassment and violence, and the challenges posed by disinformation and filter bubbles (Balcewicz, 2019).

Digital transformation contributes to economic development and enhances the well-being of society. However, individuals who lack access to Internet infrastructure or technological tools, as well as those without adequate digital competencies, are unable to fully participate in the digital society.As a result, a digitally marginalized group continues to emerge (European Commission, 2022). Digital divides both reflect and exacerbate existing social, cultural, and economic inequalities (van Dijk, 2020). Disadvantaged groups include women, migrants, refugees, people with disabilities, the elderly, children, and rural and indigenous communities (Balcewicz, 2020).

This study contributes to the existing body of research on digital exclusion by offering a comprehensive, multi-year analysis of the key socio-economic and demographic determinants associated with digital skills across the European Union. A key contribution of this research is its investigation of correlations between the Digital Skills Indicator (DSI) and selected socio-economic factors, such as GDP, education levels, and demographic composition. By analysing data from 2014 to 2023, it provides a longitudinal perspective on digital inequalities. For the most recent data from 2023, Gretl software was employed to examine these correlations, ensuring a rigorous statistical approach to uncovering patterns and relationships. The findings offer valuable insights for policymakers by identifying key areas requiring targeted interventions to reduce digital inequalities. As digital accessibility and literacy become increasingly essential in modern societies, this study provides a timely and evidence-based contribution to the ongoing discourse on digital inclusion strategies in the European Union.

The structure of the article is as follows. The first part provides the introduction to the study, followed by a literature review that examines digital skills as an aspect of digital exclusion in society. This section identifies potential factors that may determine the level of digital skills. The next section outlines the data and methodology of the empirical analysis, while the fourth section presents the results of the study along with their interpretation and discussion. The paper concludes with a section on conclusions and recommendations, which summarises the key insights and offers practical suggestions.

2. Digital skills as a driver of digital exclusion - literature review

Digital transformation, while driving economic growth and innovation, requires effective management to minimize the entrenchment and worsening of existing social, economic, and cultural inequalities. The lack of access to next-generation Internet infrastructure or insufficient digital competencies leads to digital exclusion for certain segments of society. Thus, digital exclusion is not merely a technological issue, but also a social one, with significant implications for education, the labour market, and the daily functioning of societies (van Dijk, 2020).

The concept of digital exclusion has evolved and expanded alongside technological advancements. According to the definition established by the OECD in 2001 (OECD, 2001), the digital divide refers to the difference between individuals, households, businesses, and geographical regions at varying socio-economic levels in terms of both access to and the ability to utilize information and communication technologies (ICTs) for various activities and purposes.

Studies in the field of digital inclusion have identified three levels of digital exclusion, which have been defined and refined as research on the topic has progressed. Initially, the digital divide was primarily understood as a disparity in material and physical access, distinguishing between those who had access to ICTs - such as computers, home Internet connections, or telephone lines - and those who did not (NTIA, 1998). This stage is referred to as the first-level digital divide. As research advanced, the scope of analysis expanded to include a second level of digital exclusion, which pertains to differences in digital skills among users. This aspect determines individuals' ability to effectively engage with technology and acquire information (Hargittai, 2002). The most recent approach to the digital divide considers a third level of digital exclusion, which pertains to the ability to effectively utilize digital resources for both online and offline benefits (Van Deursen, Helsper, 2015). Research indicates that digital exclusion should be addressed comprehensively across all three levels (Helsper, 2021).

Batorski (2009) emphasizes that digital exclusion is a complex and multidimensional phenomenon that extends beyond a simple digital divide. It is not merely limited to differences in access, skills, or ways of using technology but, more importantly, encompasses the underlying factors that contribute to social and economic marginalisation. Digital exclusion and social exclusion are interconnected - limited access to offline resources (economic, cultural, social, and personal) restricts the use of digital technologies, while deficiencies in digital competencies and infrastructure further intensify social marginalization (Helsper, 2012). Although digital exclusion is not a direct cause of social exclusion, it can exacerbate the challenges faced by already marginalised individuals as the rest of society increasingly integrates the Internet into daily life (Bunyan, Collins, 2013).

In the European Union, the concept of "digital inclusion" is emphasised. The *European Declaration on Digital Rights and Principles for the Digital Decade* (European Commission, 2023) highlights the importance of guaranteeing equitable, inclusive, and secure access to technology for all EU residents. Five priority areas have been identified (European Commission, 2022): enhancing ICT accessibility, improving digital skills, eliminating language barriers, ensuring reliable, high-speed, and secure connectivity, and providing access to Wi-Fi in public spaces.

Stephens and Mankee-Williams (2021) emphasize the crucial role of digital skills in adapting to continuous technological transformation, facilitating the effective use of online services, and preventing digital exclusion. These skills include not only the ability to operate digital devices and navigate the Internet but also skills related to cybersecurity and protection against threats in the digital environment. The development of key competences, including digital skills, is a fundamental pillar of the European Education Area (Council of the European Commission, 2023), which aims to ensure equal access to high-quality education and training. Digital skills, alongside literacy, mathematics and language skills, are recognized as essential for lifelong learning, playing a key role in enhancing the European Union's innovation, productivity, and competitiveness (European Commission, 2019).

One of the main factors leading to digital exclusion is insufficient levels of digital competence. According to van Dijk (2005), these deficits range from basic technical skills to more advanced competencies required for analysing and evaluating information in a digital environment (van Dijk, 2005). These deficits particularly impact the elderly, individuals with lower levels of education, and those residing in rural areas, thereby limiting their ability to utilise modern technologies effectively (European Commission, 2023).

2.1. Digital Skill Levels Across European Union Countries

The assessment of digital skills across European Union countries is essential for understanding the current state of digital competencies and identifying areas where further development is needed. A couple of key frameworks and indicators have been designed to measure digital skills, each offering unique insights into the level of digital proficiency within the population. The following analysis compares these initiatives, highlighting their contributions to the evaluation of digital skills across Europe.

The OECD Skills for 2030 (OECD, 2019) initiative aims to assist countries in adapting their education systems by focusing on essential competencies, including digital skills, critical thinking, and creativity. This initiative emphasizes the importance of a shared vision for education, developed through global dialogue, and provides a framework for shaping future curricula and teaching strategies to address emerging societal challenges. In contrast, the Global Competitiveness Report Special Edition 2020 (World Economic Forum, 2020) evaluates countries' performance in their recovery efforts following the COVID-19 pandemic, focusing on various dimensions of economic competitiveness, including digital skills and innovation capacity. However, the data presented is selective, focusing on specific aspects of competitiveness, which may not fully capture the broader picture of global economic recovery.

While various frameworks provide valuable insights into digital competencies, the Digital Skills Indicator (DSI) 2.0 offers a more direct and standardized measurement of digital skills within the European context. Developed by the European Commission, the DSI 2.0 assesses individuals' proficiency in digital technologies, ensuring cross-country comparability and providing a comprehensive overview of digital skills. Aligned with the DigComp (Digital Competence Framework for Citizens), it supports the development and measurement of digital competencies across the EU, making it valuable for addressing digital skills gaps at both national and EU levels (Vuorikari et al., 2022). The DSI 2.0 measures competencies in five key areas: working with information (browsing, searching, evaluating, and managing data), communication and collaboration (effective digital interactions, including diversity and digital identity management), content creation (editing, integrating information, and respecting copyright and licences), safety (data and device protection, well-being, and environmental awareness), and problem-solving (identifying needs, innovation, and adaptation to technological changes) (Vuorikari et al., 2016). This framework is essential for assessing the knowledge (understanding of technologies), skills (the ability to use digital tools effectively),

and attitudes (openness to learning and responsibility) necessary to thrive in a digitally-driven world, enabling reliable international comparisons and supporting the development of digital competencies across Europe (Vuorikari et al., 2016).

According to Eurostat (2023), an analysis of digital skill levels across European Union countries reveals significant differences among member states, as illustrated in Figure 1. On average, 55.56% of the EU population demonstrates at least basic digital competence. The highest rates are observed in Western and Northern European countries, with the Netherlands leading at 82.70% of its population having achieved at least a basic level of digital literacy. Finland and Ireland also report high results. In contrast, the lowest values are recorded in Romania and Bulgaria, where approximately one-third of the population has attained at least basic digital competence. The gap between the Netherlands and Romania is as large as 54.97 percentage points, highlighting significant disparities in access to technology and digital education.

However, the data presented in Figure 2 suggest that Internet usage alone does not necessarily correlate with higher levels of digital competence. Brandtzaeg et al. (2011) identify five distinct groups of Internet users, ranging from those who do not use the Internet at all to advanced users. They describe a so-called "rich-get-richer" effect, wherein individuals with high digital skills more quickly acquire new abilities and derive greater benefits from the Internet. Their forecasts indicate that inequalities in Internet usage will continue to widen, highlighting the need for initiatives aimed at digital education and improving users' technological skills.

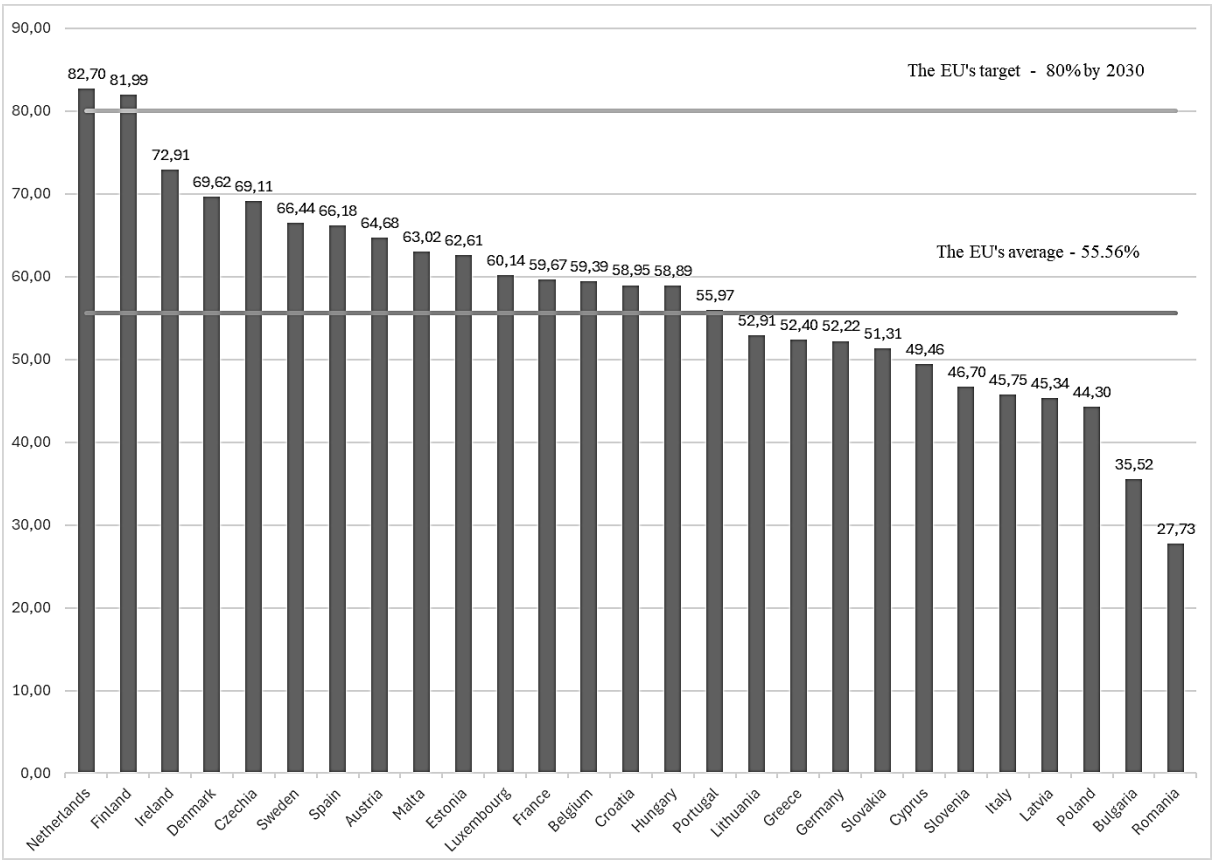

Figure 1. Percentage of people with basic and higher digital competences in Europe by country in 2023.

Source: own presentation based on data provided by Eurostat.

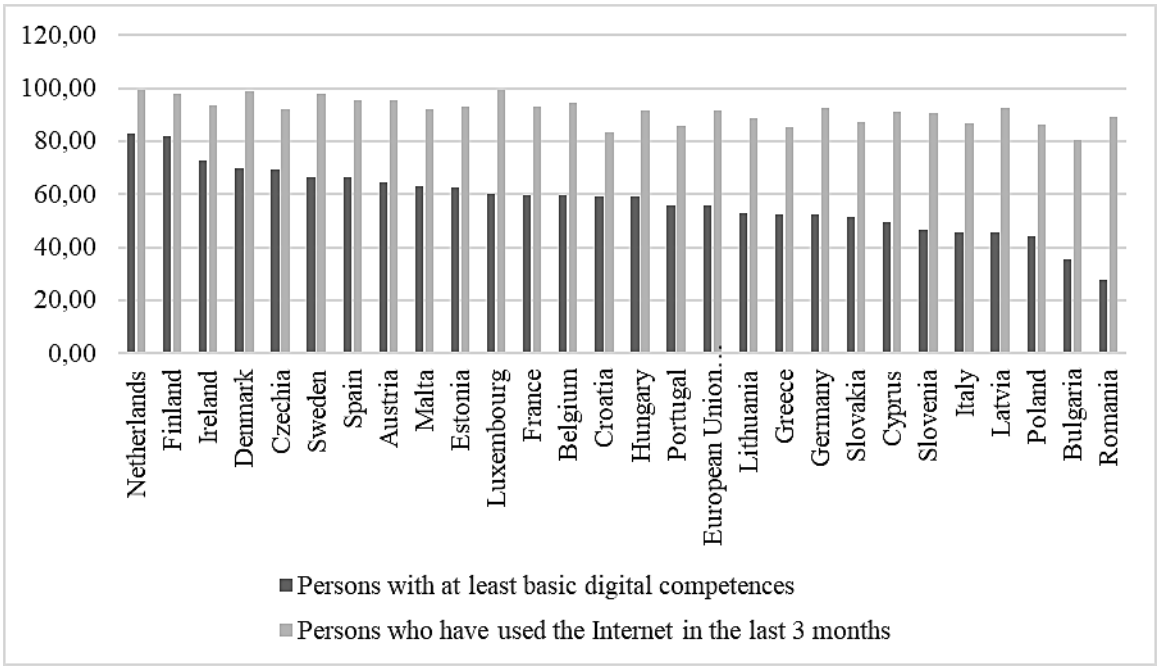

Figure 2. Comparison of the percentage of people who used the Internet in the 3 months prior to the survey with the level of digital competence by EU member state.

Source: own presentation based on data provided by Eurostat.

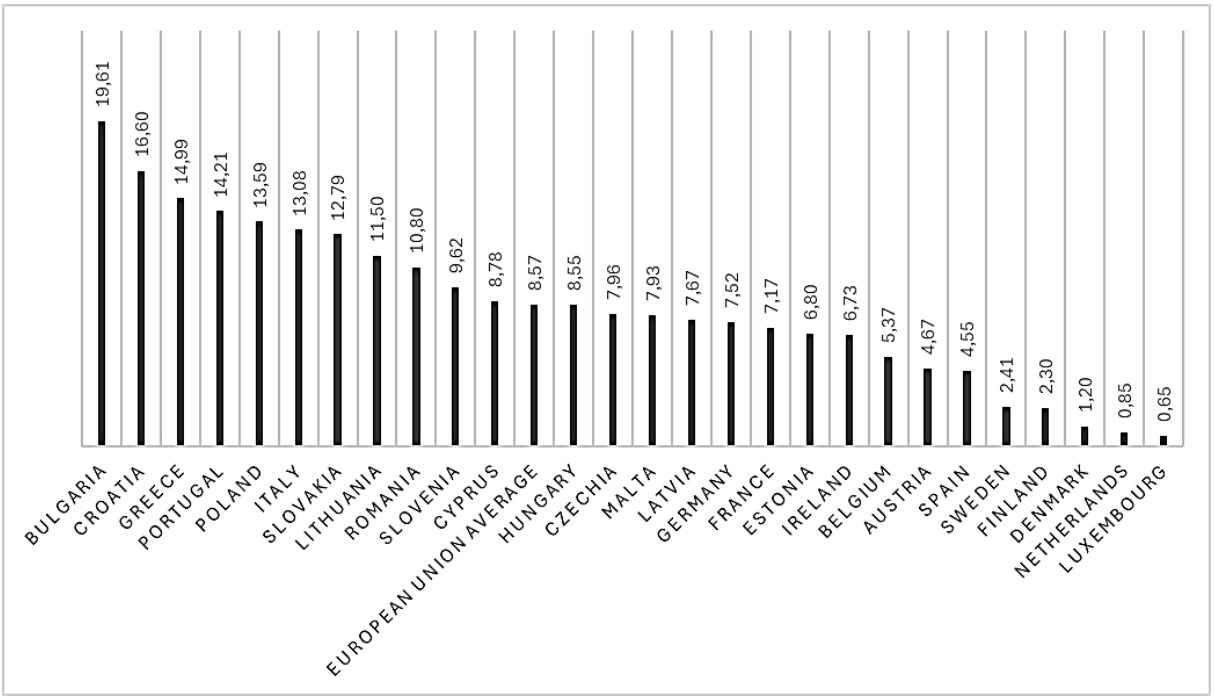

Figure 3. Percentage of people who had not used the Internet in the 3 months prior to the survey. Source: own presentation based on data provided by Eurostat.

Despite the rapid expansion of Internet infrastructure in recent decades, millions of citizens either do not use the Internet or do so only sporadically. The reasons for this issue are complex and include both lack of access to technology and reluctance or inability to use it effectively (European Commission, 2019). According to Eurostat (2023), data illustrated in Figure 3 indicate that, on average, 8% of the population in the European Union does not use the Internet or uses it only occasionally. The highest percentage of digitally excluded individuals was recorded in Bulgaria (19.61%), which correlates with the lowest level of digital skills in the EU. The next highest percentages were found in Croatia (16.60%) and Greece (14.99%). In contrast, in Luxembourg, the Netherlands, and Denmark, this percentage does not exceed 1%.

2.2. Factors affecting digital competence levels

A low level of digital competence is associated with difficulties in effectively utilising modern technologies. Researchers have identified several contributing factors to this condition. Van Dijk (2005) categorises these factors into four dimensions: motivational, material, skills, and application. Helsper (2021) further emphasizes inequalities across economic, educational, civic, social, and cultural domains. The most commonly recognized factors include economic, educational, demographic, technological, and psychological influences.

2.2.1. Economic factors

Among the most significant economic factors contributing to digital exclusion are GDP per capita, the cost of Internet access, and the unemployment rate. The level of GDP per capita serves as a key indicator of economic development, directly influencing the advancement of digital infrastructure, education levels, and the availability of digital technologies (OECD,

2020). In countries with lower GDP, digital exclusion is more prevalent, as these technologies remain financially inaccessible to many households (Robles et al., 2021).

Szeles (2018) argues that beyond economic development, investment in research and development is crucial for enhancing digital competence. Additionally, the welfare system and the level of social policy spending play a significant role in digital inclusion, particularly for older adults and the unemployed (Alexopoulou et al., 2022). The cost of Internet access is another critical factor influencing digital exclusion, especially among low-income groups, where Internet expenses compete with essential needs such as food and housing (Van Deursen, Helsper, 2015).

The unemployment rate significantly influences digital exclusion. Unemployed individuals often have limited opportunities to invest in the development of digital skills, while a lack of Internet access further restricts their ability to search for employment and participate in online education and training. However, unemployment status can increase the likelihood of using the Internet for job searches by nearly 30 percent, highlighting the role of digital technologies in the job activation process (Vallušová et al., 2022).

2.2.2. Educational factors

Szeles (2018) argues that education plays a crucial role in preventing digital exclusion. Furthermore, studies suggest a strong link between higher education levels and greater proficiency in the critical use of technology, as well as its practical application in both professional and everyday life (European Commission, 2019). Digital technologies have transformed education, expanding opportunities for both learning and teaching. Education is fundamental to enhancing employability, fostering innovation, promoting social inclusion, and bridging the digital skills gap (European Commission, 2023). The data demonstrates that digital skills among young people are largely shaped by education, particularly through the implementation of appropriate teaching strategies (OECD, 2023).

Supporting initiatives for both formal and non-formal education will be essential in achieving the EU's 2030 target of 60% of adults participating in training annually. In 2023, 30.9% of the population had attained tertiary education, 15.37% had participated in online training, and 74.6% reported proficiency in at least one foreign language (Eurostat, 2023). In 2023, the data indicates that, on average, 69% of 15-year-old students in OECD countries possess skills related to assessing the reliability of online information, a critical component of digital competence. Witczak-Roszkowska (2022) emphasises the necessity of formulating a strategic plan for the development of digital competences at an early stage of education, which is essential for addressing existing gaps and preventing future discrepancies between labour market supply and demand. Conversely, findings by Vallušová et al. (2022) indicate that individuals with lower levels of education are less likely to use the Internet. This underscores the importance of integrating digital competencies into both formal and informal education systems, as it supports individual development across different life stages (Redecker, 2017).

2.2.3. Demographic factors

Demographic and social factors, including age, gender, education, and place of residence, play a crucial role in determining digital competence and the extent of Internet use, thereby increasing the risk of digital exclusion (Helsper, Galacz, 2009; European Commission, 2023). In particular, low socio-economic status serves as a significant barrier to accessing technology, contributing to the widening of social and economic inequalities (Helsper, 2008).

A demographic indicator that reflects the average age of a population, which in turn reflects the age structure of society, is characterised by varying needs and barriers in professional, social, and cultural life (Helsper, 2012). The level of digital competence is dependent on age. According to Eurostat (2023) the youngest group (16-24 years) demonstrates the highest level of digital skills in the European Union, with an average of 69.98% of the population, indicating broad access to technology within this group. In the 25-54 age group, this rate decreases to 64.00%, while among older individuals (55-74) drops further to only 37.05%. These trends are illustrated in Figure 4. Older age groups are less likely to use information and communication technology (ICT), due to both physical and cognitive limitations, as well as reduced adaptability to new technological solutions (Vallušová et al., 2022; Rosman et al., 2022; Szeles, 2018). The ageing population, particularly in the context of "double ageing" - with the number of people aged 65 and older projected to increase by 18% between 2020 and 2030 (European Commission, 2021) - presents a significant challenge for digital inclusion. This trend underscores the need for the development and implementation of targeted strategies to prevent the marginalization of older individuals (Adamczyk, Betlej, 2021). Figure 4 illustrates significant disparities in digital competence levels across different age groups between countries. As reported by Eurostat (2023) among older individuals, the highest levels of digital competence are reported in the Netherlands (72.23%) and Finland (62.24%), while the lowest rates are recorded in Romania (10.56%) and Bulgaria (15.31%). Poland remains one of the countries with the lowest levels of digital competence among older populations in the EU, with a digital competence rate of 18.44% in the 55-74 age group. This low rate can be attributed to differences in education levels, income, and access to digital infrastructure (Adamczyk, Betlej, 2021).

The place of residence is a significant determinant of digital competence levels. In rural areas, underdeveloped digital infrastructure, higher unemployment rates among individuals aged 15 to 29, and restricted access to public services such as education and healthcare contribute to the widening of the urban-rural digital divide (European Commission, 2021). The high costs associated with infrastructure development lead to a phenomenon known as ‘profit-based discrimination,’ in which rural communities are marginalised in terms of broadband Internet access (Stephens, Mankee-Williams, 2021). A similar phenomenon was observed in a study of digital exclusion in San Antonio, where limited access to technology and the high cost of infrastructure deployment constrain access in less populated and economically disadvantaged areas (Reddick et al., 2020).

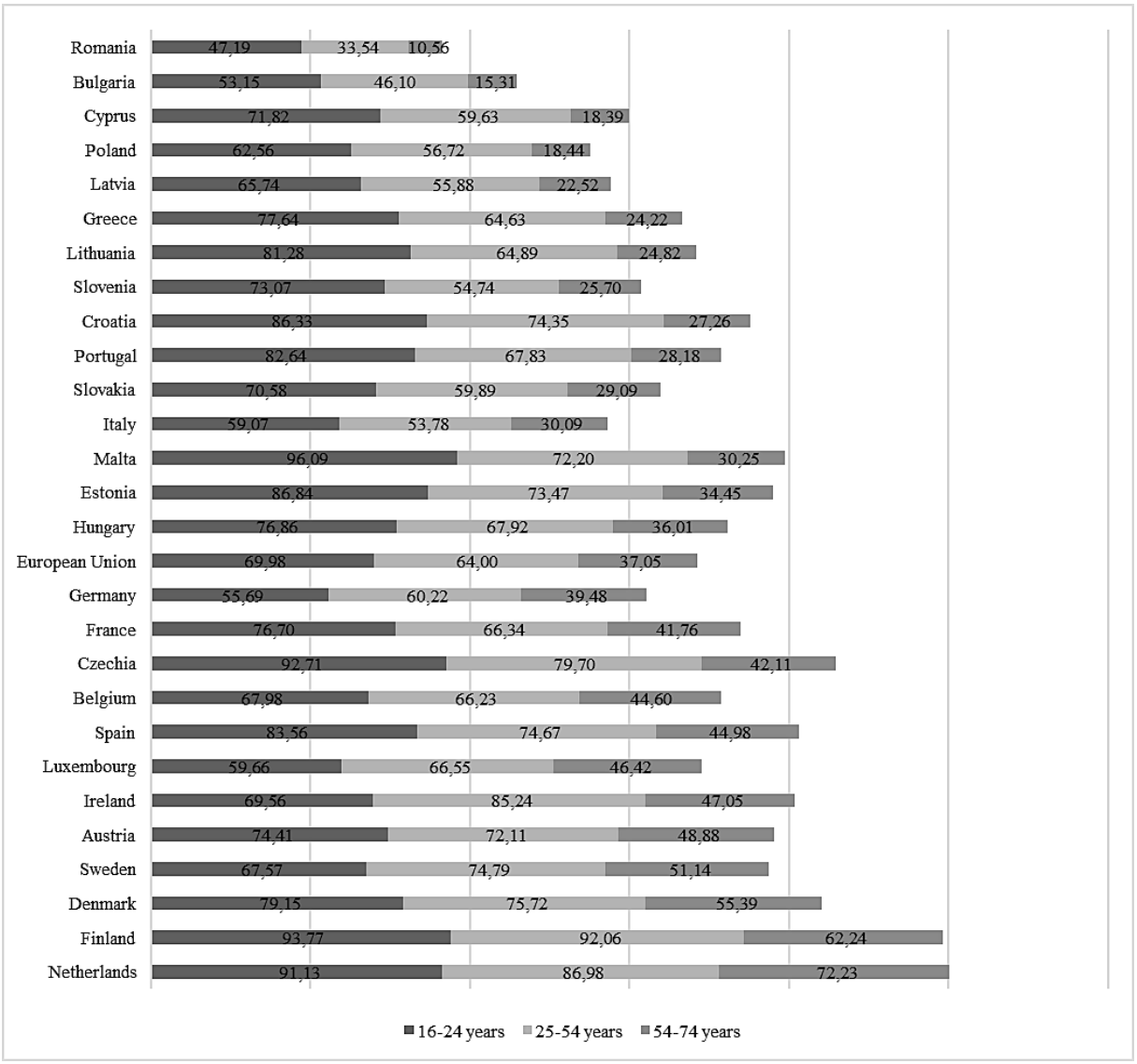

Figure 4. Percentage of individuals with basic and advanced digital competencies by age group across the analyzed countries.

Source: own presentation based on data provided by Eurostat.

The disparities in digital literacy levels based on place of residence are illustrated in Figure 5. Within the European Union, the highest percentage of individuals with basic or higher digital competencies is found in large cities (62.55%), followed by 53.25% in cities and suburbs, and 47.50% in rural areas (Eurostat, 2023). These differences are particularly pronounced in countries such as Bulgaria, Latvia, Greece, Poland, Hungary, and Portugal, where the gap between digital competence levels in large cities and rural areas exceeds 20 percentage points. In contrast, countries like Cyprus, Belgium, and Ireland exhibit minimal differences, with variations of only 1-2 percentage points.

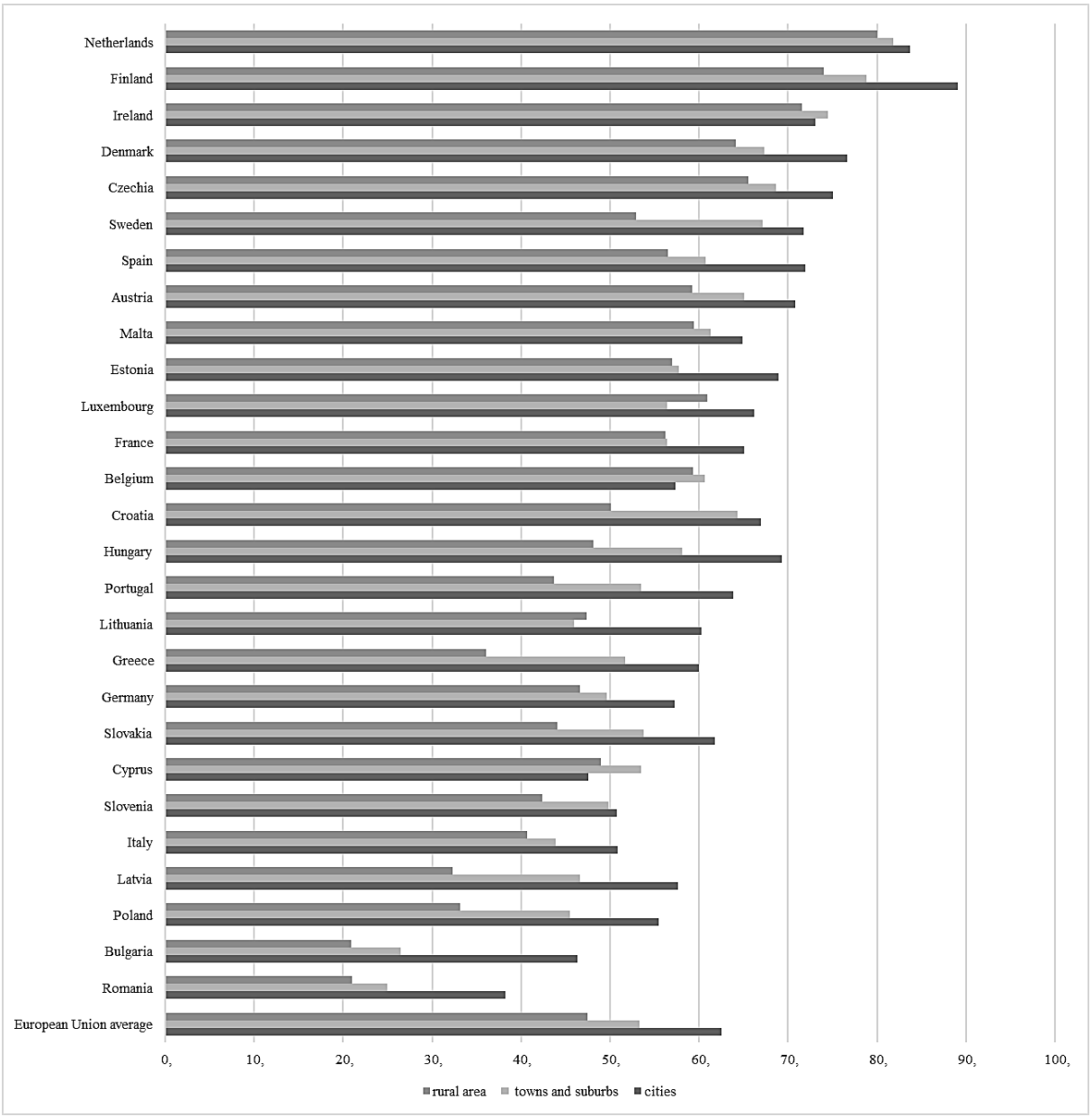

Figure 5. Percentage of people with basic and higher digital competences by big cities, cities and suburbs and rural areas within the countries analysed.

Source: own presentation based on data provided by Eurostat.

Gender is another determinant of digital skills. Although it is often assumed that males are more digitally competent, the ICILS 2013 international survey revealed that, in most European countries, 14-year-old girls scored higher in computer and information literacy (Punter et al., 2017). However, an analysis of technology use patterns shows that women are more likely to use technology for communication and social purposes, whereas men tend to engage in more advanced forms of Internet use, such as programming or data analysis (OECD, 2019). Additionally, factor analysis confirmed that the structure of digital competencies shows only small gender-based differences, with their development being closely linked to cultural background and the educational system (Aydın, 2020; Punter et al., 2017). A study conducted

in Malaysia found that gender has only a minor impact on digital literacy levels, with age and education level being the primary determinants (Rosman et al., 2022).

2.2.4. Technological factors

Technological factors play a key role in determining the level of digital competencies, with their influence closely linked to a country's economic development, the wealth of its population, and the availability of technological infrastructure. Approximately one-third of the global population, or 2.6 billion people, remained offline in 2023. While over 90% of individuals in high-income countries were using the internet in 2022, only one in four in low-income countries had access to it. Access to the internet and modern devices is crucial for acquiring digital skills, which are essential for full participation in the knowledge-based economy (World Bank, 2024). In 2019, 87% of individuals in developed countries were using the internet, whereas only 19% of people in the least developed countries had access (UN, 2020). Although 93% of the global population has access to mobile telephony or internet services, only 53.6% are actual internet users, leaving an estimated 3.6 billion people without access. This disparity not only exacerbates socio-economic inequalities but also restricts opportunities for social improvement (Reddick et al., 2020).

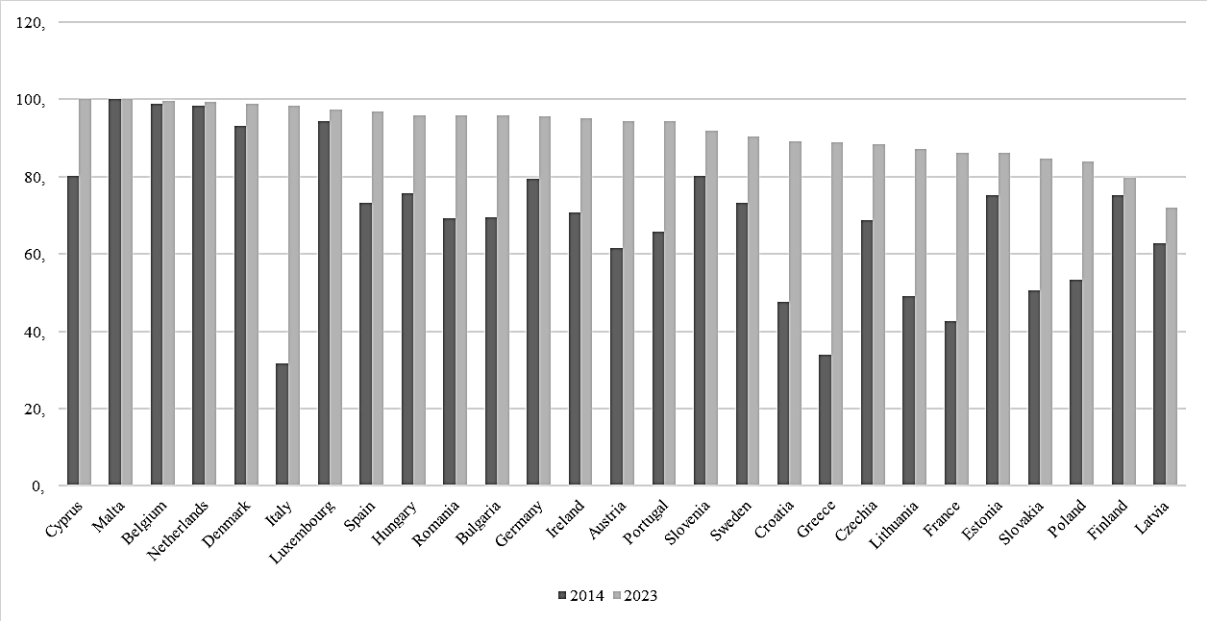

Figure 6. Percentage of households with NGA Internet access.

Source: own presentation based on data provided by Eurostat.

Figure 6 presents data on access to telecommunications infrastructure providing high-speed broadband (Next Generation Access, NGA) in EU countries. As reported by Eurostat the average percentage of households with NGA Internet access in 2023 is 92.9%, reflecting an increase of 30.2 percentage points compared to 2014. The highest levels of availability are found in Cyprus and Malta, where the rate has reached 100%. In contrast, the lowest percentages are recorded in Latvia (72%) and Finland (79.7%). The most significant increases

since 2014 were observed in Italy (an increase of 66.7 percentage points) and Greece (an increase of 54.9 percentage points).

3.2.5. Psychological factors

Psychological factors play a significant role in digital exclusion, contributing to a lack of digital engagement and, consequently, exacerbating economic and social inequalities (Helsper, 2008). Key psychological barriers include fear of technology, fear of social evaluation, and concerns about cybercrime (Tomczyk et al., 2023). A lack of self-confidence and low motivation to use digital technologies can lead to self-marginalization. Research indicates that 67.6% of households in Poland that do not use the Internet report a lack of need, while 52% identify a lack of skills as the primary barrier (Adamczyk, Betlej, 2021).

A lack of confidence in new technologies is another psychological factor contributing to digital exclusion. This is particularly pronounced among older individuals, who may fear cybercrime, loss of privacy, and difficulties in navigating complex technological interfaces (Adamczyk, Betlej, 2021). Research in Spain indicates that concerns about surveillance, personalised advertisements, and a lack of knowledge regarding personal data protection (e.g., stemming from GDPR regulations) further limit the willingness to engage with public e-services (Kaihlanen et al., 2022). Psychological barriers also include negative experiences with interactive public spaces. Individuals with lower social status and low self-esteem may avoid engaging in the digital sphere due to the potential for negative interactions, which can lead to their gradual withdrawal and further exclusion (Robles et al., 2021).

3. Data and methods of the empirical analysis

The purpose of the study was to identify factors associated with the level of digital competence across societies in the countries of the European Union, which comprised 27 member countries as of 2020. All EU countries were analysed, which vary in many respects, including geographical location and the level of economic and social development. The study explores the relationship between various economic, social, and technological indicators and the level of digital skills (DSI). Based on the research by Vuorikari et al. (2022), the DSI 2.0 indicator has demonstrated high psychometric quality, indicating its reliability and validity as a tool for measuring digital competencies. The analysis also included an empirical test of the validity of the DigComp framework, which provided the following fit indices: RMSEA (Root Mean Square Error of Approximation) = 0.033, TLI (Tucker-Lewis Index) = 0.989, CFI (Comparative Fit Index) = 0.991, and SRMR (Standardised Root Mean Square Residual) = 0.052. All of these fit indices confirm that the bi-factor model employed in the DSI 2.0 ensures an appropriate fit and serves as a robust tool for measuring digital competencies

within the context of the DigComp framework. Although various indicators can be used to assess digital skills, the DSI 2.0 was deemed the most appropriate for this study, particularly in the context of European countries. Its selection is justified by its availability, reliability, and the possibility of cross-country comparisons within the European Union. However, DSI 2.0 presents several limitations that must be considered. A key limitation is that the data utilized in its calculation can rapidly become outdated due to the fast progression of technological advancements, which may compromise the accuracy and relevance of the results. As a quantitative measure, the DSI fails to capture qualitative dimensions, such as user satisfaction. Additionally, methodological concerns regarding the DSI are noteworthy. The indicator relies extensively on self-assessment by respondents, introducing the potential for misinterpretation of individual capabilities and variability in interpretations, which can undermine the consistency of the results.

Although various indicators can be used to assess digital skills, DSI 2.0 was deemed the most appropriate for this study, particularly in the context of European countries. Its selection is justified by its availability, reliability, and the possibility of cross-country comparisons within the European Union, despite certain limitations.

Based on the literature review, variables were selected that could potentially demonstrate a relationship with the level of digital competence in the EU countries. The characteristics of these variables are presented in Table 1.In this study, several factors potentially influencing digital competencies were not considered. These include psychological aspects, such as motivation and fear of new technologies, as well as access to educational support, including resources available within the family context. Socio-cultural factors, such as attitudes towards and acceptance of new technologies within a given society, were also excluded. The omission of these variables is due to the absence of comparable data and the challenges associated with their precise definition and measurement.

The data analysed are annual and refer to 2023. Definitions and data have been compiled from the Eurostat website. All data are expressed as a percentage of the variable's value relative to a reference value, allowing for comparisons across member countries. Data on the percentage of individuals living in predominantly rural areas for Malta were calculated using information from the National Statistics Office Malta (NSO, 2024), and for Luxembourg, the data were calculated using information from the National Institute of Statistics and Economic Studies of the Grand Duchy of Luxembourg (STATEC, 2024). The criteria for calculated included a population density of less than 300 inhabitants per km² and a population of fewer than 5000 in the area. For Cyprus, the data were sourced from the Statistical Service of Cyprus (CYSTAT, 2024).

For the analysis, the Pearson linear correlation coefficient is employed. This measure allows for an assessment of both the direction and strength of the relationships between two selected variables.

Table 1.
Characteristics of the analysed variables

Variable abbreviation	Variable characteristics
DSI	Digital Skills Index (DSI), is the percentage of individuals with basic or higher general digital skills (where all five component indicators are at the basic level or higher) relative to the total population, as defined by DigComp, an indicator developed for the 16-74 age group.
PKB	The GDP per capita indicator, expressed in purchasing power standards (PPS), is related to the average value for the European Union, which is set at 1. Data expressed in PPS, a common currency, allow for cross-country comparisons by eliminating differences due to price levels, thus enabling a more meaningful analysis of GDP size (European Commissin, 2024).
CI	The price of Internet access, expressed as a percentage of GDP per capita, was defined in euros for the cheapest mobile Internet offer with 50 GB of data, excluding additional services, available in the respective member country.
DI	The percentage of households with next-generation Internet (NGA) access includes technologies such as optical fibre, 5G, Wi-Fi 6, and LTE/4G Advanced.
SW	The average age of the population in the age range of 16-74.
ON	The percentage of individuals with disabilities (functional or health limitations) within the economically and socially active population aged 16-74 years old (European Commssion, 2024).
SB	The unemployment rate, is the percentage of the labour force (the total number of employed and unemployed individuals), as defined by the International Labour Organization ILO (European Commission, 2024).
WW	The percentage of individuals with education beyond secondary level, classified according to the International Standard Classification of Education ISCED 2011 (European Commission, 2024).
SO	Percentage of individuals participating in training through online technologies, regardless of the subject matter (European Commission, 2024).
JO	Percentage of individuals with knowledge of at least one foreign language. The data is self-reported.
OW	Percentage of individuals residing in predominantly rural areas. A predominantly rural area is defined as one where more than 50% of the population lives in areas classified as rural, with a population density of less than 150 persons per km² (Zysk; Źróbek-Różańska, 2015).

Source: own presentation based on Eurostat.

4. Results and discussion

As previously mentioned, the empirical analysis covered 27 European Union countries. A linear correlation analysis was conducted for 11 variables.

The results of the study, presented in Table 2, reveal a significant correlation between education in its broadest sense, the economic situation, and the level of digital skills in society. Research highlights the multifaceted nature of the digital skills gap, with studies such as those by Van Dijk (2005) and Helsper (2021) confirming that it is primarily driven by social, economic, and educational factors.

Table 2.
Correlation between selected variables; critical value (with two-sided 0.05 critical area) = 0.381 for n = 27

	DSI	PKB	CI	DI	SW	ON	SB	WW	SO	JO	OW
DSI	1	0,449 *	-0,254	0,049	-0,458 *	0,294	0,025	0,483 *	0,782*	0,353	-0,176
PKB	0,449 *	1	-0,521 *	0,364	-0,675 *	-0,219	-0,198	0,598 *	0,413*	0,226	0,053
CI	-0,254	-0,521 *	1	-0,169	0,443*	-0,126	-0,242	-0,406 *	-0,302	-0,290	-0,150
DI	0,049	0,364	-0,169	1	-0,308	-0,434 *	-0,155	0,036	0,050	-0,297	-0,269
SW	-0,458 *	-0,675 *	0,443 *	-0,308	1	0,099	0,146	-0,710 *	-0,412 *	-0,329	0,022
ON	0,294	-0,219	-0,126	-0,434 *	0,099	1	0,110	-0,007	0,144	0,303	0,161
SB	0,025	-0,198	-0,242	-0,155	0,146	0,110	1	0,106	0,134	-0,103	-0,131
WW	0,483 *	0,598*	-0,406 *	0,036	-0,710 *	-0,007	0,106	1	0,489*	0,490*	-0,106
SO	0,782 *	0,413 *	-0,302	0,050	-0,412 *	0,144	0,134	0,489 *	1	0,341	-0,167
JO	0,353	0,226	-0,290	-0,297	-0,329	0,303	-0,103	0,490 *	0,341	1	-0,003
OW	-0,176	0,053	-0,150	-0,269	0,022	0,161	-0,131	-0,106	-0,167	-0,003	1

*** -** statistically significant at the 0.05 significance level

Source: own compilation based on data from Eurostat.

Research underscores that GDP per capita and the cost of Internet access are key determinants of digital exclusion (OECD, 2020; Robles et al., 2021). While the correlation analysis in this study did not reveal a significant relationship between Internet costs and the level of digital competence, Van Deursen and Helsper (2015) identified Internet cost as a critical factor, particularly for lower-income households. The lack of significance in this study may be attributed to the relatively low cost of Internet access in EU countries, especially when compared to the overall wealth of the population (GDP per capita). In addition, data presented by the United Nations further highlight that cost remains a significant barrier to internet access, particularly in developing countries (UN, 2020). In some of these nations, the price of internet access can reach as much as 20% of GDP per capita, while the United Nations has set a goal to reduce this figure to 2% of GDP per capita by 2030. Instead, GDP per capita emerged as a significant variable, supporting Szeles' (2018) earlier findings, which emphasize the pivotal role of economic development in enhancing digital competence. A higher GDP facilitates improved digital infrastructure and greater accessibility to modern technologies, thereby reducing the extent of digital exclusion.

The results of the study indicate that both informal education (SO indicator) and the level of formal education (WW indicator) are correlated with the level of digital skills, as measured by the Digital Skills Index (DSI). Furthermore, the correlation between the tertiary education indicator (WW indicator), the online education level indicator (SO indicator), and the foreign language proficiency indicator (JO indicator) suggests that individuals with higher education are more likely to enhance their qualifications and possess stronger foreign language skills. This is also supported by OECD research (OECD, 2023), which shows that educational attainment has a significant impact on foreign language skills: 10% of individuals with tertiary education, 23% with upper secondary education, and 41% with at most lower secondary education are unable to speak any foreign language. The significant role of education in shaping digital competencies is strongly emphasised in the literature. Both formal and informal education, including competence upgrading and lifelong learning, significantly influence

citizens' digital skills (European Commission, 2023; Rosman et al., 2022). A key driver of upskilling is employment, as more than four-fifths (81.8%) of non-formal education and training activities undertaken by adults in the EU are work-related (Eurostat, 2023). These findings confirm previous research by Szeles (2018), which emphasized that education and the development of digital skills are crucial for the labour market.

The findings of the correlation analysis revealed a negative correlation between age and the level of digital skills. However, no significant relationship was found between the level of digital skills and other demographic factors, such as the percentage of people with disabilities or place of residence (rural vs. urban). The literature indicates clear differences in digital competence levels based on age and place of residence (Helsper, 2010; Szeles, 2018). Additionally, previous studies (European Commission, 2021; Stephens, Mankee-Williams, 2021) have emphasized the impact of place of residence on access to digital infrastructure. This represents a discrepancy, as the results of the current correlation study did not demonstrate such a relationship. On the other hand, the correlation between the demographic factor of average age and the level of digital competence was confirmed, which may be attributed to both cognitive barriers and a lower perceived need to use digital technologies among older individuals (Adamczyk, Betlej, 2021).

The lack of a significant correlation between technological factors and the level of digital competence observed in the study may indicate that, in the European Union, technological infrastructure has reached such an advanced level (92.90%) that it is no longer a significant differentiating factor. Consequently, the digital skills gap appears to be more closely linked to socio-economic factors rather than access to technology. In developed countries, educational policies and programs designed to equalize opportunities in technology use are thus becoming increasingly important.

In conclusion, a comparison between the study findings and previous research reveals a consensus on the importance of education and economic factors in shaping digital competence. However, discrepancies emerge regarding the impact of Internet costs and place of residence - factors considered significant in the literature - which did not exhibit strong correlations in the analysis. This may indicate that certain digital barriers, such as Internet affordability and NGA Internet access, have already been minimised, while disparities linked to education level and economic status continue to play a crucial role.

5. Conclusions and recommendations

This paper examines the factors that may be related to the level of digital competence in European Union countries. The results demonstrate a statistically significant relationship between digital competence and factors such as education level, wealth, and age. A positive

correlation is observed for education level and economic status, while a negative correlation is found for age. Based on these findings, policy recommendations can be formulated in the context of economic and social policy.

The rapid development of technology, combined with an inadequately effective digital education system, may lead to a situation in which individuals with basic digital competencies gradually lose the ability to use them effectively. This process occurs due to the challenge of adapting to the rapidly changing technological demands, resulting in a renewed deficit in digital competencies and their gradual decline. To address these dynamic changes, it is essential to develop and implement inclusive educational initiatives that are adapted to the needs of various social groups and encompass all stages of life. A key element of the strategy should include both foundational training and advanced programmes, ensuring that digital education facilitates effective and secure participation in the digital environment. Moreover, the effectiveness of these programmes requires their adaptation to the diverse needs that arise from differing levels of technological skills and varying capabilities in utilizing digital tools. Given the rapid obsolescence of acquired technological knowledge, such educational efforts should be continuous to maintain digital competence over time.

Significant attention should be given to the needs of older adults, who often encounter both technological and psychological barriers, such as fear of technology, uncertainty about their own competencies, or feelings of embarrassment when interacting with younger technology users. It is important to note that older individuals are not a homogeneous group. Distinctions exist between the so-called "third age" (60-75 years), which is characterised by greater independence, and the "fourth age" (75-85 years), in which health issues and dependence on care are more prevalent (Adamczyk, Betlej, 2021). An important issue is also the limited scope of research on the digital competencies and needs of older adults, which typically includes individuals up to the age of 74. In the context of an aging society, this results in a lack of knowledge regarding the digital skills and Internet usage of older individuals, potentially leading to restrictions on their access to health, social, administrative, and financial services. Consequently, designing effective programs to prevent social, digital, and financial exclusion among seniors becomes more challenging. Access to digital technologies among older adults is further restricted due to economic barriers and the inadequacy of technological tools for their specific needs. Therefore, it is crucial to implement solutions that ensure broad access to technology in public spaces, such as libraries, local authorities, or senior citizens' clubs, which would help to equalise opportunities for using modern digital tools, irrespective of one's financial situation or place of residence. At the same time, an important consideration is the adaptation of applications and user interfaces to address health issues commonly faced by older adults, such as impaired vision or hearing, while also enhancing their overall intuitiveness. This approach can help reduce barriers to technology use and combat digital exclusion within this demographic group.

Digital exclusion is typically examined in older individuals, people with disabilities, and those with low economic status. However, younger Internet users are also affected, although in a different manner. Despite widespread Internet access, many of them may lack the necessary digital competencies to adequately manage the risks associated with online activities, such as cybercrime, disinformation, and online harassment or hate speech. Education should emphasise the use of digital tools by both students and teachers, fostering the development of digital competencies, particularly in the areas of analysing and critically evaluating online information, as well as ensuring safe use of digital technologies. Digital education at the primary education stage should lay a solid foundation for the further development of digital competencies, supporting lifelong learning. Furthermore, those in the working age group require systematic support in adapting to rapidly changing technologies and continuously upgrading their skills, enabling them to meet the evolving demands of the labour market. However, the available training programmes, primarily offered by employers, often prove insufficient. Therefore, it is crucial to implement a comprehensive and accessible skills enhancement system that encompasses various social groups and ensures equal access to digital education, regardless of one's place of residence or professional status. It is also worth noting that the younger generation could play a key role in supporting older individuals in developing digital skills, especially in rural areas and regions with limited access to adult education. However, this intergenerational support may be impeded by the younger and middle-aged generations' lack of awareness of the psychological barriers that older individuals often encounter.

Government initiatives, such as e-services for administration, healthcare, social care, and education, despite their significant potential, often do not reach the most socially excluded groups. This is primarily due to the fact that effective access to these services requires basic digital competencies, which these groups frequently lack. Therefore, public institutions should not only require digital skills but also actively foster them. Futhermore, a significant barrier to the use of technology remains the fear of cybercrime and concerns regarding privacy and data security. For this reason, it is essential for the state and public institutions to engage in digital education and the fight against cyber threats. To effectively counter digital exclusion, it is crucial to ensure universal access to technological infrastructure and develop strategies that support groups at risk of digital marginalisation. Consequently, the implementation of comprehensive educational programmes is necessary, both at the national and local levels, including both online courses and in-person training. Particular emphasis should be placed on eliminating psychological barriers, such as fears of surveillance, data leaks, and online fraud.

The consequences of inaction in this area may include both the widening and deepening of digital, social, and economic inequalities. Thus, digital exclusion is not merely a technological issue but also a complex social and economic challenge that can affect not only marginalized groups but also broader segments of society to varying degrees. It is therefore necessary to take action to improve digital competencies throughout society and to eliminate psychological barriers related to technology and Internet use, such as fear of surveillance or the need to protect personal and financial data.

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