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**DIGITAL TRANSFORMATION AND DIGITAL DIVIDE IN TIMES
OF COVID-19: REGIONAL PATTERNS OF CHANGE
IN EUROPEAN TRANSITION ECONOMIES**

**DIGITÁLIS ÁTALAKULÁS ÉS DIGITÁLIS SZAKADÉK COVID-19
IDEJÉN: A VÁLTOZÁS REGIONÁLIS MINTÁZATAI
AZ EURÓPAI ÁTMENETI GAZDASÁGOKBAN**

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1. INTRODUCTION

1.1. MOTIVATIONS BEHIND THE CHOICE OF TOPIC

There is no doubt that digitalisation and Information and Communication Technologies (hereinafter ICT) have become crucial in driving economic growth (Vu et al. 2020), improving the competitiveness of the economy (Boikova et al. 2021) and creating sustainable development (Mondejar et al. 2021) for the last couple of decades. Humanity has been moved into an emerging ‘virtual world’ of socio-economic development in which online infrastructure, virtual trade and online markets grow in importance (Øverby–Audestad 2021). On the one hand, digitalisation is an opportunity to reduce costs, provide new services, establish new business models and technologies, break out poverty, and so on. On the other hand, the access, use and benefit of ICT are disproportionate (Nevado-Peña et al. 2019), and many are benefiting much less and fall behind; thus, it is no surprise that there is also a sorting out in every society.

The adoption of telecommunication and use of ICT open broad avenues also for regional development by giving local production system greater competitiveness and efficiency (Capello–Nijkamp 1996, Yilmaz–Dinc 2002, Capello 2016). However, new threats arise as technologies advance; for instance, digitalisation raises the question of *digital divide* in every society, whereby some people and some places – especially geographical space without technology – are being ‘left out’ of the new information economy, resulting in increasing development gaps between regions (Stimson et al. 2006). Besides, a quick spread of the COVID-19 crisis and its consequences accelerated *digital transformation* (Agostino et al. 2021); this has become especially important when the governments of countries have implemented extraordinary measures, like the lockdown or social distancing, which has increased the application of technology (Ha, 2022).

Geographic digital divide situations are occurring in many parts of the world, so also in the European Union (hereinafter EU) (Várallyai et al. 2015, Boikova et al. 2021). Avoiding the deepening of the digital divide and facilitating digital transformation have been and are still of high priority in the European common market. In the EU, the aspect of digitalisation – as a process of applying digital technologies and infrastructures in diverse dimensions of business, households and individuals – has come into focus for the last two decades. Both the European Council and the European Commission consider that ICT are critical to improving the competitiveness of the European industry and meeting the demands of its

society and economy. Accordingly, the European Commission set out priority areas in strategic agendas (cf. Lisbon Strategy, Europe 2020 Strategy, A new strategic agenda for the EU 2019–2024¹) as well as political guidelines (cf. Commission priorities for 2019–2024²) to shift to a knowledge-based society through the use of the key elements of modern economies (e.g. Internet, e-business, e-commerce, research and development, telecommunication, e-inclusion etc.).

My personal motivation in choosing this topic comes from many reasons. As a student of the International Economy and Business MA programme, I find it important to better understand digital transformation and digital divide across European countries and regions, especially in times we live in now.

The COVID-19 pandemic has had a tremendous impact on the world and life; it caused an enormous shift in the economic life, and I have eagerly followed everything that was happening. The virus originated in 2019 from China, and by the end of January 2020 it reached Europe. Not even a month later, the virus infected people in all European countries. Apart from complete lockdowns, countries opted for less severe measures such as school closures and social distancing measures. Nonetheless, all restrictions had an enormous impact on the European economy, such as job losses, decrease in production and productivity, trade limitations, as well as complete shutdown of certain industries.

The COVID-19 pandemic has had a significant influence on computer and social networks. Thus, I would like to know more about how the pandemic affected and changed households' and individuals' attitude towards ICT usage. I believe that an in-depth investigation on the smallest unit of society (level of households and individuals) is crucial for getting a better insight into the current state of the digital transformation. I believe that digitalisation will affect social inclusion and integration of the most vulnerable groups of societies in the following years and decades. I am very sensitive to this topic, and I have thoughts about it.

Furthermore, I am interested in getting an insight in the current state (level) of digital transformation and characteristics of digital divide in the EU Member States and regions, with special focus on some of the countries that joined the EU after the millennium. This

¹ Priority 2 (Developing a strong and vibrant economic base) aims to build a resilient economy by embracing digital transformation. Available at https://european-union.europa.eu/priorities-and-actions/eu-priorities_en

² Commission political priorities include *A Europe fit for the digital age* priority that focuses on embracing digital transformation by investing in businesses, research and innovation, reforming data protection, empowering people with the skills necessary for a new generation of technologies and designing rules to match. Available at https://european-union.europa.eu/priorities-and-actions/eu-priorities_en

group of European countries are often termed as ‘*transition economies*’ as they discovered the power of market economy in the late 1980s and early 1990s after the collapse of command economies and centrally planned (bureaucratically controlled) systems.

1.2. RESEARCH AIMS, METHODS AND STRUCTURE

The main purpose of this work is *to empirically examine the level of digital development, the status of digital transformation and spatial characteristics of digital divide on regional (NUTS-2³) level in European transition economies through measuring the recent changes (2016–2021) in the ICT usage in households and by individuals*. The specific research questions of the study are as follows:

- What is ‘digital divide’ and what factors influence digital divide? How can it be assessed and measured?
- Does ‘digital divide’ exist in the EU, as well as in its Member States and regions? How can European transition economies and regions of these countries be characterised by the level of digitalisation?
- What is the role of the EU in promoting digital development and digital transformation? What are the related objectives and fields of action? How does the EU financially support digitalisation?
- How can the usage of ICT be captured and measured on the level of regions?
- How large are the differences within the regions of European transition economies? In which way and to what extent do these countries differ from the European average?
- Does the COVID-19 outbreak have any short-term influence and impact on digital transformation in this group of regions?

In this work, the term ‘transition economies’ covers 11 Central and South-East European countries (hereinafter CSE-11), which joined the EU in the 2000s. In other words, CSE-11 includes countries that are Member States of the EU either since 2004, 2007 or 2013: Bulgaria (BG), Croatia (HR), Czechia (formerly Czech Republic) (CZ), Estonia (EE), Hungary (HU), Latvia (LV), Lithuania (LT), Poland (PL), Romania (RO), Slovakia (SK) and Slovenia (SI).⁴

³ NUTS is Nomenclature of territorial units for statistics. It is a geocode standard for referencing the subdivisions of countries for statistical purposes.

⁴ International Monetary Fund (2000) and World Bank (2002) classify several other countries as “transition economies”, such as countries in the former Soviet Union (Commonwealth of Independent States), in Asia

On the one hand, research methods are literature review on the terminological background and dimensions of digital divide and measurement of digital competence, as well as textual analysis for investigating the content of existing policy documents, actions and initiatives, assessment methods, key achievements and financial background in shaping the EU's digital future.

On the other hand, quantitative analysis techniques are called into service to measure ICT usage in households and by individuals empirically on NUTS-2 regional level in CSE-11 countries. The dataset considers the following three years: 2016 (baseline year), 2019 (last year of economic boom before the COVID-19 outbreak) and 2021 (data available for the last year). The empirical analysis is based on secondary data collection from Eurostat database. Regional breakdowns are available for a selection of indicators disseminated in the regional tables (*Regional statistics by NUTS classification / Regional digital economy and society (reg_isoc)*). In this study, 7 indicators from regional ICT statistics are selected to capture the status (level) of digitalisation and indicate digital divide.

Both univariate and multivariate statistical analyses are developed to get an insight into the regional patterns of change, regional diversity, issue of balances versus imbalances, and issue of regional convergence versus divergence. For multivariate analysis, multidimensional scaling (MDS) is used as explanatory tool and assessment technique.

The remainder of my work is organised as follows. Chapter 2 and 3 review related works. Chapter 4 introduces the data and applied methods. Empirical results are provided in Chapter 5. Key findings derived from univariate and multivariate statistical analyses are presented separately: in subchapters 5.1. to 5.3., as well as in subchapter 5.4. Results are demonstrated visually on maps and scatter plots throughout this part of my study. Chapter 6 concludes the work, summarizes the limitations, and highlights future research agenda. In the Annexes 1 to 9, further information on data and calculations, as well as supporting visual material corresponding to univariate statistical procedures are provided.

(e.g. Cambodia, Vietnam), as well as non-EU countries in Europe (e.g. Albania, Bosnia and Herzegovina, Northern Macedonia); however, in this work, these countries are not considered.

2. CONCEPTUALIZING AND MEASURING DIGITAL DIVIDE

2.1. DIGITAL DIVIDE: TERMINOLOGICAL BACKGROUND

According to the standard definition proposed by the OECD (2001), digital divide refers to the gap between individuals, households, businesses, as well as geographic areas at different socio-economic levels with regard both to their opportunities to access ICT and use of the Internet for a wide variety of activities. Accordingly, digital divide emerges both between and within countries, and the differences between opportunities for connectedness and availability of ICT for people derive from several diverse sources and reasons.

A very simple explanation by Norris (2001) is as follows: digital divide is any and every disparity within the online community. As research on the subject evolved, as well as new aspects of digitalisation emerged, interpretations were revised. For instance, Fuchs and Horak (2007, 15–16) give a complex explanation of digital divide: it refers to “unequal patterns of material access, usage capabilities, benefits, and participation concerning ICT” that are “due to the asymmetric distribution of economic (money, property), political (power, social relationships), and cultural capital (skills)”.

As Bruno et al. (2011) point out, the debate on the definition of digital divide among practitioners and scholars from different academic circles is constant as the concept of digital divide is dynamic and evolving, shifting from focusing solely on access to technological resources to a multidimensional understanding of inequality and includes a complex set of divides caused by a variety of factors.

2.2. DIMENSIONS OF DIGITAL DIVIDE

Widespread research in academic circles and policy discussion occur about the growing importance of digital divide. Of the firsts, Riggins and Dewan (2005) systematise the different approaches towards digital divide and conclude that research topic is of high importance.

Norris (2001) underlines the multidimensionality of digital divide and distinguishes three dimensions of digital divide (Table 1.):

1. *Global divide among countries* emerges due to disparities between industrialized and developing countries. Compared to advanced economies, developing countries entered the digital world decades later and fail to catch up eventually. This group of countries still lack the necessary skills, resources and infrastructure to better invest in the information society.

2. The *social stratification within countries* is a challenge emerged within the national borders mainly due to the uneven distribution of technological resources. Significant differences can be detected in Internet penetration according to income and educational levels, between racial and ethnic groups, old and young generations, single and dual-parent families, as well as people with and without disabilities. Accordingly, certain groups are steadily excluded, such as poorer neighbourhoods, working-class households and peripheral rural communities.
3. Furthermore, within the online community, *democratic divide* is an emerging problem between those who use and do not use Internet to engage and participate in public life.

Table 1.: Dimensions of digital divide

Dimensions	Interpretation
<i>Global divide among countries</i>	Dichotomy of integration into the digital world between developed and developing countries.
<i>Social stratification within countries</i>	Differences between technological resource availability of certain social groups within a country.
<i>Democratic divide</i>	Difference between people who use and do not use digital networks for civic and public engagement.

Source: Own elaboration based on Norris (2001) pp. 3–14.

Wei et al. (2011) also reveal the levels of digital divide; according to their classification, digital divide can be captured on three levels:

1. *Individual level*: the gap is originally between individuals. Certain people and group of people are technologically, sociologically or economically disadvantaged; therefore, they lack access to ICT;
2. *Organisational level*: on the one hand, some organisations can utilise ICT for gaining advantage against rivals or changing the circumstances within their industry; on the other hand, there are several other organisations that lag behind from the technological point of view and are in strategically disadvantageous position;
3. *Global level*: there are significant differences between countries. Some countries have already initiated actions successfully to promote digital development and competence, while other countries still struggle with providing areas – mainly rural areas – with Internet broadband access. This phenomenon can be observed not only on country level, but also on regional level.

According to Lucendo-Monedero et al. (2019), the initial understanding of the digital divide was solely restricted to the *conditions* available in a certain territory, namely the ability to access information (known as *first-level digital divide*, also referred to as *access divide* or *narrow sense of digital divide*). According to Scheerder et al. (2017), the common practice is to capture the availability or unavailability of ICT as the basis of measuring digital divide. The authors emphasise that in several countries of advanced economy, the first level of digital divide has lost its fundamental role in creating inequalities as broadband access and the availability of digital devices has become prevalent.

The next step in understanding digital divide is to consider the different motives in ICT usage. This level is frequently referred to as *second-level digital divide* or *capability divide*. Moreover, the accumulation of digital competencies can be termed as ‘digital capital’ (Ragnedda 2018). These competencies consist of information, communication, safety, content creation, problem-solving and the usage of digital technology. From this viewpoint, digital competencies refer to a set of internalized ability and aptitude.⁵

As research on the subject evolved, another crucial factor emerged to describe the differences between individuals and households in connection with ICT usage, namely the *benefits* from ICT usage. For example, van Deursen et al. (2014) examine the importance of certain sets of skills (communication, operational, formal, information and strategic) that influence the individual benefits of Internet use. This stage of digital divide can be referred to as *third level of digital divide* or *outcome divide*.

Table 2. summarises the main features of the three-level digital divide framework.

Table 2.: The Three-Level Digital Divide Framework

Level	Kinds of digital divide				
<i>Individual level</i>	First-level digital divide: digital access	⇒	Second-level digital divide: digital capability	⇒	Third-level digital divide: digital outcome (benefits)
<i>Organizational level</i>					
<i>Global level</i>					

Source: Own elaboration based on Wei et al. (2011), Scheerder et al. (2017) and Lucendo-Monedero et al. (2019).

As Vicente and López (2011) notice, previous research on the subject focused on two relevant issues: on the one hand, the measurement of digital divide regarding its extent,

⁵ The possession of digital capital affects both the second and the third level of digital divide. Besides, higher level of Internet use proficiency enables to convert digital capital to other forms of capital (e.g. economic, social, relational capital) (Ragnedda 2018). Furthermore, according to Park (2017), digital capital can be understood as an integral digital ecosystem that is formed based on human interaction during which digital technologies are used as platform.

evolution and pace, on the other, the explanation of digital divide through the assessment of its drivers. The authors reveal that ICT adoption is determined by the following factors:

- differences in the wealth of territories as well as individuals;
- income that affects the infrastructure and diffusion of ICT technologies;
- level of education of a territory;
- socio-demographic factors and population size, level of urbanization, population density, age of the population, racial construction;
- proportion of younger generations within the society;
- network effects (spillover) as the extent of ICT diffusion of the surrounding environment influences the likelihood of a household to acquire such technologies;
- institutional and governmental factors, commercial openness, and cultural elements.

Capello (2016) stresses that the effects of ICT on regional disparities is still dubious. In the past 15–20 years two currents of thought have interpreted the impact of ICT on regional disparities:

1. The first viewpoint maintains that new ICT are able to resolve the problem of peripherality. The greater access to information, knowledge and specific services to production reduce the disadvantages of a peripheral location;
2. The second opinion argues that stronger areas of great potential demand and of more knowledge have the ability to better exploit technologies, so the gap widens between the core and the periphery.

The explanation of digital divide on regional basis have recently been put in the spotlight as fresh articles in the field show.

For instance, Nevado-Peña et al. (2019) suggest that the relationship between the quality of life of citizens and the technological characteristic of areas is clearly detectable as the most technologically developed societies are happier in general. However, the elimination of the gap between regions is a challenging task and can only be successful when paired with the promotion of research and development (R&D) and investment in the training of people.

According to Mondejar et al. (2021), advanced digital technologies – such as Internet of things (IoT), big data management and artificial intelligence (AI) – are perfect means to

enhance sustainable development. The contribution of these technologies to the development of agriculture, smart cities, water accessibility, energy efficiency, green manufacturing, healthcare, as well as to fight against climate change is undeniable; however, without ensuring equal access to data, the process of digitalisation can lead to the further increase of digital divide instead of closing the gap.

Furthermore, Øverby and Audestad (2021) notice that although there has been an increase in the access to Internet worldwide over the last decade, the key issue to tackle is to provide the developing areas with access to the Internet as there are still significant differences – an existing digital divide – within and between countries.

Bannykh and Kostina (2022) point out that modern researchers claim that there are already four levels of the digital divide due to the ongoing digital changes: geographic, technological, cultural and spiritual. The authors underline the increased vulnerability of certain social groups, such as elderly people and residents of small settlements in peripheral areas.

In addition, alongside the digital shift in technology, there has been a change in narrative with user-experience, engagement and co-creation taking place in service design and technology as COVID-19 has affected all areas of public service delivery, with public authorities having to move their operations wholly or in partly online. Both governments and organisations had to act and react over a short period (Agostino et al. 2021). Without doubt, the COVID-19-induced digital acceleration is an opportunity to follow how digital gaps changed in the last couple of years.

2.3. MEASURING THE LEVEL OF DIGITALISATION: AN OVERVIEW OF INDEXES

Scholars use various measures to quantify the level of digitalisation. There are several indicators that capture the state of digital competence of the resident population, such as the number of people using the Internet, the number of people having access to the Internet from home, and the number of people selling or ordering services online, and so on.

According to Bannykh and Kostina (2022), digitalisation can be measured on two different levels: on micro and macro level. The first comprises indicators related to digital literacy of individuals, while the second includes the availability and quality of digital infrastructure, the level of digital society and digital economy. In addition, a grouping of indicators with respect to the tangible (hard) and intangible (soft) infrastructure can be created. The first reflects the available devices, while the second refers to the usage and knowledge of such devices.

To get a deeper understanding in the level of digitalisation of households and by individuals, certain composite indices have been created by different institutions as follows:

1. *Digital Skills Indicator*⁶: It covers four competence domains: information, communication, content creation and problem solving. Directorate-General for Communications Network, Content and Technology (DG CONNECT) and the Eurostat Information Society Working Group agreed to create and publish this indicator. Data is collected through the ICT survey on ICT usage by households and individuals.
2. *Digital Competence Framework*⁷: It was created within the framework of the DigComp 2.1 proposal defined by European Digital Competence Framework for Citizens; however, recently the complete DigComp 2.2 framework has become available. The DigComp framework identifies the key components of digital competence in 5 areas:
 - 1) information and data literacy;
 - 2) communication and collaboration;
 - 3) digital content creation;
 - 4) security;
 - 5) problem solving.

Figure 1. summarises the DigComp conceptual reference model with 21 competencies.

⁶ Digital Skills Indicator. Available at <https://digital-strategy.ec.europa.eu/en/library/new-comprehensive-digital-skills-indicator>

⁷ DigComp Framework. Available at https://joint-research-centre.ec.europa.eu/digcomp/digital-competence-framework_en

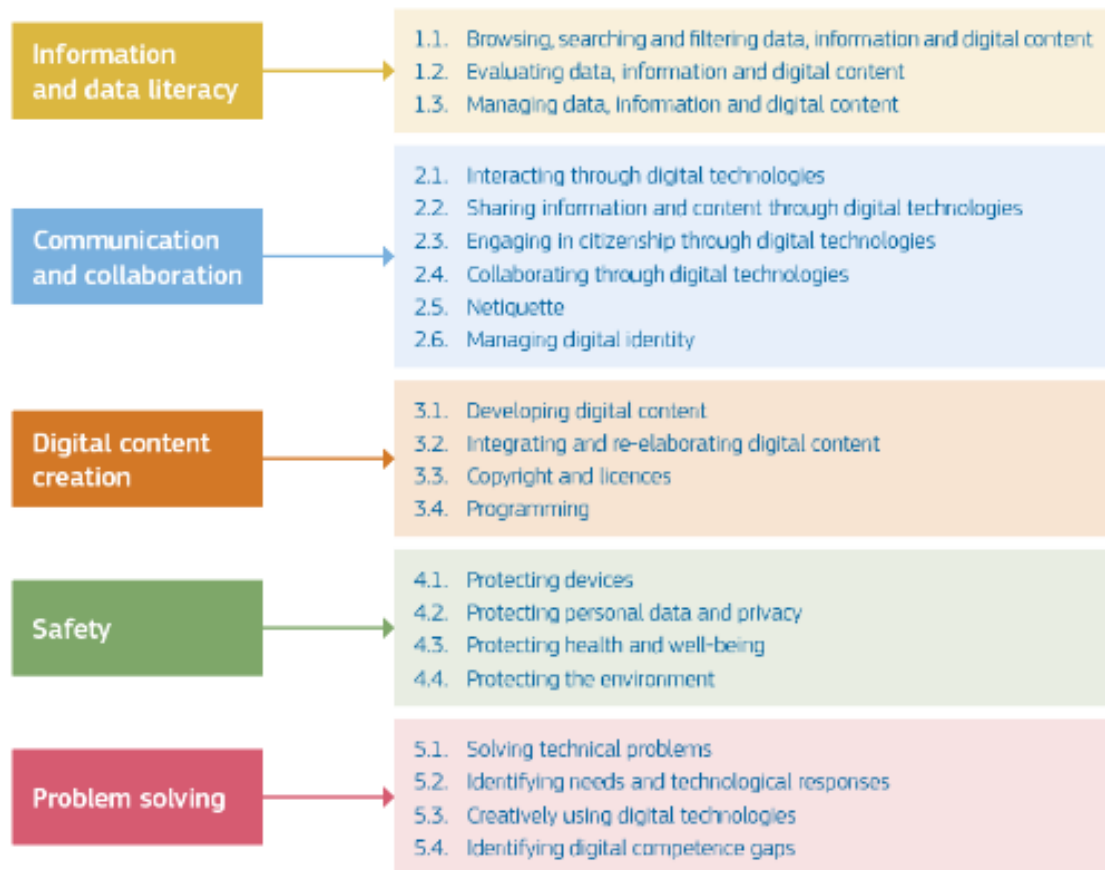


Figure 1.: DigComp 2.2 conceptual reference model

Source: https://joint-research-centre.ec.europa.eu/digcomp/digcomp-framework_en

3. *ICT Development Index (IDI)*⁸: This is a composite index proposed by International Telecommunication Union (ITU) that was published from 2009 to 2017. IDI combined 11 indicators into a composite score. It was used for monitoring and comparing developments in ICT between countries and over time. Figure 2. presents the indicators, reference values and weights of IDI.

⁸ The ICT Development Index. Available at <https://www.itu.int/en/ITU-D/Statistics/Pages/IDI/default.aspx>

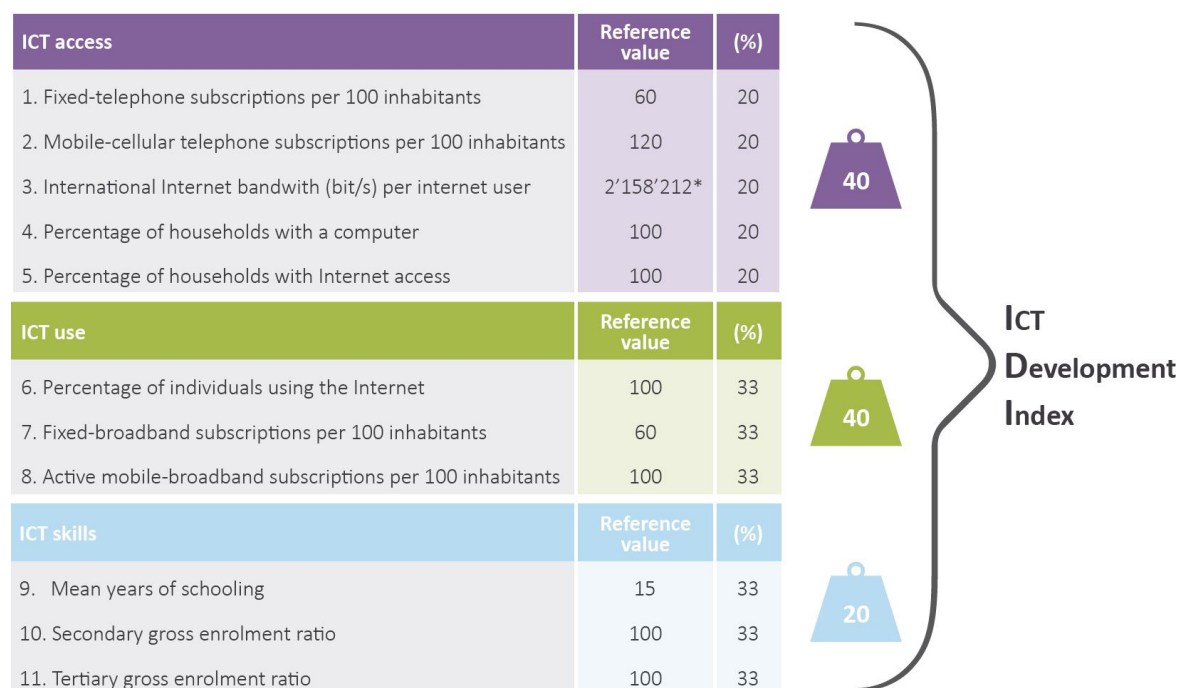


Figure 2.: IDI Development Index

Source: <https://www.itu.int/en/ITU-D/Statistics/Pages/publications/mis2017/methodology.aspx>

4. *Global Cybersecurity Index (GCI)*⁹: This is a trusted reference provided by ITU Global Cybersecurity Agenda that measures the commitment of 194 countries to cybersecurity. It is used to raise awareness of the importance and different dimensions of the issue. As cybersecurity has a broad field of application, cutting across many industries and various sectors, each country's level of development or engagement is assessed along five pillars:

- 1) legal measures;
- 2) technical measures;
- 3) organizational measures;
- 4) capacity development;
- 5) cooperation.

⁹ Global Cybersecurity Index. Available at <https://www.itu.int/en/ITU-D/Cybersecurity/Pages/global-cybersecurity-index.aspx>

3. ACTIONS OF THE EU IN THE FIELD OF DIGITAL DEVELOPMENT

3.1. POLICIES AND ACTIONS IN SUPPORT OF DIGITAL DEVELOPMENT IN THE EU

The institutions of the EU consider that ICT are critical for improving the competitiveness of European industry in meeting the demands of its society and economy. The contribution of ICT to the European economy has been fundamental for the development of knowledge-intensive products and services since the last couple of decades. There has been an important need to address ICT-related skills (e-skills) issues to ensure that every citizen is digital literate in a lifelong learning context (e-inclusion). Moreover, key enabling technologies have been considered to be essential in a shift to a low carbon economy.

To efficiently promote digital transformation and counteract against existing digital divide, which can be observed in the EU according to recent studies (e.g. Várallyai et al. 2015, Boikova et al. 2021), it is crucial to identify the manner in which the EU influences digitalisation. One of the first initiatives, *i2010* used to be a EU policy framework for the information society and media. It promoted the positive contribution that ICT can make to the economy, society and personal quality of life (CEC 2005). Further policy actions in the field have been taken over the 2010s and at the beginning of the 2020s.

3.1.1. A Digital Agenda for Europe

The Digital Agenda for Europe (hereinafter Agenda, EC 2010a) was launched by the European Commission as a flagship initiative of the Europe 2020 Strategy (EC 2010b). The Agenda was created to identify the key enabling role of ICT that are crucial for reaching the priorities of the Europe 2020 Strategy.

The Agenda was based on the important issue of developing the EU in the field of digitalisation. Accordingly, seven action areas were set out and elaborated in detail for boosting the EU's social and economic performance with the help of digitalisation. Continuous engagement and commitment were required on the following levels: EU, Member States and regions. As transformations are inevitable to increase the digital economy and society, the Agenda aimed at creating the adequate circumstances and preparing the common market to the challenges of the following decades. One of the most important aspects of digitalisation was outlined as follows: the EU should use of the Internet more efficiently as it became an essential medium of economic and societal activity.

The expected results of the Agenda include spurring innovation, economic growth and improvements in the daily lives of citizens and businesses. Going further, reaching the goals of the Agenda can contribute to several fields of life of Europeans, such as better healthcare,

safer and more efficient transport solutions, cleaner environment, new media opportunities and easier access to public services and cultural content.

On the one hand, it was highlighted that the ICT sector contributes to the European GDP with a remarkable share (5%), as well as plays an enabling role as it affects how other sectors operate. On the other hand, the social impact of the sector cannot be underestimated, which can be confirmed by the increasing number of daily Internet users and percentage of Europeans owning mobile phones. The importance of digital devices and the online world is expected to increase even further; accordingly, the Agenda compares the revolutionary impact of high-speed networks at present to the development of electricity and transportation networks previously.

The Agenda proposes a virtuous cycle of the digital economy that includes the main components of the process towards an increasingly digital economy and society. The three pillars within the cycle are as follows:

1. *Creation of Content and Borderless Services*: attractive content and services are to be made available in an online environment that is interoperable and borderless;
2. *Increase of service demand*: this emerges as the consequence of the first pillar; the demand for higher speed and capacity is formed on the basis of consuming online content and using services via Internet;
3. *Roll-out of networks*: while the second pillar captures the demand, and the third one matches the supply with it, as it opens the way for exploiting higher speeds via innovative services.

According to the Agenda, there are still serious challenges for the EU as the single market, which was established before the appearance of the Internet, lacks completeness to the online world. It is a great concern that Europe is not adequately equipped in the ICT sector to participate in the global competition for investments, jobs and economic influence. Approximately 30% of Europeans have not used the Internet yet, and there is only 1% penetration of high-speed network (compared to Japan: 12%, South Korea: 15%). Besides, the ICT research and development budget of the EU only counts for 40% of the US level.

While finding the causes of this lagging position, through consultation with stakeholders and using the insights of previous documents (e.g. Granada Declaration, the European Parliament Resolution), seven obstacles were identified that negatively impact the possibilities of the EU to exploit the chances in ICT.

These barriers are as follows:

1. *Fragmented digital markets:*

- Europe is a patchwork of national online markets;
- The elimination of regulatory barriers is needed to reach the flow of commercial and cultural content across borders;

2. *Lack of interoperability:*

- There are weaknesses in standard setting, public procurement and in the co-ordination between public authorities;

3. *Rising cybercrime and risk of low trust network:*

- Engagement of people in online activities is held back by their fear of unreliable networks;
- Europe needs to address new forms of cybercrime and develop responsive mechanisms;
- IT systems and networks are to be made resilient and secure to prevent all sorts of threats;

4. *Lack of investment in networks:*

- The roll-out and take-up of broadband at increasing speeds using fixed and wireless solutions is needed;
- Investment into the new very fast open and competitive Internet networks is crucial for the economy of the future;
- Incentives to promote private investments along with carefully targeted public investment are to be made;

5. *Insufficient research and innovation efforts:*

- The problems are underinvestment, fragmented efforts, lack of creativity of the SME sector, and the failure to convert research into market-based innovations;
- There is a need to build an innovation ecosystem where European companies can develop high quality products, and by that, demand is also to be increased;

6. *Lack of digital literacy and skills:*

- The threat of a growing shortage in ICT skills along with the digital literacy deficit is faced by Europe;

- These are obstacles for productivity growth, as the multiplier effect of ICT take-up is locked by the exclusion of EU citizens from the digital society and economy;

7. *Missed opportunities in addressing societal challenges:*

- The efficient exploitation of ICT could lead the EU towards the solution to problems such as climate change and environmental degradation, ageing population and its pressure on the healthcare system, inefficient public services and the social exclusion of people with disabilities.

Key actions are the most important tasks on certain action areas defined by the EC. The ones that are of high relevance in light of the current topic are as follows:

- *Key Action 8 (KA8)*: Adopt a Broadband Communication in 2010 that lays out a common framework for actions at EU and Member State to meet the Europe 2020 broadband targets. For the EC, this includes work on the funding of high-speed broadband through EU instruments, attraction of capital through credit enhancement, proposing a European Spectrum Policy Programme, encouraging investment in Next Generation Access (NGA) networks. Member States should develop national broadband plans to meet the Europe 2020 targets, facilitate broadband investment on national levels, utilise the Structural and Rural Development Funds, implement the European Spectrum Policy Programme and the NGA Recommendation;
- *Key Action 10 (KA10)*: Propose digital literacy and competences as a priority for the European Social Fund regulation (2014–2020);
- *Key Action 13 (KA13)*: Undertake pilot actions to equip Europeans with secure online access to their medical health data by 2015 and to achieve widespread deployment of telemedicine services by 2020;
- *Key Action 14 (KA14)*: Propose a Recommendation defining a minimum common set of patient data for interoperability of patient records to be accessed or exchanged electronically across Member States by 2012;
- *Key Action 16 (KA16)*: Propose by 2012 a Council and Parliament Decision to ensure mutual recognition of e-identification and e-authentication across the EU based on online ‘authentication services’ to be offered in all Member States (which may use the most appropriate official citizen documents).

Table 3. presents the structure of the Agenda with the action areas, sub-areas and the required key actions (KA).

Table 3.: The structure of the Digital Agenda for Europe

Action area	Sub-areas	Key actions
<i>1. A vibrant digital single market</i>	1.1 opening up access to content	KA1
	1.2 making online and cross border transactions straightforward	KA2; KA3
	1.3 building digital confidence	KA4
	1.4 reinforcing the single market for telecommunication service	
<i>2. Interoperability and standards</i>	2.1 Improving ICT standard-setting	
	2.2 Promoting better use of standards	
	2.3 Enhancing interoperability through coordination	KA5
<i>3. Trust and security</i>		KA6; KA7
<i>4. Fast and ultra-fast Internet access</i>	4.1 Guarantee universal broadband coverage with increasing speeds	
	4.2 Foster the deployment of NGA networks	
	4.3 Open and neutral Internet	KA8
<i>5. Research and innovation</i>	5.1 Step up efforts and efficiency	
	5.2 Driving ICT innovation by exploiting the single market	
	5.3 Industry-led initiatives for open innovation	KA9
<i>6. Enhancing digital literacy, skills and inclusion</i>	6.1 Digital literacy and skills	
	6.2 Inclusive digital services	KA10; KA11
<i>7. ICT-enabled benefits for EU society</i>	7.1 ICT for environment	KA12
	7.2 Sustainable healthcare and ICT-based support for dignified and independent living	KA13; KA14
	7.3 Promoting cultural diversity and creative content	KA15
	7.4 eGovernment	KA16
	7.5 Intelligent Transport Systems for efficient transport and better mobility	

Source: Own elaboration based on EC (2010a).

3.1.2. A Europe fit for the digital age and the 2030 Digital Compass

In 2019, the EC set four priority areas that shape the political and policy agenda until 2024¹⁰. Priority 2 (*Developing a strong and vibrant economic base*) aims to build a resilient economy by embracing digital transformation. Besides, the *von der Leyen* European Commission determined six political priorities derived from the European Council's strategic agenda and discussions with the political groups of the European Parliament. Priority 2 (*A Europe fit for the digital age*) aims to embrace digital transformation by investing in businesses, research and innovation, reforming data protection, empowering people with the skills necessary for a new generation of technologies and designing rules to match.

¹⁰ European Union priorities 2019–2024. Available at https://european-union.europa.eu/priorities-and-actions/eu-priorities_en

The EU's digital strategy was formed with the purpose of facilitating the digital transformation of people and businesses, while supporting the climate neutral Europe by 2050. In addition, Europe aims to strengthen its digital sovereignty and set the standards instead of accepting them. The most relevant issues in light of this topic are as follows:

- *Digital skills and jobs*: The EC set the goals to tackle the digital skills gap and contribute to the improvement of digital skill levels in Europe by promoting projects and strategies;
- *Connectivity*: By 2030 the EU committed to Europe being the most connected continent. The main goal is for every household to have access to high-speed Internet coverage by 2025 and gigabit connectivity by 2030;
- *Digital Identity for all Europeans*: Creating a European Digital Identity that is available to every citizen, resident or business, widely usable as a way of identification, or as a proof of eligibility of access to services, giving full control to citizens in choosing which personal data and certificates are their willing to share.

The EC formulated its vision for shaping Europe's digital future (EC 2020a)¹¹. With this document the EC set out three key objectives that can lead Europe through the digital transformation while benefiting people and respecting values and helping the EU become a trendsetter. The important objectives are as follows:

1. *Technology that works for people*: Introduction of technology that people benefit from in their daily lives, an economy that masters and shapes technology in line with the European values;
2. *A fair and competitive economy*: A single market that supports companies in developing, marketing and using digital technologies, products and services, respecting consumer rights;
3. *An open, democratic and sustainable society*: Creating an environment that enhances democratic values and respects the fundamental rights, contribute to sustainable, climate-neutral and resource efficient economy.

¹¹ Available at https://ec.europa.eu/info/sites/default/files/communication-shaping-europes-digital-future-feb2020_en_4.pdf

In March 2021, the *2030 Digital Compass* (EC 2021) was released to lead Europe through the digital transformation. Table 4. presents the structure of the Compass. The Compass revolves around four cardinal points:

1. A digitally skilled population and highly skilled digital professionals;
2. Secure and performant sustainable digital infrastructure;
3. Digital transformation of businesses;
4. Digitalisation of public services.

Table 4.: The structure of the 2030 Digital Compass

Cardinal Point	Dimensions	2030 EU Target
1) <i>SKILLS</i>	ICT specialists	- 20 million+ ICT specialists - Gender convergence - 80% of population having basic digital skills
2) <i>INFRASTRUCTURE</i>	Connectivity	- Gigabit for everyone, 5G everywhere
	Semiconductors	- Double EU share in global production to 20%
	Data – Edge / Cloud	- 10,000 climate-neutral highly secure edge nodes
	Quantum computing	- First computer with quantum acceleration
3) <i>BUSINESS</i>	Tech up-take	- 75% of enterprises using Cloud/AI/Big Data
	Late adopters	- 90%+ SMEs reach at least basic level of digital intensity
	Innovators	- Grow scale-ups and finance to double EU Unicorns
4) <i>GOVERNMENT</i>	Government as a platform	- 100% of key public services online - 100% of citizens having access to medical records - 80% of citizens using digital ID

Source: Own elaboration based on EC (2021).

3.2. THE DIGITAL ECONOMY AND SOCIETY INDEX (DESI)

DESI¹² assessment system was created with the aim to monitor the digital progress of EU Member States. The yearly DESI reports have been released since 2014 with country profiles and thematic chapters of overall European analysis according to the components of DESI. The index is used for researching the digital transformation of Member States, industrial sectors, and socio-economic dimensions of the EU that are important for the transparent execution of the improvement of competitiveness. The key areas of DESI are as follows (Table 5.):

1. *Human capital*: Internet user skills along with advanced skills and development are monitored across the EU;

¹² The Digital Economy and Society Index (DESI). Available at <https://digital-strategy.ec.europa.eu/en/policies/desi>

2. *Connectivity*: it is monitored by measuring the supply and demand of fix and mobile broadband;
3. *Integration of digital technology*: the integration of new technologies into businesses and e-commerce are assessed;
4. *Digital public services*: the goal is the use of digital public services.

Table 5.: Dimensions of the DESI

Human Capital	Internet use, basic and advanced digital skills
Connectivity	Fixed broadband, mobile broadband, and prices
Integration of Digital Technology	Business digitalisation and e-commerce
Digital Public Services	eGovernment and eHealth

Source: Digital Economy and Society Index, Eurostat¹³

According to Bánhidi et al. (2020), the advantage of DESI is its methodology, since it is general and applicable, allowing researchers to make comparisons between years or between the Member States. Although DESI is widely used among practitioners and policy makers, too, the index has certain limitations. Despite being the most suitable robust approach for analysing the EU's progress in the field of digitalisation, the index does not include information that is detailed enough to create an adequate deep analysis or to explain certain phenomena related to digitalisation. In addition, the composition of dimensions changes yearly, and there are differences between the approaches used by statistical offices.

The Digital Economy and Society Index 2022 shows that Member States have made progress in general, and – as it was found in comparison with the 2020 DESI results – the COVID-19 pandemic has left its mark on digital development, mainly by enhancing the process of digital transformation. However, the implementation of key digital technologies for businesses has remained at a low level. Thus, further efforts are needed for the full deployment of ubiquitous connectivity infrastructure and the advancement of insufficient digital skills as these phenomena can deepen the digital divide (EC 2022).

The relative progress of Member States over the period 2017–2022 is presented on Figure 3. On Figure 4. the overall 2022 DESI results are shown according to dimensions and countries.

¹³ Data Visualization Tool – Data & Indicators. Available at <https://digital-agenda-data.eu>

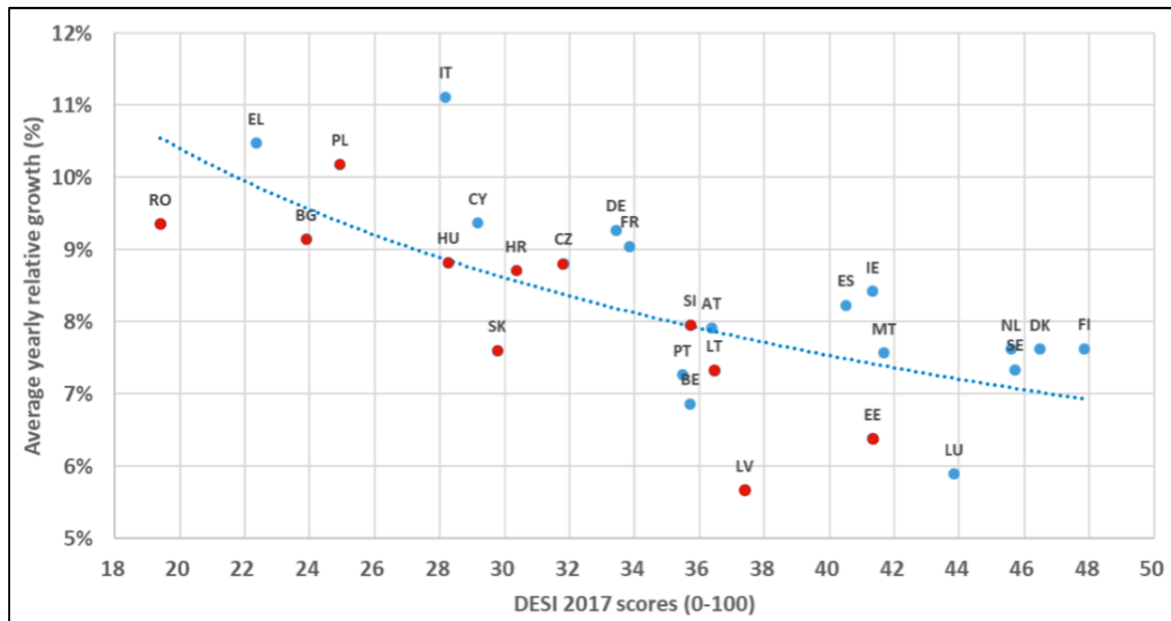


Figure 3.: DESI scores: average yearly relative growth, 2017–2022 (%)

Source: EC (2022) p. 17.

One can detect that with respect to the transition economies the initial scores were relatively higher in the Baltic states (Estonia, Latvia and Lithuania) as the results of these countries are much closer to the frontrunner North-Western European Member States. In addition, there is a clear divide between two groups of countries: the greater part of the CSE-11 countries belongs to the group with relatively low results at the baseline year, although higher annual growth rates can be detected in these countries. Poland, Czechia, Croatia and Slovenia are to be found above the blue line, which means that these countries managed to grow more than it was expected.

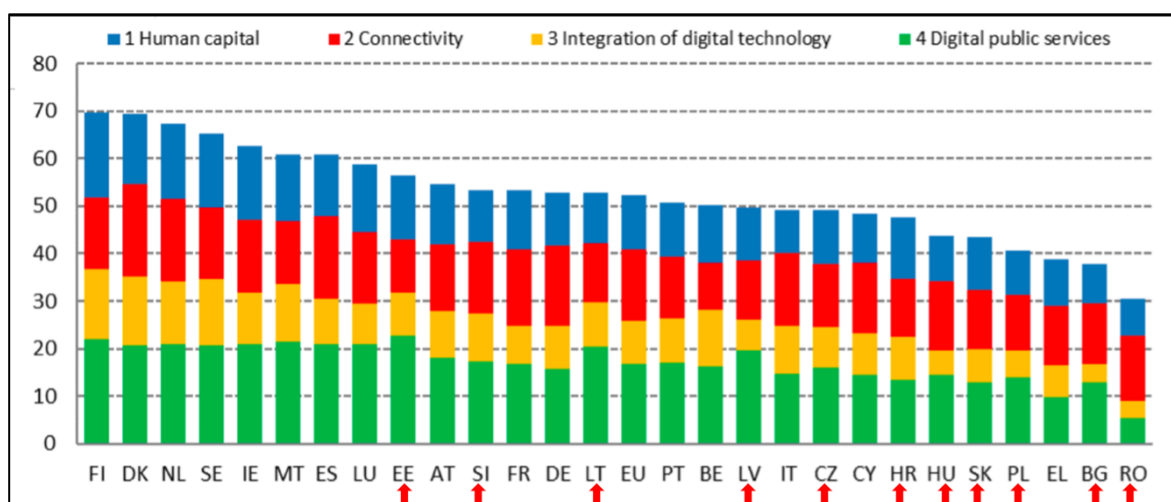


Figure 4.: Digital Economy and Society Index, 2022 (score)

Source: EC (2022) p. 19.

According to the ranking, the situation in the CSE-11 countries is unsatisfactory; however, Estonia, Slovenia and Latvia can be found above the EU average. Other CSE-11 countries are in lagging positions, and four out of the five worst performers belong to this group of countries, namely Romania, Bulgaria, Poland and Slovakia (plus Greece).

3.3. MULTIANNUAL FINANCIAL FRAMEWORKS AND EUROPEAN DIGITAL DEVELOPMENT

1. The 2014–2020 Multiannual Financial Framework (MFF)

As digital transformation became a field of key importance for the EU with the release of the Digital Agenda for Europe, substantial financial contribution from the EU was allocated for the execution of digital transformation within the MFFs. The 2014–2020 MFF contained the following six Headings:

- Heading 1: Smart and inclusive growth
 - Heading 1a: Economic, social and territorial cohesion
 - Heading 1b: Competitiveness for growth and jobs
- Heading 2: Sustainable growth: natural resources
- Heading 3: Security and citizenship
- Heading 4: Global Europe
- Heading 5: Administration
- Heading 6: Compensations

Heading 1a covered an amount of € 371.4 billion that is 34% of the overall MFF. The initiation called *Connecting Europe Facility* accounts for 12% of Heading 1a, and by that, it was the third largest share in this heading.

2. The 2021–2027 Multiannual Financial Framework (MFF)

The focus of this MFF has shifted in the sense that digitalisation and digital development became areas that have been considered crucially important for the future of the EU. The headings of this MFF were formed as follows (EC 2020b¹⁴):

- Heading 1: Single Market, Innovation and Digital
- Heading 2: Cohesion, Resilience and Values
- Heading 3: Natural Resources and Environment

¹⁴ Available at https://ec.europa.eu/info/sites/default/files/about_the_european_commission/eu_budget/mff_factsheet_agreement_en_web_20.11.pdf

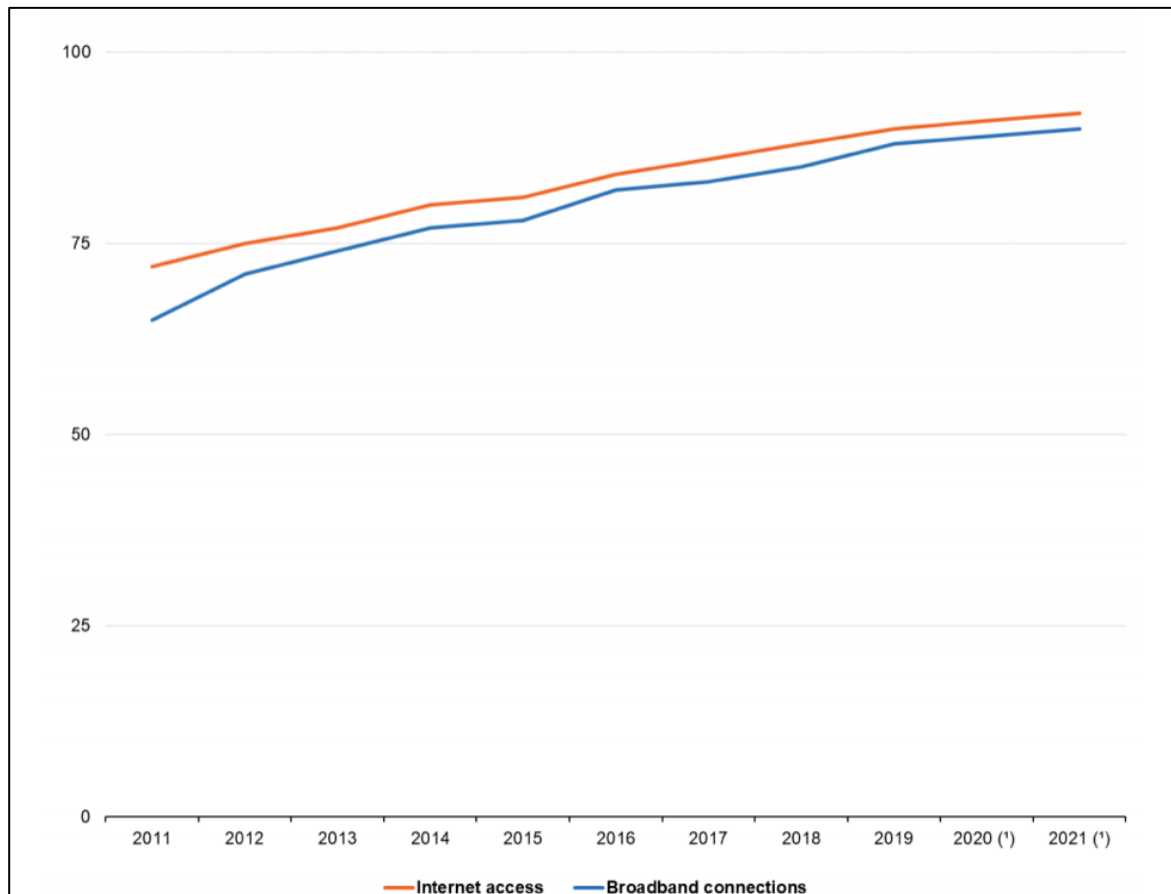
- Heading 4: Migration and Border Management
- Heading 5: Security and Defence
- Heading 6: Neighbourhood and the World
- Heading 7: European Public Administration

As one can detect solely by reading the names of the headings, digital development explicitly appears and among the most supported headings. Heading 1 received altogether € 143.4 billion of total allocation from MFF and Next Generation EU (NGU). In addition, in the period of 2021–2027 MFF, aspects related to climate change and digitalisation are handled as high priorities in each program; besides, 20% of funds from the Recovery and Resilience Facility (RRF) must be allocated for these purposes.

3.4. OVERVIEW OF LEVEL OF DIGITALISATION IN THE EU BASED ON EUROSTAT AND DESI

Internet access and broadband Internet connection are to be considered as the basis of knowledge-based informed society; accordingly, it is essential to analyse the change of the percentage of households having access to the Internet and broadband connection.

Data and trend related to Internet access and broadband Internet connections of households are shown during a ten-year period (2011 to 2021) on Figure 5. Based on the trendline, one may conclude that there has been an increase in the level the EU countries regarding both Internet access and broadband connections. As Eurostat reported, more than 50% of the EU citizens have had access to the Internet since 2007, and the ratio has been increasing ever since. In 2012, the proportion of households accessing the Internet was around 75%, then continued to increase and reached 80% in 2014. In overall, within the last ten years an increase of 20% can be observed. By taking a closer look at the trendline concerning broadband access, one can conclude that the proportion of households having this type of access has been growing at a faster pace; the increase was 25% from 2011 to 2021 with a proportion of 90% in 2021.



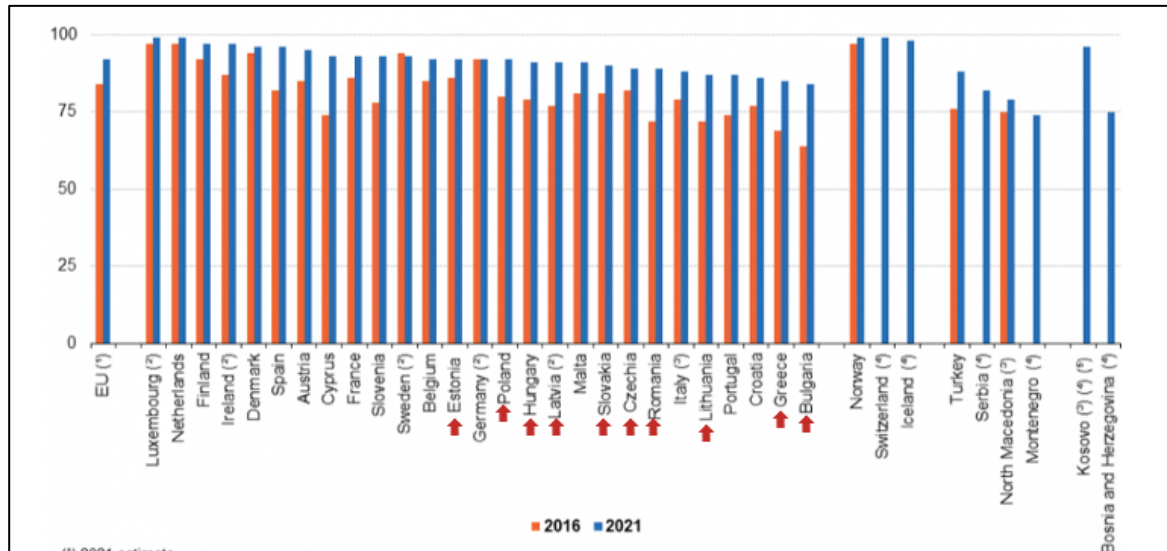
Note: (*) Estimation.

Figure 5.: Internet access and broadband Internet connections of households in the EU, 2011–2021 (% of households)

Source: Eurostat – Digital economy and society statistics¹⁵

As Figure 6. presents, Internet access of households increased from 2016 to 2021 in European countries. Regarding the performance of Member States in the CSE-11 group, one can conclude that these countries were not among the highest performers in 2016; however, the results from 2021 show quite positive outcomes as households had Internet access at above 84% in these countries. The highest increase was performed by Bulgaria, where the results from 2021 is more than 20% higher than the result from 2016. In 2021, three countries (Slovenia, Estonia and Poland) are above the EU average, or at least, at the same level (92%).

¹⁵ Eurostat – Digital economy and society statistics. Available at https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Digital_economy_and_society_statistics_-_households_and_individuals#Internet_access

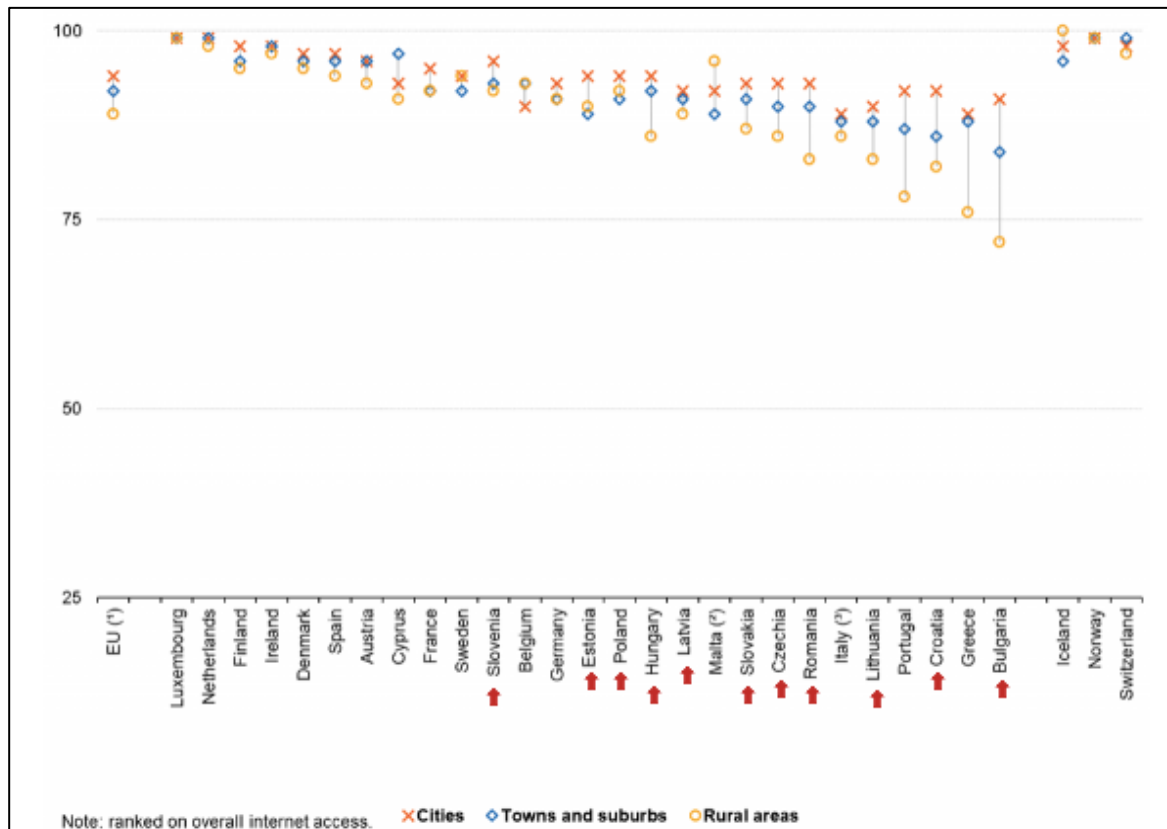


Notes: (1) 2021 estimation; (2) Break in the time series; (3) 2020 instead of 2021; (4) 2016: not available; (5) This designation is without prejudice to positions on status, and is in line with UNSCR 1244/99 and the ICJ Opinion on the Kosovo declaration of independence.

Figure 6.: Internet access of households, 2016 and 2021 (% of all households)

Source: Eurostat – Digital economy and society statistics

As this research puts the regional perspectives in the focus, it is important to understand the differences within the countries from an urbanisation point of view. On Figure 7. the existing urban-rural divide is presented regarding the access to Internet. With data from 2021, one can get insight into the current state of the divide. The figure shows that households in cities, towns and suburbs can be associated with high rates of Internet access (around 80–90%). In contrast, rural areas have relatively lower access rates than the previous types. In some CSE-11 countries, the dichotomy between the urban and rural areas is quite sharp. These are Bulgaria, Croatia and Romania; in these countries, the overall Internet access rate does not reach the EU average. Some exceptions from the standard divide are Estonia and Poland, where instead of rural areas having the lowest ratio of Internet use, it can be associated with towns and suburbs.



Notes: ranked on overall Internet access, (¹) Estimation; (²) Rural areas: low reliability; (³) 2020 instead of 2021.

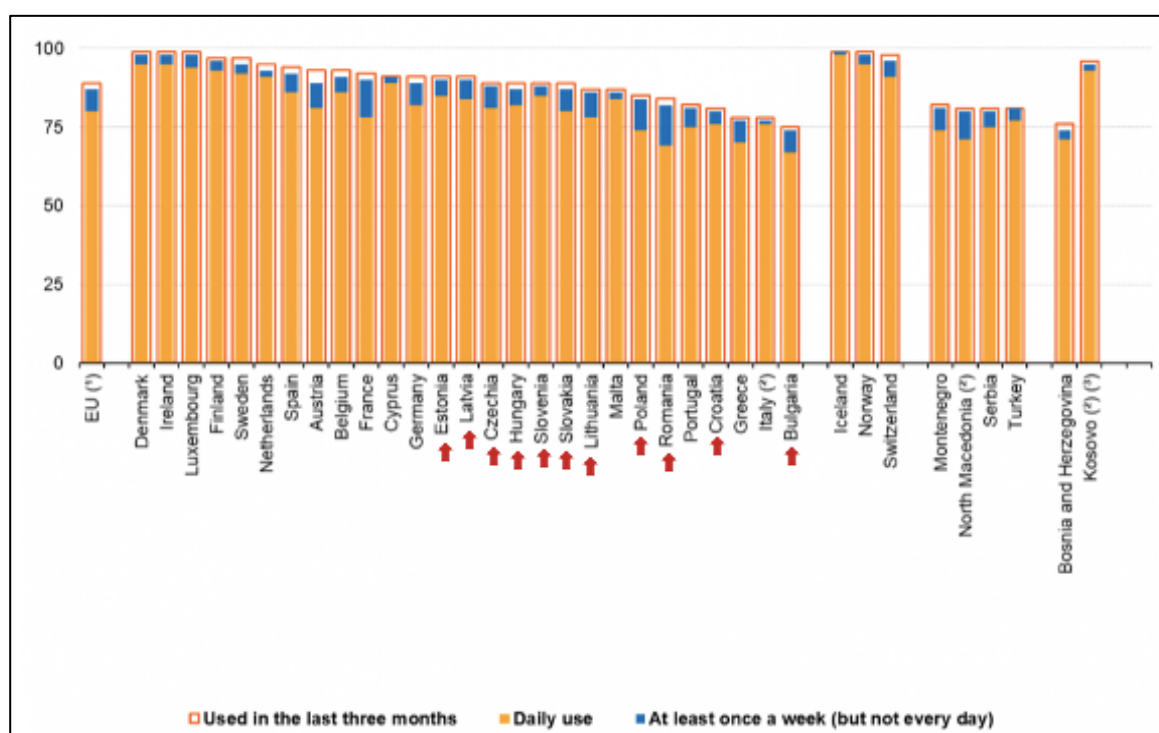
Figure 7.: Internet access in households by degree of urbanisation, 2021 (% of all households)

Source: Eurostat – Digital economy and society statistics

As Internet access is the first step of connectedness and the base of digitalisation, the second aspect to cover for understanding the digital maturity of a society is the frequency of Internet use among the citizens. As shown on Figure 8., the EU in overall averaged 89% of citizens aged 16 to 74 years that used the Internet at least once within the three months prior to the survey. Higher shares of Internet users are typical in Northern and Western European countries with Denmark, Ireland and Luxembourg (owing the top three positions of Internet users). By examining the situation of CSE-11 countries, one can note that this group of countries are not among the best performing Member States. The ratio was the lowest in Bulgaria and Poland, while Romania and Croatia were below the EU average, as well. On the other hand, some exceed the overall EU level (e.g. Estonia, Latvia) or reported promising ratios.

Another important measure is the change of the ratio that expresses how many EU citizens have never used the Internet. This proportion decreased to 8% by 2021. The same ratio was 26% in 2011, which means the amount of people that have never used the Internet

decreased to around one third of its level. 80% of EU citizens used the Internet daily in 2021, which shows how important it is for the citizens to be connected to the digital world on daily basis. One can be considered a regular user of the Internet if he uses it at least once a week; the proportion of such users was 87%. Another interesting aspect is the ratio of daily Internet users within all Internet users who used the Internet at least once in the three months prior to the survey. The average of this ratio was 90% in overall. The country with the lowest ratio was Romania (82%), and among the CSE-11 countries Poland has a considerably low percentage, too.



Notes: (¹) Estimation; (²) 2020 instead of 2021; (³) This designation is without prejudice to positions on status, and is in line with UNSCR 1244/99 and the ICJ Opinion on the Kosovo declaration of independence.

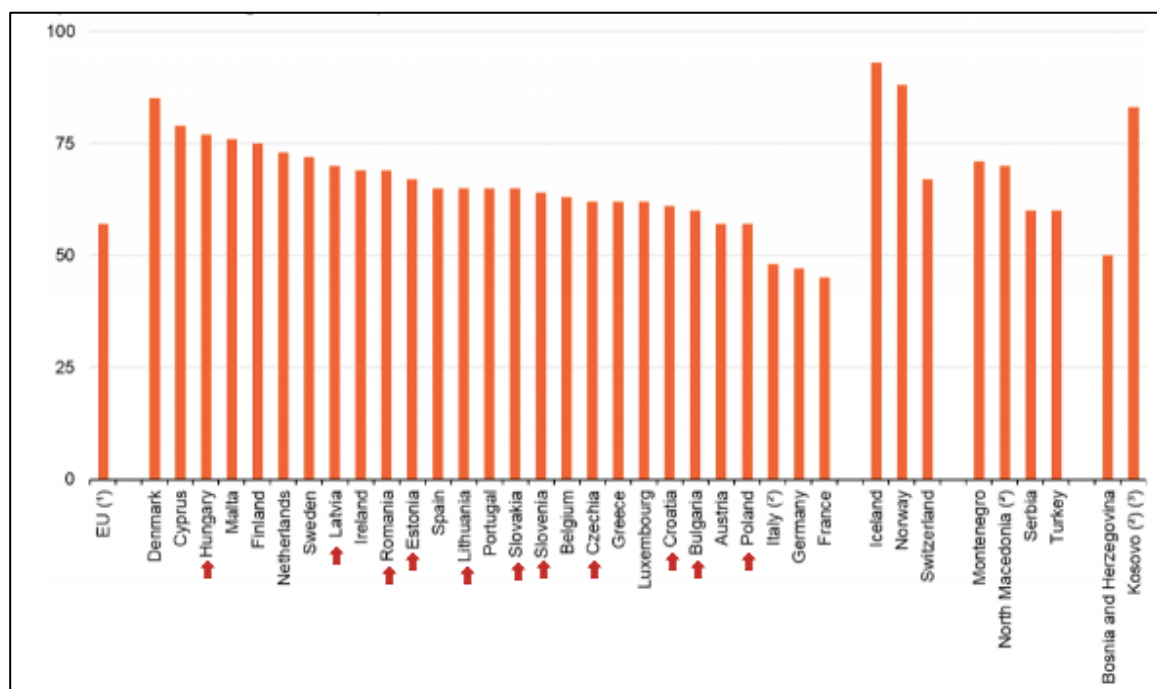
Figure 8.: Frequency of Internet use, 2021 (% of individuals aged 16 to 74)

Source: Digital economy and society statistics – households and individuals, Eurostat

The next important field within digital involvement of people is understanding the motives of accessing the Internet, or in other words, what are EU citizens using the Internet for? One of the main online activities is participating in social networks nowadays, which was the most common activity in the EU in 2021.

On Figure 9., the ratio of people that engaged in activities connected to social networks are shown. In overall, among the individuals aged 16 to 74, more than half of EU citizens (57%) participated in social networking. From this aspect, the highest ratio was reported from Denmark, while countries with the least amount of people engaging in social

networking was France, Germany and Italy. As the EU average is around 50%, all CSE-11 countries provided ratios that exceed, or at least reach that. The third highest percentage can be associated with Hungary, which is the best performance within the CSE-11 group.

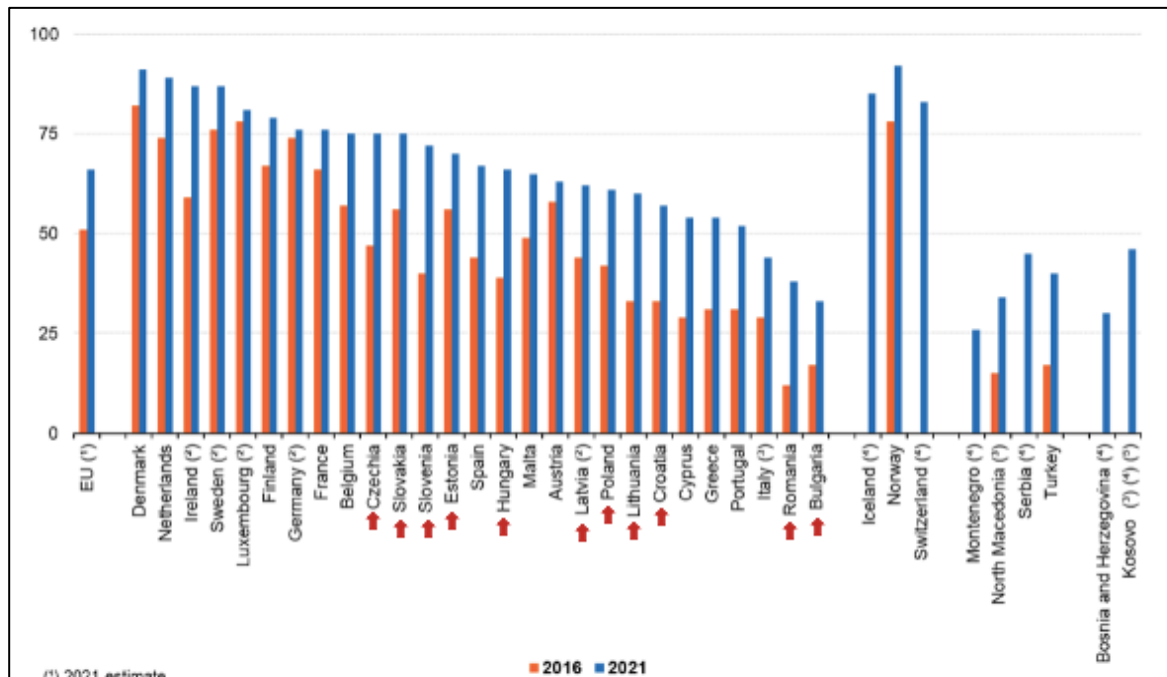


Notes: (¹) Estimation. (²) 2020 instead of 2021; (³) This designation is without prejudice to positions on status, and is in line with UNSCR 1244/99 and the ICJ Opinion on the Kosovo declaration of independence.

Figure 9.: Individuals who used the Internet for participation in social networking, 2021 (% of individuals aged 16 to 74)

Source: Eurostat – Digital economy and society statistics

Among the functions of the Internet, purchasing and ordering via online platforms are worth mentioning. By examining Figure 10., one can note that on the overall EU level, there has been an increase of 15% within the period of 2016–2021. The highest ratios belong to Denmark, the Netherlands, Ireland and Sweden (all above 85%), while the lowest ones can be associated with Romania and Bulgaria; none of these provided satisfactory levels of ratio. In 17 Member States there was an increase of at least 15% between 2016 and 2021. Most of the CSE-11 countries, with the exception of Slovakia and Estonia, were below the average in 2016; however, the highest increase can be observed within these countries: Slovenia – 32%, Czechia – 28%, Hungary and Lithuania – both 27%. In 2021, four CSE-11 countries exceeded the EU average, namely Czechia, Slovakia, Slovenia and Estonia.



Notes: (1) 2021 estimation; (2) Break in the time series; (3) 2020 instead of 2021; (4) 2016: not available; (5) This designation is without prejudice to positions on status, and is in line with UNSCR 1244/99 and the ICJ Opinion on the Kosovo declaration of independence.

Figure 10.: Individuals who ordered goods or services over the Internet for private use in the 12 months prior to the survey, 2016–2021 (% of individuals aged 16 to 74)

Source: Eurostat – Digital economy and society statistics

Within the field of human capital, one that is within the current priorities of the EU regarding digital development, a key objective is increasing digital skills. Figure 11. presents the 2021 state of Member States in the field of having at least basic digital skills. The overall European target is to have at least 80% of the population that possess basic digital skills by 2030. One can conclude that even the forerunners lag behind the target for now; however, there is still plenty of time to reach it. In general, 54% of Europeans were provided with at least basic digital skills. The countries analysed in this research are primarily to be found in lagging positions, except Estonia and Slovakia. The worst results are provided by Bulgaria and Romania, where the level of basic digital skills among individuals is less than half of the desired target.

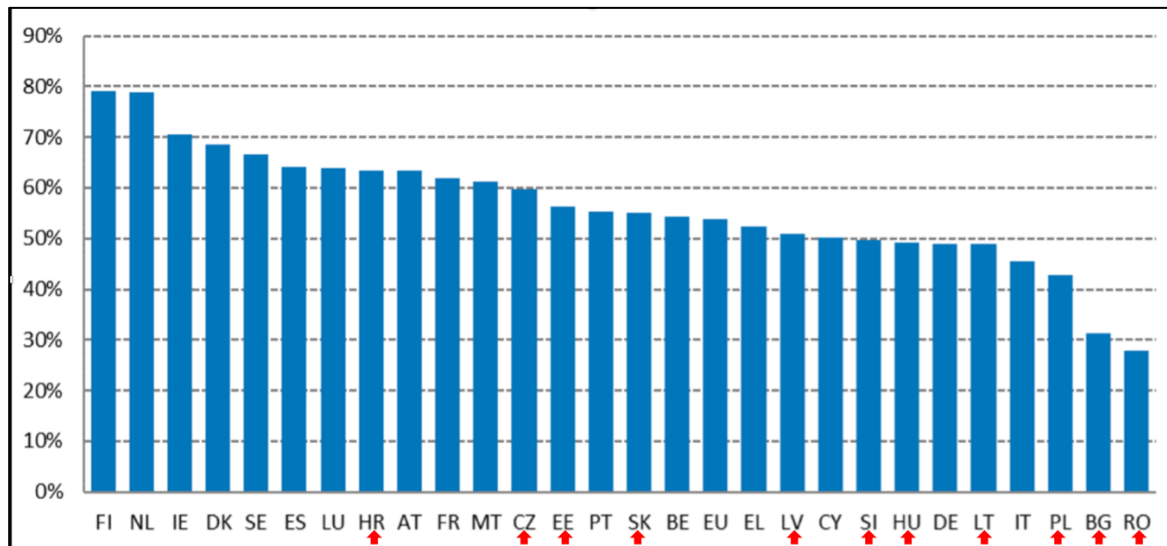


Figure 11.: At least basic digital skills, 2021 (% of individuals)

Source: EC (2022) p. 14. based on European Union survey on the use of ICT in households and by individuals provided by Eurostat.

4. MATERIALS AND METHODS

4.1. THE DATASET AND THE RELATION OF INDICATORS WITH THE LEVELS OF DIGITAL DIVIDE

Based on Eurostat's *Regional digital economy and society* database, a dataset of 7 ICT-related indicators is employed in the current study.¹⁶ My dataset considers the period 2016–2021; accordingly, it partially covers the years of COVID-19 crisis. The geographical unit of the analysis is represented by the NUTS-2 regions, according to NUTS version 2016. In this analysis, 49 regions from 11 Central and South-East European countries are involved. All countries are Member States of the European Union and known as transition economies. Due to the lack of data, NUTS-2 level data are substituted with data on corresponding NUTS-1 levels in the case of Poland. In the case of Hungary and Lithuania there has been minor change of in the NUTS classification, so NUTS-2 level data are replaced with country level data for 2016 and 2017 in the following regions: Pest (HU), Budapest (HU), Sostines regionas (LT) and Vidurio ir vakaru Lietuvos regionas (LT).

The 7 selected indicators are presented in Table 6. The first two indicators (1. Households with broadband access, 2. Frequency of Internet access: daily) reflect access to and use of ICT by individuals and in households (*first level of digital divide*). Four indicators (3. Internet use: participating in social networks; 4. Internet use: interaction with public authorities; 5. Internet use: Internet banking; 6. Online purchases: from sellers from other EU countries) are more concerned with ICT competence and skills (*second level of digital divide*). These indicators reflect the skills in using of the Internet and social networks for different purposes (e-commerce, exchange information and services with governments and public administrations, e-government). Finally, 'Internet use: selling goods or services' (indicator no. 7) serve as a good measure of the *third level of the digital divide* as it captures a key action to realise economic benefit through online commerce. The abbreviations shown in the fourth column of Table 6. are used consequently in my study from this point.

¹⁶ The EU survey on the use of ICT in households and by individuals is an annual survey conducted since 2002 aiming at collecting and disseminating harmonised and comparable information on the use of ICT in households and by individuals. Data presented in this domain are collected by the National Statistical Institutes and are based on Eurostat's annual model questionnaire. This questionnaire is updated each year to reflect the evolving situation of ICT. Indicators from this survey are used for benchmarking purposes and in particular, this survey supports measuring the implementation of priorities for the period 2019–2024 of the *von der Leyen* European Commission (ICT usage in households and by individuals. Available at https://ec.europa.eu/eurostat/cache/metadata/en/isoc_i_esms.htm).

Table 6.: Set of indicators

Nr.	Name of indicator	Definition of indicator	Abbreviation	Measurement unit
<i>Indicators related to first level digital divide (digital access)</i>				
1.	Households with broadband access	The indicator measures the share of private households with broadband access (density of broadband Internet services).	BBACC	% of households
2.	Frequency of Internet access: daily	The indicator measures the percentage of individuals who regularly use the Internet.	DUINT	% of individuals
<i>Indicators related to second level digital divide (digital competence)</i>				
3.	Internet use: participating in social networks	The indicator measures the use of Internet for the following purposes: creating user profile, posting messages or other contributions to Facebook, Twitter, etc.	SOCMED	% of individuals
4.	Internet use: interaction with public authorities	The indicator measures the percentage of individuals who used the Internet to exchange information and services with governments and public administrations in the last 12 months.	PUBAU	% of individuals
5.	Internet use: Internet banking	The indicator measures the percentage of individuals who used online banking services.	ONBANK	% of individuals
6.	Online purchases: from sellers from other EU countries	The indicator measures the percentage of individuals who ordered goods and services online from other EU Member States.	ORDER	% of individuals
<i>Indicator related to third level digital divide (digital outcome)</i>				
7.	Internet use: selling goods or services	The indicator measures the percentage of individuals who sold goods and services online.	ONSELL	% of individuals

Source: Own elaboration.

4.2. APPLIED METHODS

4.2.1. Univariate analysis

For detecting the highest (top five) and lowest (bottom five) performing regions, the absolute and percentage changes from 2016 to 2021 and from 2019 to 2021 are calculated for each region with respect to all indicators. The results of the percentage changes are used for detecting the highest and lowest changes. To capture the patterns in the development of each NUTS-2 region and make comparisons with respect to the EU-27 and CSE-11 average, I label regions using the convergence or divergence patterns borrowed from the classification of the Eurofound (2018). The classification system, with relabelled arrows – Region/Member State instead of Member State, and EU-27/CSE-11 instead of EU – is available in Annex 1. The classification system is shown on Figure 12. Datasheets including calculations can be found from Annex 2 to 8.

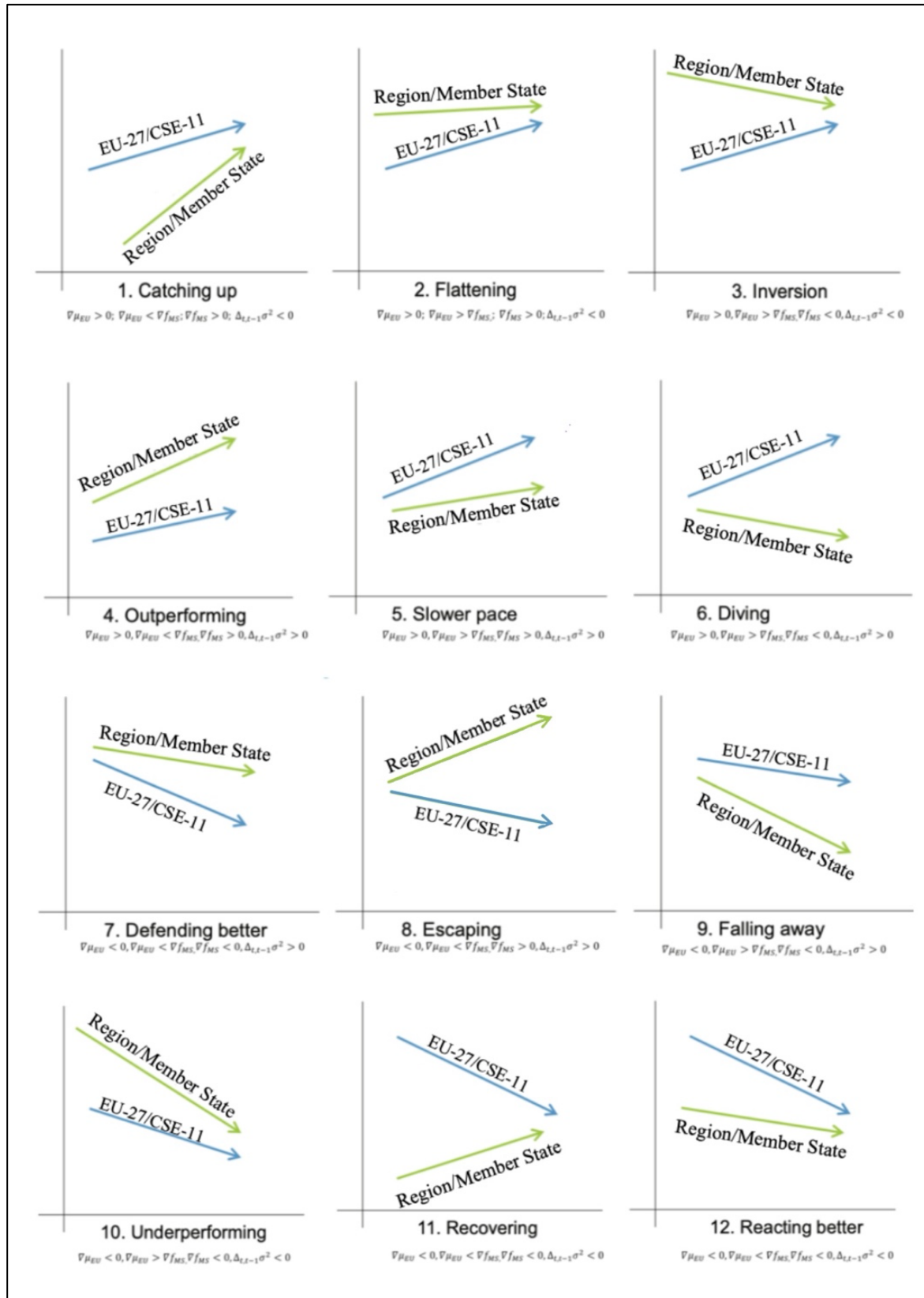


Figure 12.: The classification of convergence and divergence patterns

Source: Own elaboration based on Eurofound (2018), pp. 25–26.

Figure 12. presents twelve different possible convergence and divergence patterns that can be used for further regional and country comparison. According to Eurofound (2018), upward convergence is reached through the maximisation of the indicator in the case when the direction is positive, or through the minimisation of the indicator when the direction is negative. According to the classification system, upward convergence is reached by the maximisation of indicators. Within the *Upward convergence* category, one can detect three patterns as described below:

1. *Catching up*: When the performance of a region / Member State (hereinafter MS) is lower than the EU-27 / CSE-11 average at the beginning, but it grows quicker and reduces the gap;
2. *Flattening*: Occurs when the region / MS has a higher initial performance than the EU-27 / CSE-11 average, but it grows slower, and the gap is reduced;
3. *Inversion*: In this case the starting performance of the region / MS is higher than the EU-27 / CSE-11 average, but its performance declines, and the distance narrows, as the EU-27 / CSE-11 average is simultaneously increasing.

The second category is called *Upward divergence*, and includes three patterns:

4. *Outperforming*: The performance of the region / MS is higher at the starting point, and it grows faster than the EU-27 / CSE-11 average. This leads to the gap widening further;
5. *Slower pace*: The initial performance of the region / MS is lower than the EU-27 / CSE-11 average and grows at a slower rate. The gap increases over time;
6. *Diving*: The performance of the region / MS is worse initially, and it declines further, while the EU-27 / CSE-11 average increases, and results in the further expansion of the gap.

The third category represents *Downward divergence* with three patterns:

7. *Defending better*: The performance of the region / MS is higher at the beginning, then both decline, but the EU-27 / CSE-11 average falls at a faster rate. The gap increases;
8. *Escaping*: The starting performance of the region / MS is higher, and as it grows, the EU-27 / CSE-11 average declines; consequently, the gap widens;

9. *Falling away*: At the beginning the performance of the region / MS is lower, then both decline. The EU-27 / CSE-11 average falls at a slower rate, leaving the gap to expand.

The fourth category includes three pattern and can be labelled as *Downward convergence*:

10. *Underperforming*: The initial performance of the region / MS is higher, then both fall. There is convergence, as the EU-27 / CSE-11 average declines at a slower pace;
11. *Recovering*: At the beginning the performance of the region / MS is lower, but it grows, while the EU-27 / CSE-11 average declines, and the gap between them narrows;
12. *Reacting better*: The performance of the region / MS is lower initially, then both decline, but the EU-27 / CSE-11 average falls at a slower pace, so the gap shrinks.

While labelling the regions based on the above mentioned twelve basic categories, two additional pattern types emerged as follows:

13. *At the same pace*: Occurs when then the magnitude of the change performed by the region / MS is the same as the one performed by the EU-27 / CSE-11 average (the slope of the two trendlines are equal);
14. *Intersecting*: When the path of the region / MS and the path of the EU-27 / CSE-11 average cross with each other at some point, so there are two observable patterns between the two examined years. In these cases, both patterns are indicated next to each other.

For a better understanding of the balance vs. imbalance patterns, as well as gaining an insight into the regional development dynamics, I calculate the mean, the standard deviation, and based on these, the coefficient of variation for each indicator based on data from 2016 to 2021. Coefficient of variation (CV) is the ratio of the standard deviation to the mean and shows the extent of variability in relation to the mean of the population. The higher the CV, the greater the dispersion. Regional CV is calculated as follows:

$$CV_{[2016;2021]}^{REG} = \frac{Std.deviation_{[2016;2021]}^{REG}}{Mean_{[2016;2021]}^{REG}} \quad (1)$$

To make my result more visible, I create scatterplots for each indicator that contain the values from the 49 regions under observation, as well as EU-27 and CSE-11 averages. Scatterplots represent the mean on the horizontal (x-) axis and coefficient of variation on the vertical (y-) axis. Scatterplots serve as a good tool as they enable the comparisons of regions with each other and the EU-27 and CSE-11 averages.

4.2.2. Multivariate analysis

The application of Multidimensional Scaling (hereinafter referred as MDS) is based on data of ‘distance’ or ‘similarity’ nature, or data that can be transformed into such. MDS refers to a set of statistical techniques that are used to reduce the complexity of a data set, permitting visual appreciation of the underlying relational structures contained therein. With this method one can systematically create geometric representations for given objects (e.g. regions), which reflect the relationship of these objects (e.g. regions) in a geometric space with the appropriate number of dimensions with the smallest possible distortion. Although not in great number, the application of the method has already been demonstrated in space-specific research carried out by Hungarian authors (e.g. Lengyel 1999, Lukovics–Lóránd 2010, Dusek 2012).

To show the similarities and distances, namely to capture the sense of ‘distance’ and ‘similarity’ among the NUTS-2 regions regarding their performance in the 7 ICT-related indicators, I reduce the original 7 dimensions (indicators) to the two-dimensional space by performing MDS. I use the IBM SPSS (Statistical Package for Social Sciences, 25th version) for conducting the analysis. The approach and mathematical foundations of MDS for SPSS are already available in Hungarian language in different handbooks (Székely–Barna 2008, Ketskeméty et al. 2011) and journal articles (Mérő 1986, Takács 2013, Bánhidi et al. 2020).

Out of the two common techniques of performing this analysis, Alscal routine and Proxscal routine, the latter is chosen. MDS Proxscal routine can be reached under the following command line: *Analyze/Scale/Multidimensional Scaling (PROXSCAL)*. In the Data Format dialog box, create proximities from data is selected as proximities among the regions are generated. Values are standardized, so none unequally high weights can be assigned to any indicator that would influence the results.

Concerning the test statistics, the co-called S-stress formula is widely used to express the goodness of fit of the MDS model. It is calculated as follows:

$$S - stress = \sqrt{\frac{\sum_{i=1}^n \sum_{j=1}^n (d_{ij} - d_{ij}^*)^2}{\sum_{i=1}^n \sum_{j=1}^n (d_{ij})^2}} \quad (2)$$

where (d_{ij}) is the (initial) distance matrix consisting of symmetric, non-negative elements, as well as $(d_{ij} - d_{ij}^*)$ the distance matrix that measures the difference in numerical terms. If there is a perfect correspondence between the originally detected and the depicted differences $(d_{ij} - d_{ij}^*)$, then the error is zero, and so is the value of the S-stress. In other words, SPSS examines and selects the configuration for which the value of S-stress is minimal. Therefore, the smallest possible value of S-stress is desirable, because it corresponds to the smallest distortion (Table 7).

Table 7.: The value and quality of the S-stress (rule-of-thumb)

S-stress value	The quality of the reconstruction
<i>0.00 – 0.05</i>	<i>Excellent</i> , probably contains all relevant information.
<i>0.05 – 0.10</i>	<i>Good</i> , appropriate, the results can be interpreted.
<i>0.10 – 0.20</i>	<i>Acceptable</i> , worth dealing with it, the result is still interpretable.
<i>above 0.20</i>	<i>Poor</i> , the dimension number can only be interpreted with a large loss of information, it is worth trying a larger dimension number.

Source: Ketskeméty et al. (2011), Takács (2013).

I test five different distance methods (also known as Minkowsky p-values). The goodness of fit for all the possible intervals is tested to decide which distance method is the most adequate for the dataset. In the case of the Euclidean distance ($p=2^1=2$) for all examined years, and in the case of the Minkowsky distance ($p=3$) regarding the years 2019 and 2021, the S-Stress values seem to be ‘excellent’ (S-Stress values are between 0.025 and 0.049). However, out of the possible options, the best fit measures can be associated with the Manhattan distance ($p=2^0=1$) as the S-Stress values fall in the ‘near perfect fit’ category as they are between 0.000 and 0.024. Accordingly, this distance method is used for further analysis on the subject. MDS test statistics are shown in Table 8.

Table 8.: MDS test statistics: goodness of fit – stress and fit measures

Distance (interval)	Manhattan Distance (Minkowsky p=1)	Euclidean Distance (Minkowsky p=2)	Squared Euclidean Distance	Minkowsky Distance (p=3)	Chebychev Distance (Minkowsky $p \Rightarrow \infty$)
2016					
<i>Normalized Raw Stress</i>	0.0206	0.0287	0.0451	0.0342	0.0411
<i>Stress – I.</i>	0.1434	0.1695	0.2124	0.1849	0.2026
<i>Stress – II.</i>	0.2905	0.3604	0.3830	0.4066	0.4652
<i>S-Stress</i>	0.0221	0.0420	0.1034	0.0602	0.1011
<i>Dispersion Accounted For (D.A.F.)</i>	0.9794	0.9714	0.9549	0.9658	0.9590
<i>Tucker's Co-efficient of Convergence</i>	0.9897	0.9855	0.9772	0.9828	0.9793
2019					
<i>Normalized Raw Stress</i>	0.0191	0.0206	0.0486	0.0206	0.0381
<i>Stress – I.</i>	0.1380	0.1436	0.2205	0.1433	0.1951
<i>Stress – II.</i>	0.2792	0.3065	0.4001	0.3164	0.4511
<i>S-Stress</i>	0.0259	0.0262	0.1000	0.0310	0.0850
<i>Dispersion Accounted For (D.A.F.)</i>	0.9810	0.9794	0.9514	0.9795	0.9620
<i>Tucker's Co-efficient of Convergence</i>	0.9904	0.9896	0.9754	0.9897	0.9808
2021					
<i>Normalized Raw Stress</i>	0.0155	0.0207	0.0405	0.0262	0.0442
<i>Stress – I.</i>	0.1247	0.1440	0.2013	0.1618	0.2103
<i>Stress – II.</i>	0.2581	0.3103	0.3623	0.3559	0.4727
<i>S-Stress</i>	0.0217	0.0330	0.1003	0.0466	0.0973
<i>Dispersion Accounted For (D.A.F.)</i>	0.9845	0.9793	0.9595	0.9738	0.9558
<i>Tucker's Co-efficient of Convergence</i>	0.9922	0.9896	0.9795	0.9868	0.9776

Source: Own elaboration based on SPSS output table.

As mentioned before, scatterplots are created to make results more apparent. Each region is marked with dot on the figures and labelled with geocode in the next chapter. Furthermore, along the Dimension 1, which compresses most indicators (6 out of the 7 indicators), regions are split up into three categories: ‘*Laggards*’, ‘*Average*’ and ‘*Leaders*’; while the first category consists of regions that show relatively low performance, the third group includes regions with relatively high levels in ICT infrastructure and usage. For 2016, 2019 and 2021, maps demonstrate the classification of regions according to the three categories which also enables to detect the changes in times of the COVID-19 outbreak.

5. PRIMARY RESULTS

5.1. TOP AND BOTTOM POSITIONS OF ICT-RELATED INDICATORS ON REGIONAL LEVEL

1. *Household with broadband access – BBACC*

Regarding this indicator, the overall European development is around 13%, while the CSE-11 countries average shows almost 18% increase from 2016 to 2021. The regions with the lowest levels of development within this period are two regions from Czechia, Estonia, the Romanian capital region and a Slovakian region. The top performers include two Romanian regions and three regions in Bulgaria.

During the period 2019–2021, the average increase for the EU-27 is slightly below 5%, while within the CSE-11 group it is a little higher, almost 7%. There are two Czech regions where the number of houses having broadband access did not increase, but stagnated or slightly decreased. Other low results are associated with two Czech regions that are among the laggards within the other time period, as well Estonia. Regions with the most remarkable increase are three Bulgarian regions, and two regions from Slovakia.

2. *Frequency of Internet access: daily – DUINT*

Examining individuals who use the Internet daily one can see that the EU-27 average is around 20%, while in the CSE-11 countries an average increase of more than 25% can be presented. During the period 2016–2021 there is one region from each of these countries among the lowest performers: Estonia, Croatia, Hungary, Poland and Slovakia. All the highest performing regions are associated with Romania, all having increases above 50%.

For the period 2019–2021, the EU-27 average is slightly above 7%, and the CSE-11 average is almost 10%. There is a decrease in the case of two Czech regions, and stagnation in one Hungarian and one Slovakian region. The top performers are again Romanian regions along with some Bulgarian ones.

3. *Internet use: participating in social networks – SOCMED*

The EU-27 average is a bit above 20%, and it was somewhat higher, almost reaching 30%, in the CSE-11 countries. The lowest performances appear in Czechia, Croatia, Hungary and Slovakia, while the biggest change during the period is associated with Romania, Slovenia and Bulgaria.

The period from 2019 to 2021 brings changes between 8–10% in the EU-27 and the CSE-11 averages. Decrease is also detectable in three Czech and one Slovakian regions, and

one in region from Bulgaria there is stagnation. The highest increases are to be found in two Bulgarian, one Slovenian and two Slovakian regions.

4. Internet use: interaction with public authorities – PUBAU

Between 2016 and 2021 the EU-27 average increase is slightly below, and the CSE-11 average slightly above 30%. The lowest performances were provided in Estonia, Latvia and Slovakia. The highest performances are associated with two Romanian and three Czech regions, in all of which an increase above 110% is performed.

For the period between 2019 and 2021 both the EU-27 and the CSE-11 averages are between 16–17%. In several cases a decrease can be detected, with the most unsatisfactory cases being in two Bulgarian and three Slovenian regions. The highest increases, on the other hand, are to be found in two Bulgarian, two Hungarian and one Romanian regions.

5. Internet use: Internet banking – ONBANK

The average increase for the EU-27 is 32%, while in the CSE-11 countries it is somewhat higher, reaching 37% for the period 2016–2021. Regions with relatively low level performances are to be found in Poland, Slovakia and Estonia. The highest performances are detected in Bulgaria and Romania, where in some regions the number of individuals using Internet banking has grown four–five times higher compared to the initial level.

For the period between 2019–2021 the average increase for the EU-27 and the CSE-11 is both around 13%. In one Bulgarian region, a decline can be detected. Other low performances are associated with Estonia, Hungary, Poland and Slovakia. The most promising results are provided by two Bulgarian and four Romanian regions, in all of which the initial level was at least doubled.

6. Online purchases: from sellers from other EU countries – ORDER

During the period 2016–2021 there is an increase of around 8% in the number of individuals who ordered goods online from other Member States in case of the EU-27, while in the CSE-11 countries the average has grown by almost 30%. On the regional level the least sufficient results, that are all declines, reaching even -50% in some cases, are to be found in Bulgaria, Poland and Romania. The highest-level performances can be detected in Czechia and Romania, where some regions have grown to more times the initial level.

During the years between 2019 and 2021 there is a decline in both the EU-27 (-8%) and CSE-11 (-4%) averages. The lowest performers show declines of around -50% and can

be detected in regions of Bulgaria, Hungary and Romania. Despite of the overall lower-level performance of regions within this indicator, there are some positive examples, too. In some regions in Czechia and Romania an increase of 45–100% can be detected.

7. Internet use: selling goods or services – ONSSELL

Both the EU-27 and the CSE-11 average increases are around 36% for the period 2016–2021. The most unsatisfactory results are provided by regions in Bulgaria, Czechia and Poland, all have undergone a decline of at least 40%. The high performing regions include one Lithuanian, three Hungarian and one Romanian regions. In these the initial level has been doubled at least.

Between the year 2019 and 2021 the EU-27 and the CSE-11 averages has increased by around 24%. In case of some regions in Bulgaria, Czechia and Poland, decline of 40–60% is detectable. The highest performances, on the other hand, means at least doubling the initial levels for certain regions in Lithuania, Hungary and Romania.

5.2. CONVERGENCE VS. DIVERGENCE PATTERNS OF CSE-11 COUNTRIES AND NUTS-2 REGIONS¹⁷

The first six indicators (BBACC, DUINT, SOCMED, PUBAU, ONBANK, ONSSELL) show remarkably similar pictures within the distribution of patters between the CSE-11 regions. In these indicators the patterns appearing were exclusively within the upward convergence (catching up, flattening, inversion) and upward divergence (outperforming, slower pace, diving) types. In BBACC and DUINT patterns of upward convergence dominate, while in the others upward divergence is more extensive.

In addition, for these six indicators the number of cases where regions are associated with downward trends are minimal. However, there are some exceptions: in SOCMED for the period 2019–2021 in three Czech regions there was a downward trend, in PUBAU for the period 2019–2021 almost all regions of Slovakia and Bulgaria are categorized by a downward trend, and most outstandingly, in ONSSELL a downward trend is presented in almost all of Poland as well as in some Czech, Slovakian, Bulgarian, Croatian and Slovenian regions.

The last indicator, ORDER, deviates from the others as all possible categories appear. The most interesting ones are the patterns appearing within the period 2019–2021, as these are ones of downward divergence (defending better, escaping, falling away) and downward

¹⁷ The detailed overview of results related to this analysis is presented through maps available in Annex 9.

convergence (underperforming, recovering, reacting better). Most regions are assigned to downward convergence, but a decent number of regions are associated with downward divergence, as well in both cases. In these two cases regions presenting a downward trend outnumber the ones with an upward trend. Results for the period 2016–2021 show similar tendencies to the first six indicators, as these include upward convergence and upward divergence patterns. There are some exceptions in Bulgaria, Poland, Romania and Slovakia, but in overall, upward tendencies are more common in these two cases.

5.3. BALANCE VS. IMBALANCE PATTERNS OF CSE-11 COUNTRIES AND NUTS-2 REGIONS

5.3.1. Households with broadband access – BBACC

The results of the analysis on the balance vs. imbalance of regions regarding the indicator concerning with the number of households having broadband connection at home is shown on Figure 13. By examining the figure one can see that all the regions had average performances above 65%, and that within this indicator the results are relatively high in overall. This might be related to the fact that the BBACC indicator is special, as it is the basis of the other indicators, since an individual has to have access to the Internet in order to participate in any kinds of activities online. In this case the difference between the EU-27 and the CSE-11 is relatively less significant.

The lowest average performances were provided within Bulgarian and Romanian regions, however, in the capital region of Romania (RO32) one of the highest average values were reached. Despite the Bucharest region, the most favourable average values, that exceed even the EU-27 average, are to be found in regions of Czechia, Hungary, Slovenia, Poland, and Slovakia. When the growth rates are under focus, it is important to mention that the scale of the growth rates (y-axis) is the shortest in this case among the seven indicators, which again can be related to the high initial performances: there was not much space left for growth. The highest pace of growth is to be associated with the regions of Romania and Bulgaria in which the average values are not so satisfactory. Apart from the ones mentioned as extremities, most of the regions are grouped around the two averages, which can mean that in overall, the performances provided by the CSE-11 regions do not show extreme differences.

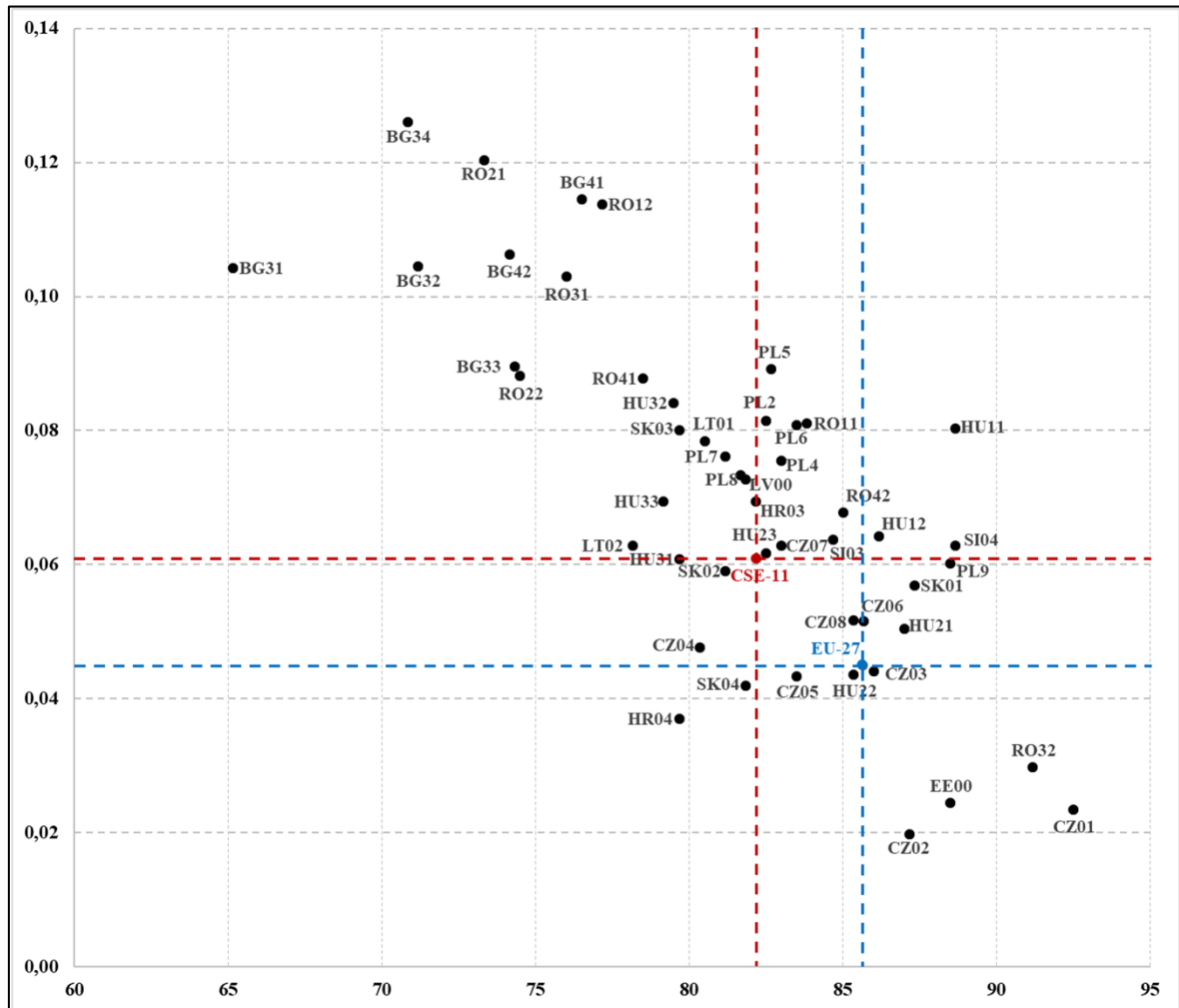


Figure 13.: Households with broadband access: mean (x-axis) and coefficient of variation (y-axis) across the CSE-11 regions, 2016–2021

Source: Own elaboration.

5.3.2. Frequency of Internet access: daily – DUINT

On Figure 14. the dynamics of regions within the number of individuals who use the Internet daily is shown. Examining the two axes one can find that while the maximal value of the x-axis is lower than in the case of BBACC, the scale is wider for the y-axis, meaning that the average results of regions were lower while the growth of regions was more remarkable.

The relationship between the two means shows that the average value for the CSE-11 countries was significantly, more than 10%, lower than the EU-27 average. The difference between the average growths is substantial in comparison with the other indicators. One can see that once again, the lowest average results belong to Romanian and Bulgarian regions. These, apart from the capital regions, all fall below the CSE-11 average on the x-axis. All other regions, except for PL8 (Makroregion Wschodni), have higher average mean than the

regional average. Most CSE-11 regions fall between the EU-27 average and the CSE-11 average, the x value is higher than the EU-27 in only five of them.

Regarding the y-axis, the highest coefficient of variation is associated with some Romanian and Bulgarian regions, the ones which were associated with the lowest mean values according to the x-axis. Most CSE-11 regions performed above the CSE-11 average in terms of their growth pace. The lowest y values are detected in Estonia, and in one Hungarian, one Czech, one Polish and one Slovakian regions.

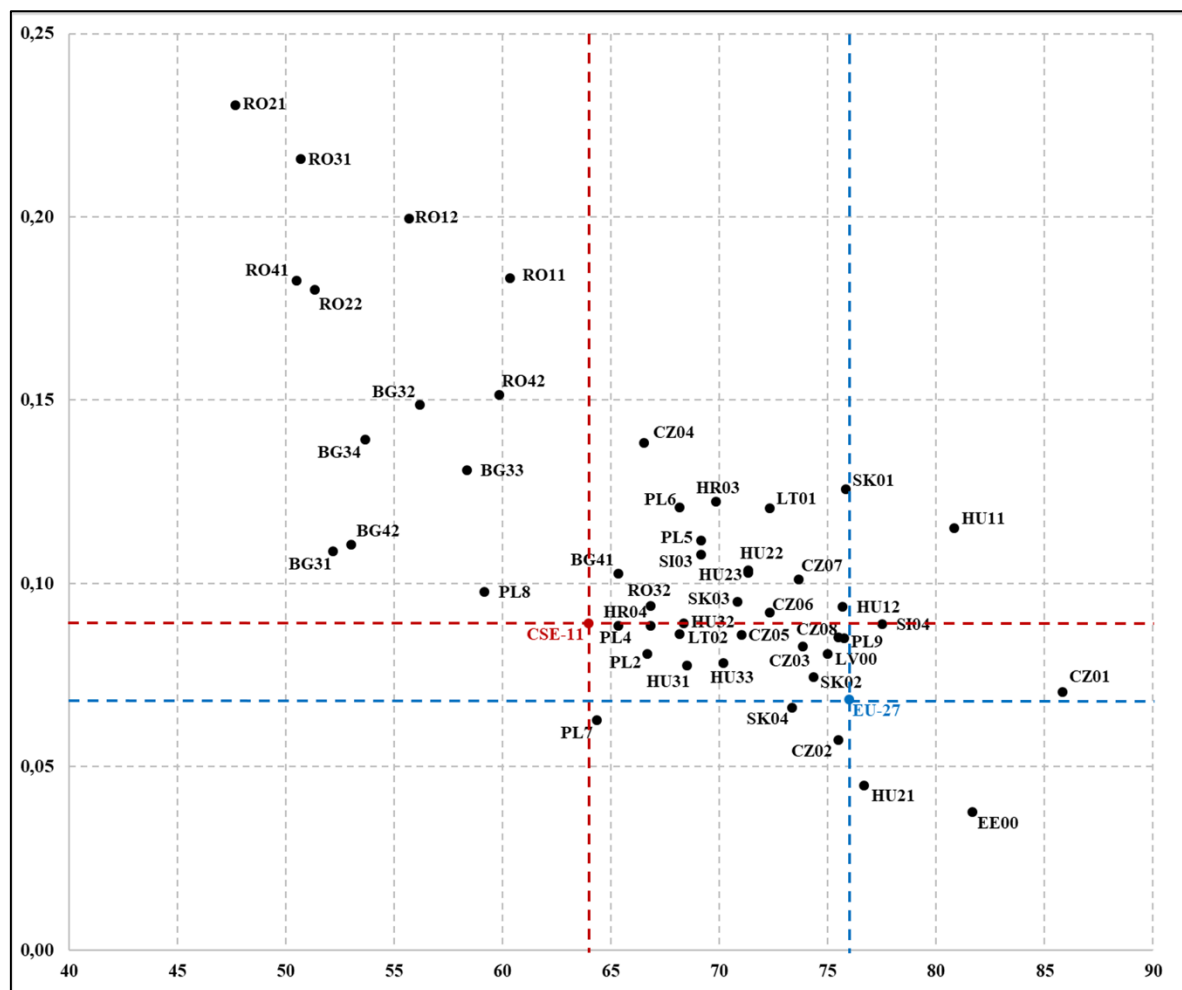


Figure 14.: Frequency of Internet access: daily: mean (x-axis) and coefficient of variation (y-axis) across the CSE-11 regions, 2016–2021

Source: Own elaboration.

5.3.3. Internet use: participating in social networks – SOCMED

The next indicator under observation is the one concerning with the intensity of social media use among the individuals within a region, the result of which is presented on Figure 15. One can see that while the scale of the y-axis remained the same, the x-axis shrunk further compared to previous indicators, as here there are no values above 90%.

Concerning the relationship between the two averages, the difference between them – regarding the mean value – is almost minimal. There are numerous regions below the CSE-11 average from Bulgaria, Poland, Czechia, Romania and Croatia. On the other hand, in several regions from Hungary, Estonia, Slovakia, Latvia, Lithuania and Romania performance was above the EU-27 average, which is quite unique among the seven indicators.

Regarding the mean values, the country with outstandingly high performance in terms of the x-axis is Hungary, with all of its regions well-above the EU-27 average. Among the lowest values there are Bulgarian and Polish regions, however the usually underperforming Romanian ones are placed among the moderately performing regions. Czech regions are to be found in less satisfactory positions within this indicator.

For the values distributed on the y-axis one can note that the highest growth is associated with the two Slovenian regions, followed by three Romanian and one Czech regions. The lowest level of growth is detected in two Slovakian regions, while in the other two performance above the CSE-11 average is detected. Other lower growth pace can be found in Estonia and one Hungarian region.

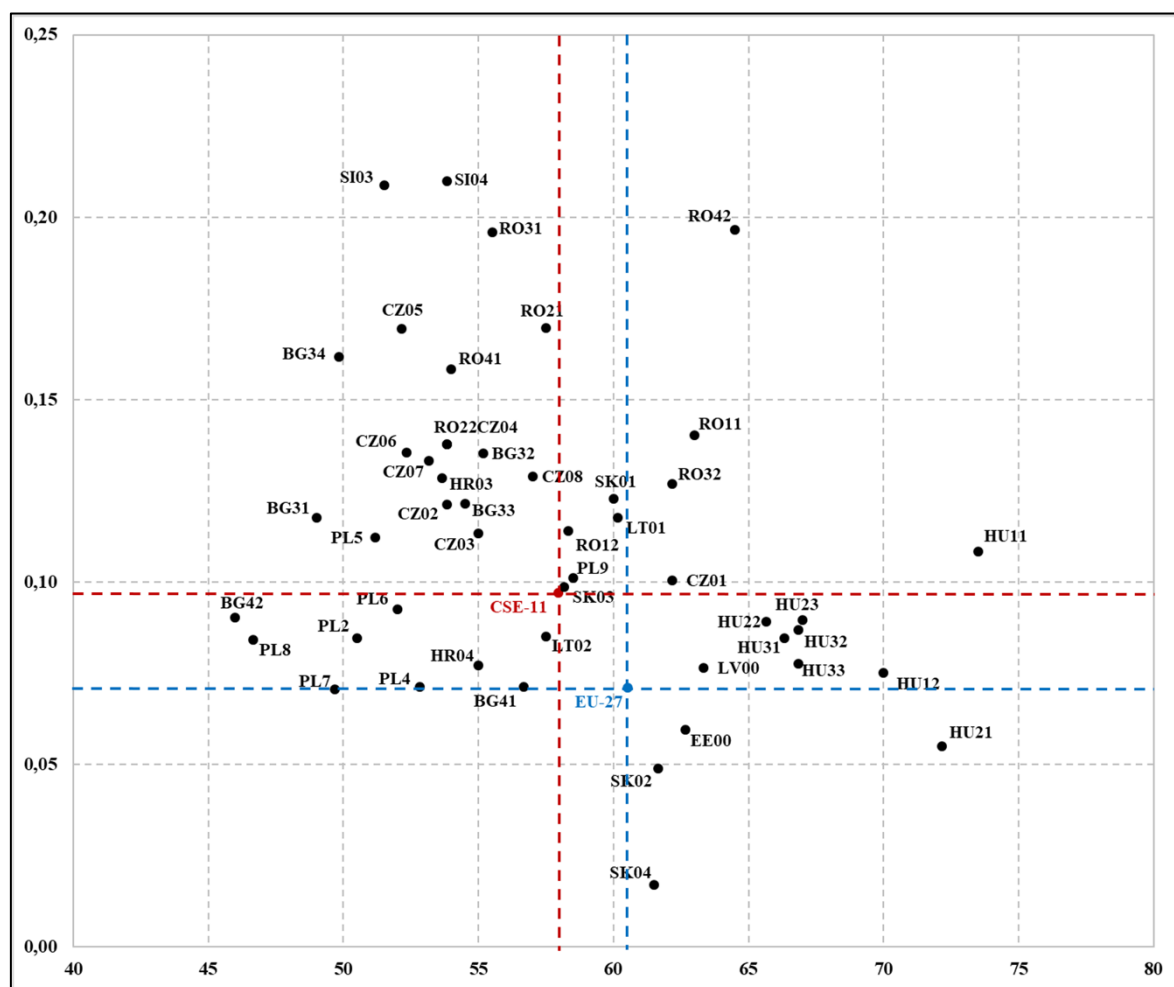


Figure 15.: Internet use: participating in social networks: mean (x-axis) and coefficient of variation (y-axis) across the CSE-11 regions, 2016–2021

Source: Own elaboration.

5.3.4. Internet use: interaction with public authorities – PUBAU

For understanding the balance vs imbalance within the indicator that assesses the number of individuals interacting with public authorities online, the regional results are shown on Figure 16. The scale of the y-axis is considerably higher than in the case of Figure 15, while the x-axis has a shorter scale, meaning that the mean values are lower (there are no values above 75%) and that there are graver differences between the coefficient of variation of the regions.

One can see that the difference between the EU-27 and the CSE-11 averages has not changed significantly, however, it is remarkable regarding the x-axis, where it is around 10%. There are several regions below the CSE-11 average on the x-axis (mostly Romanian, Bulgarian, Croatian and Polish ones). Between the two averages there are Czech, Hungar-

ian, Slovakian, Slovenian and Lithuanian regions. In Estonia, and in some regions of Hungary, Czechia, and one-one Slovenian, Slovakian Romanian regions the EU-27 average was overperformed.

The dispersion of results in terms of the y-axis shows that there is one region (RO22 – Sud-Est) that stands out by far as the highest result. Other top performers include Romanian, Czech and Bulgarian regions. The lowest value for coefficient of variation is detected in Estonia, in which almost no growth happened. Latvia, Slovakia, Lithuania and Hungary also had regions among the lowest values of the y-axis.

Regarding the x-axis, the lowest results are associated with Romania, some of which do not reach 10%. The highest value was provided by Estonia, which had a mean of almost 80%.

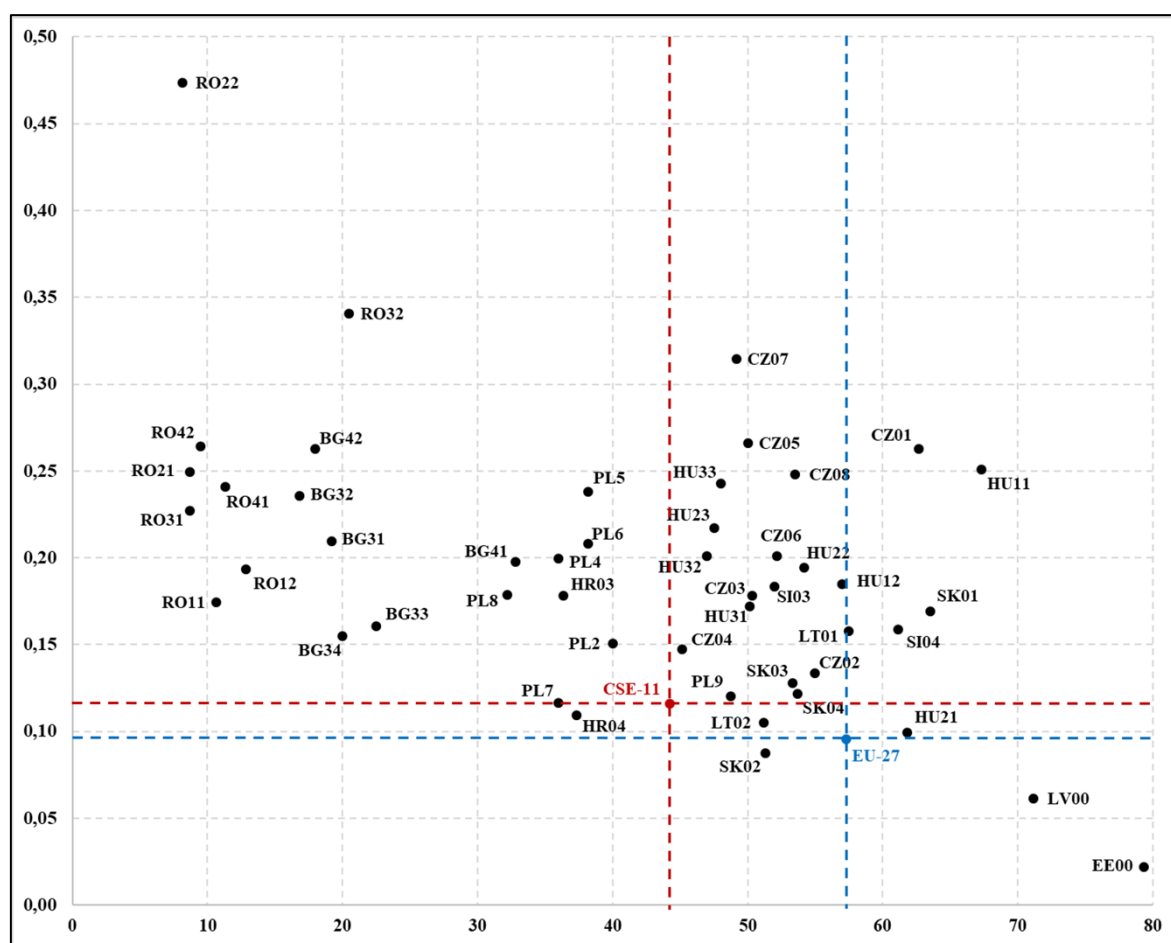


Figure 16.: Internet use: interaction with public authorities: mean (x-axis) and coefficient of variation (y-axis) across the CSE-11 regions, 2016–2021

Source: Own elaboration.

5.3.5. Internet use: Internet banking – ONBANK

The result of the analysis based on the indicator concerning with the number of individuals using online banking are presented on Figure 17. In this case the scale of the y-axis widened further compared to the one of the previous indicators, meaning that the differences between the growth dynamics of regions increased. On the x-axis one can note that the scale widened, as there is a region in which a mean value above 80% was provided.

Regarding the two averages, the difference between them based on the x-axis is again, around 10%, while on the y-axis the two values representing the EU-27 and the CSE-11 remain close, as well. Most regions are located around the two averages, however, the two typically lagging countries are further away from the CSE-11 average, with only the Romanian capital region converging towards the other regions.

Observing the dispersion of values on the y-axis, one can see that there is a break between two groups of regions. The first one consists of Romania and Bulgaria, and is characterized by high values, meaning that regions within these countries have higher growth rates than other regions. Within the second group highest y values are provided by mostly Hungarian regions, as well as the Romanian capital region. Estonia is an out stander, as its result is considerably lower than any other regions.

Dispersion on the x-axis shows almost the same pattern. Romanian and Bulgarian regions, here with the Romanian capital included, all performed under 20%, and are far from the results in other regions. The second group performed between around 35-70% with mostly Hungary and Croatia at the bottom of the group, Polish and Slovakian regions in the middle, and Czech and Lithuanian regions at the top. Estonia stands out from this aspect, as well, as it has the absolute best mean result, remarkably higher than any other regions.

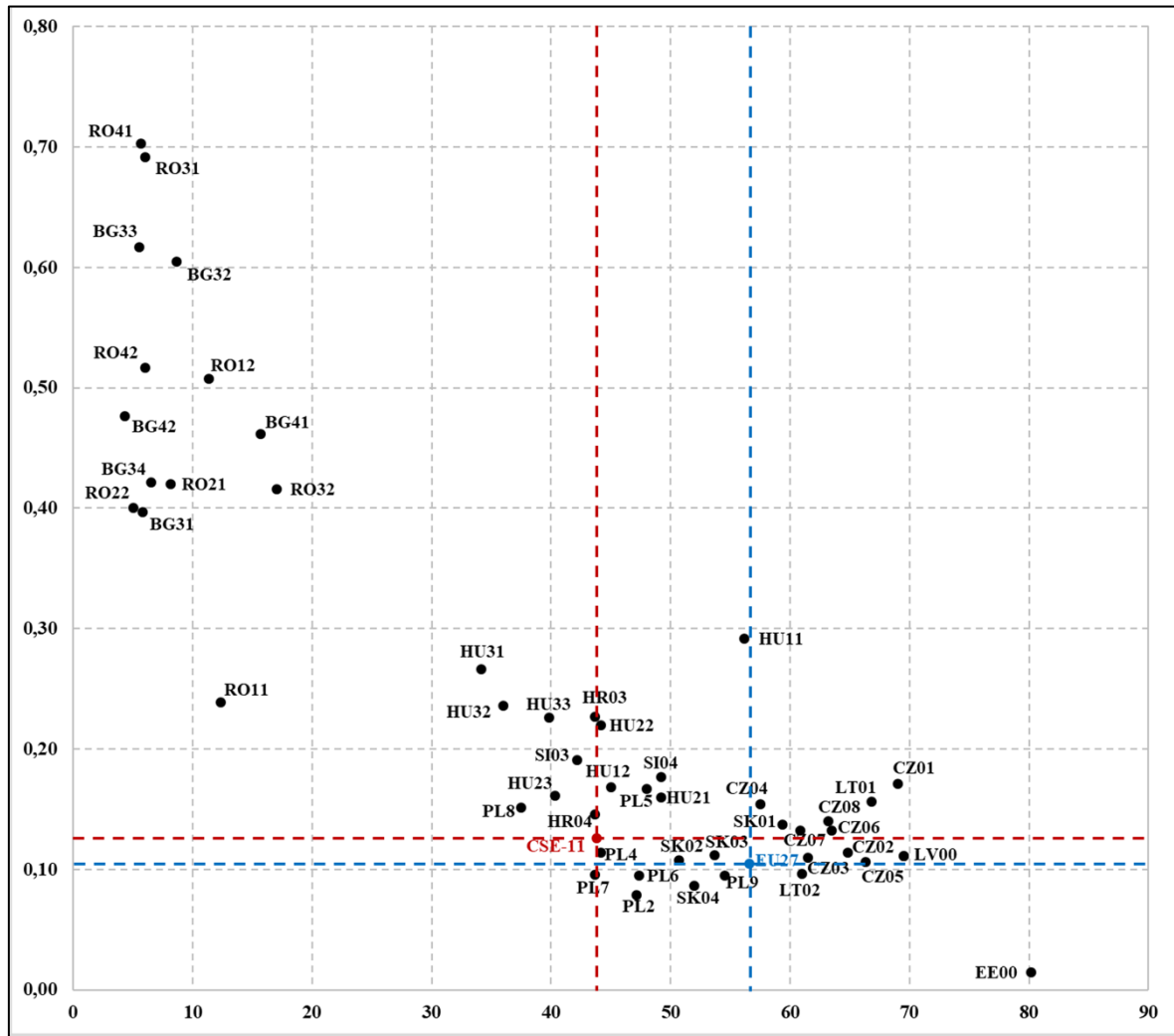


Figure 17.: Internet use: Internet banking: mean (x-axis) and coefficient of variation (y-axis) across the CSE-11 regions, 2016–2021

Source: Own elaboration.

5.3.6. Online purchases: from sellers from other EU countries – ORDER

The last indicator under observation measures the number of individuals that conducted online purchases from seller from other EU countries. The results are presented on Figure 18.

Observing the relationship between the two averages, one can conclude that the distance between them on the x-axis rose to 10%, which can be considered high, relatively to the scale of the axis. The difference between them is somewhat higher regarding the y-axis.

Examining the x-axis, one can see that the regions are dispersed relatively evenly on the scale. The worst results are connected to Romanian regions, then comes Bulgaria and Poland. Some Czech and Hungarian regions are below the CSE-11 average. There were only three regions where the EU-27 average was overperformed: one Slovenian, one Slovakian and Estonia.

Regarding the values on the y-axis, it is noticeable that most of the regions are distributed evenly, apart from the two Romanian regions in which the highest results were performed. The vast majority is located within the middle part of the scale, including regions from Romania, Czechia, Bulgaria, Hungary, Lithuania, Slovenia and Estonia. The lowest values are associated with three Slovakian, one Polish, one Croatian regions, as well as Latvia.

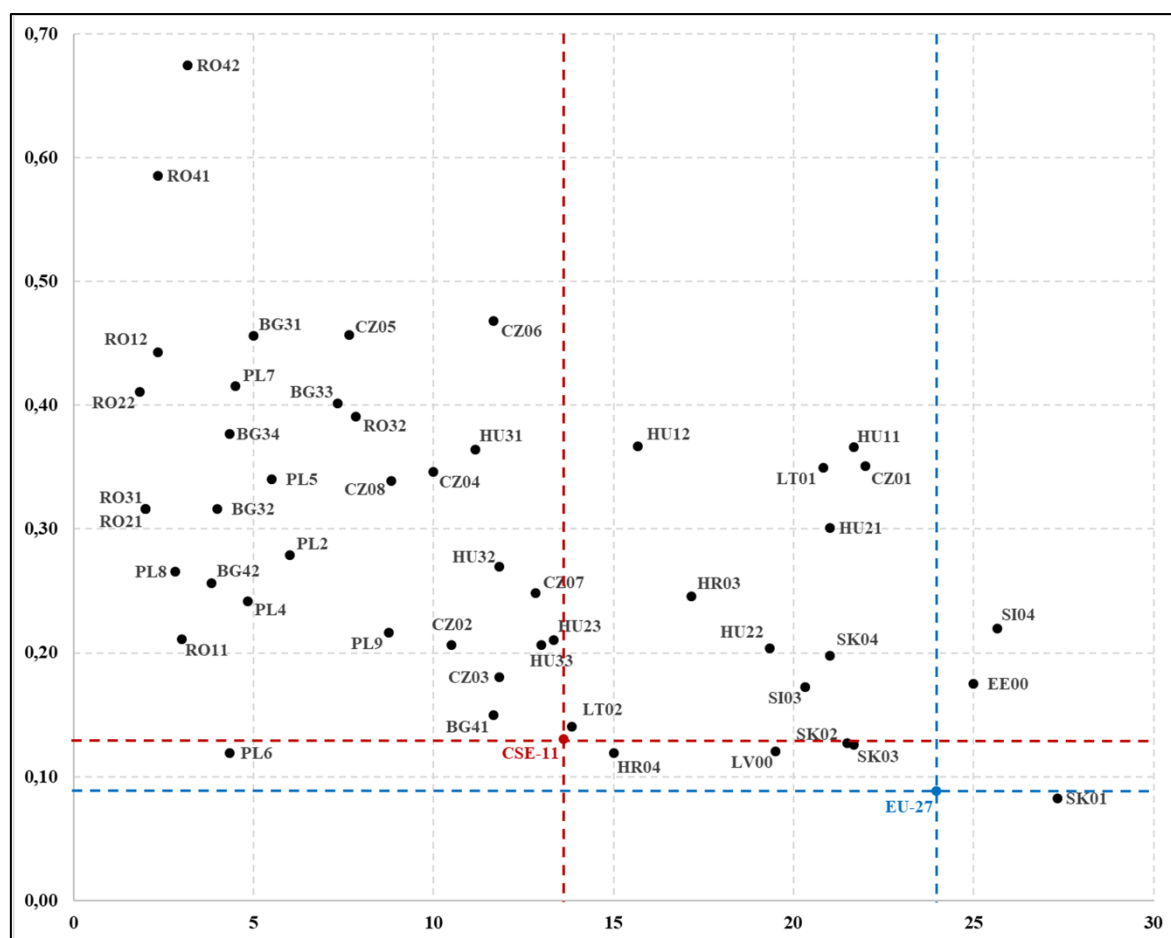


Figure 18.: Online purchases: from sellers from other EU countries: mean (x-axis) and coefficient of variation (y-axis) across the CSE-11 regions, 2016–2021
Source: Own elaboration.

5.3.7. Internet use: selling goods or services – ONSSELL

The next indicator under observation is the one concerning with the number of individuals who sold goods or services online, the result of which is shown on Figure 19. One can see that the scale of the x-axis is the shortest among the indicators (together with the previous one on Figure 18.), meaning that relatively to the other indicators, the regions in this case are closer to each other. On the other hand, the scale of the y-axis is the widest here, as the

highest coefficient of variation, detected in RO41 (Sud-Vest Oltenia), belongs to this indicator.

Examining the differences between the CSE-11 and the EU-27 averages one can see that regarding the mean values, the difference is only around 5%, which is relatively low in comparison with the other indicators. On the y-axis the difference is again, minimal, so the two average values are certainly close to each other.

Values on the x-axis are dispersed relatively evenly, there are no clear outlier regions. The lowest results, once again, belong to Romania, then Bulgaria, with all Romanian regions being under 5%. The highest value is connected to one of the Croatian regions, however, this one is still under 30%. Other well-performing regions are located in Slovakia, Croatia and Estonia.

Examination of the y-axis reveals that the highest value was provided in a Romanian region, that is by far above the following ones. Other higher coefficients of variation are to be found in Hungary and Romania. Below that, regions are located more densely. The lowest performances, that are positioned below the EU-27 average, are associated with Poland, Bulgaria, Croatia and Czechia. It is interesting to mention that Romanian regions are widely dispersed on the y-axis that leads to the conclusion that there are grave differences within the country.

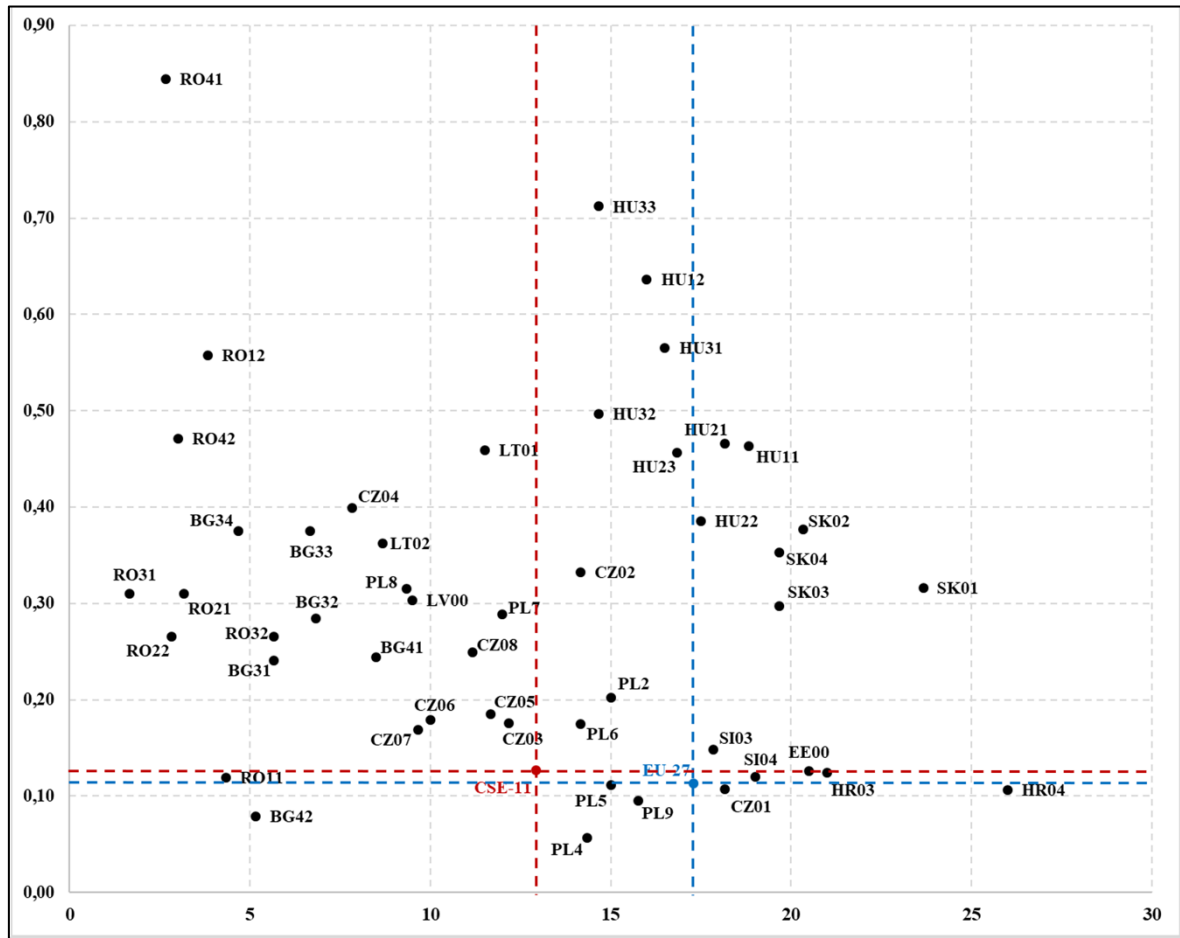


Figure 19.: Internet use: selling goods or services: mean (x-axis) and coefficient of variation (y-axis) across the CSE-11 regions, 2016–2021

Source: Own elaboration.

5.4. RESULTS OF THE MULTIDIMENSIONAL SCALING (MDS)

5.4.1. The 2016 MDS results

The results of MDS for 2016 are presented on Figure 20 and 21. The two dimensions are indicated as the two axes of the diagram. Most of the indicators appear in Dimension 1, where the order of these based on the extent of their influence on the dimension is as follows: DUINT, PUBAU, ONBANK, ORDER, BBACC, ONSSELL, and the directions of the included indicators are the same with no exceptions. The only indicator influencing Dimension 2 is SOCMED. The constellation of indicators in the dimensions does not change significantly through the three years, consequently the three results are comparable with each other.

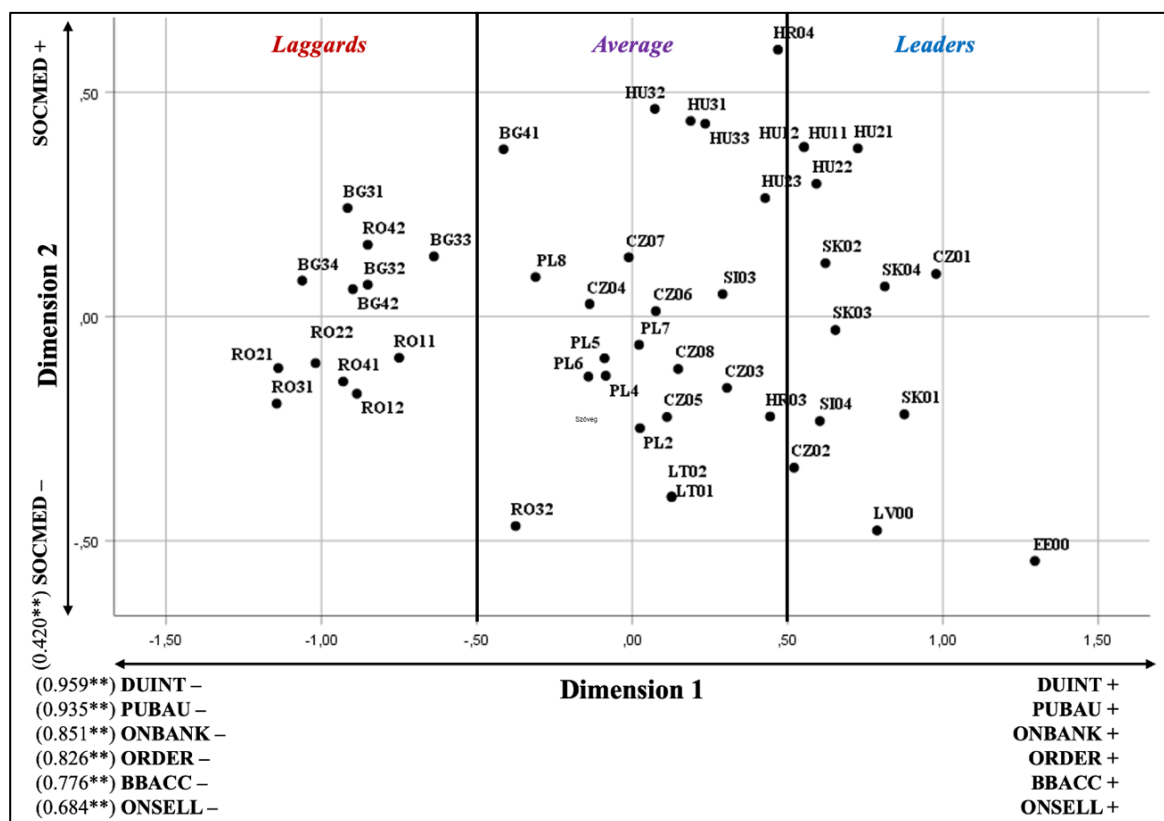
Based on the two dimensions, the most favourable positions are in the upper right corner of the diagram, while the lowest-level performances are associated with the bottom left corner. Regarding Dimension 1, the weakest results can be witnessed in the Romanian

and Bulgarian regions, with the exclusion of the capital regions of both countries, as these fall into the ‘Average’ category. The highest values within Dimension 1 were given to Estonia and Latvia, as well as, all regions of Slovakia, three Hungarian, two Czech and one Slovenian regions. Within Dimension 2, the performance of Estonia was the weakest, and the highest result is associated with a Croatian region, which stands out especially compared to the other Croatian region (HR03 – Jadranska Hrvatska).

The NUTS-2 regions of the CSE-11 countries tend to group together in several cases. For example, Romanian and Bulgarian regions are close to each other, apart from the capital regions of both countries (RO32 – Bucuresti-Ilfov; BG41 – Yugozapaden). Hungarian regions are located near each other, as well, where regional performances brought results slightly higher than average in Dimension 1, completed with high intensity of social media use that is descriptive of the country. In the middle part of the diagram, within the ‘Average’ category, there are mostly Polish, Czech and Lithuanian regions.

By comparing the results of the MDS analyses of 2019 and 2021, one can conclude that the NUTS-2 regions were almost divided into three parts, with some exceptions in the year 2016. The laggards – mostly Bulgaria and Romania; the above-average – consisting of Hungarian and Slovakian regions; and the middle part – Czech, Polish, Lithuanian regions; and some outliers.

Examining the visualization of the categories based on Dimension 1, one can see that the ‘Laggards’ category consists of regions of two Member States: Bulgaria and Romania. The ‘Average’ regions are located in Croatia, Poland, Lithuania, the Eastern half of Slovenia, the Southern and Eastern part of Hungary, the peripheral regions of Czechia, and the capital regions of Bulgaria and Romania. The category consisting of the ‘Leader’ regions include Slovakia, Estonia and Latvia, the Western part of Slovenia and Hungary, the central regions of Czechia.



Note: ** At 95% confidence ($p < 0.050$).

Figure 20.: MDS results in CSE-11 NUTS-2 regions, 2016

Source: Own elaboration.

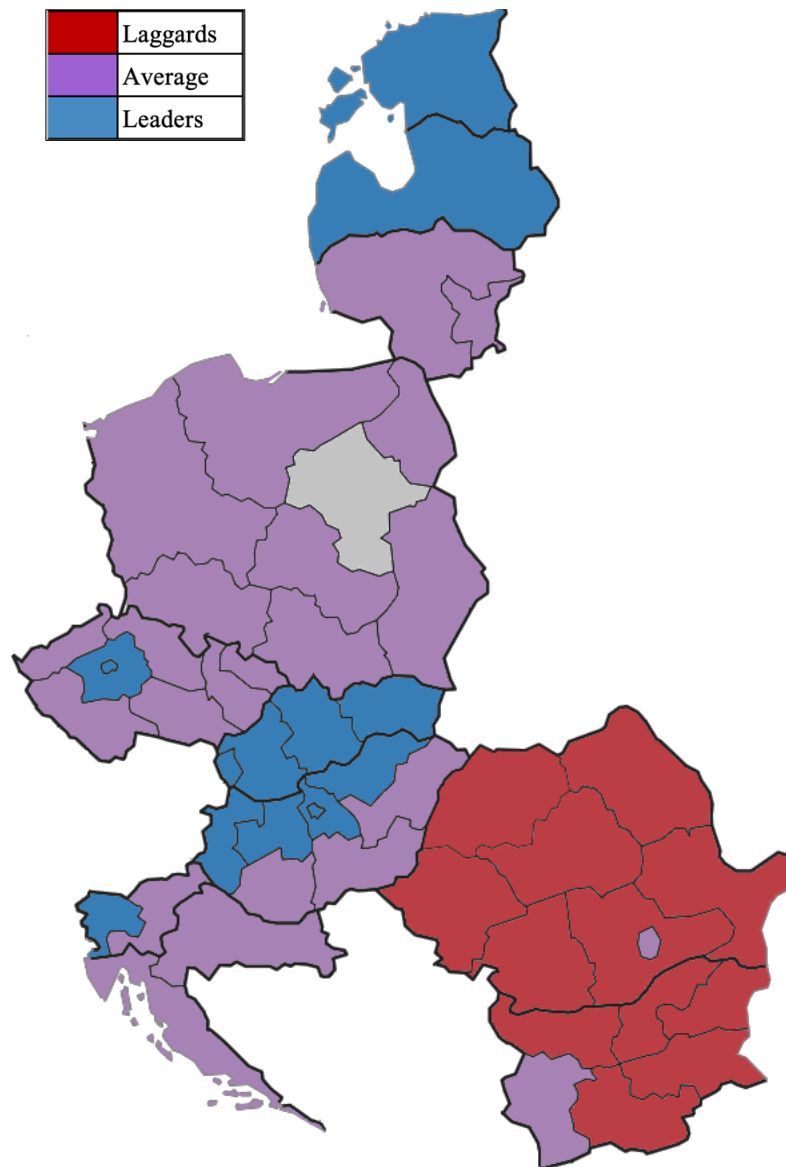


Figure 21.: Classification of CSE-11 NUTS-2 regions based on Dimension 1, 2016
Source: Own elaboration (design and cartography by the author).

5.4.2. The 2019 MDS results

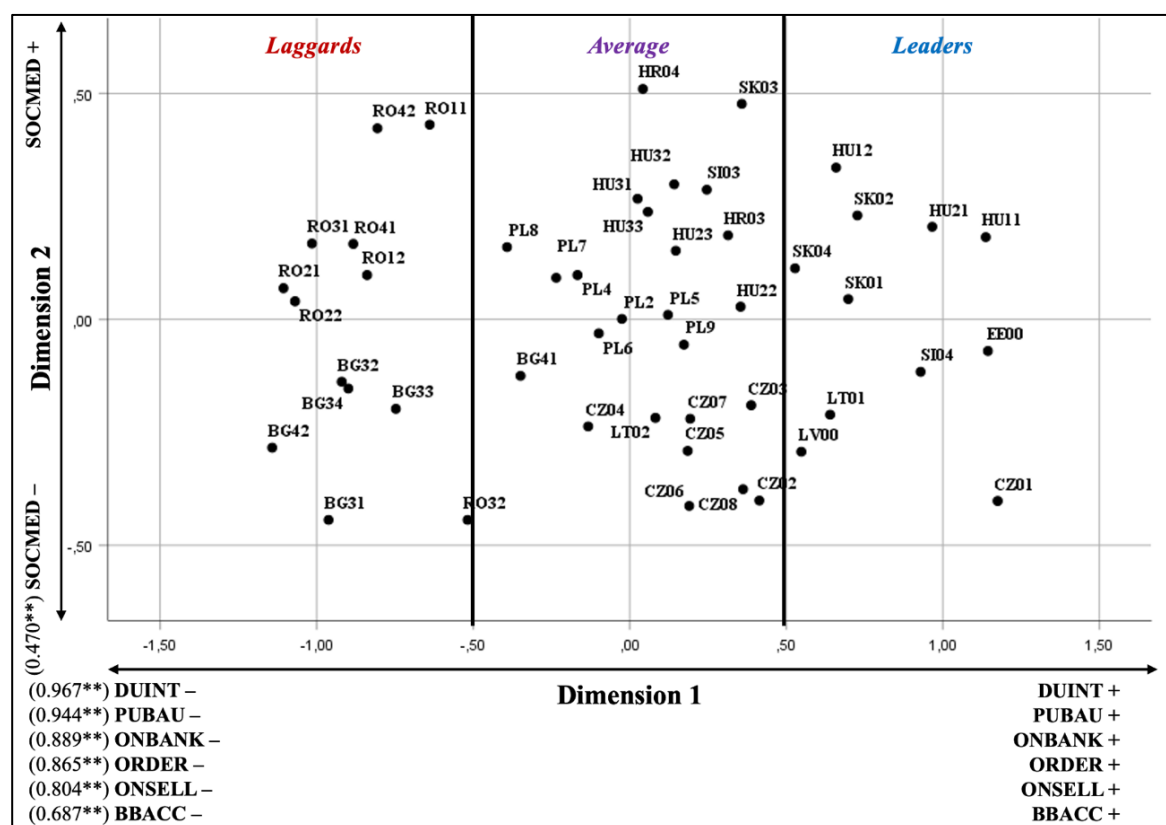
On Figure 22. and 23. the results of MDS for 2019 are presented. Within the set of indicators influencing the dimensions the only difference from the year 2016 is change between the ONSELL and the BBACC regarding their level of influence.

According to Dimension 1, the lowest performances once again are detected in Bulgarian and Romanian regions, however, their position in terms of social media use changed: in 2016 Bulgarian regions were better according to Dimension 2, while in 2019 Romanian regions have better positions, except for the capital region. The best performances based on Dimension 1 are in Estonia, the Czech capital region and two central regions of Hungary. From the point of view of Dimension 2, Estonia, Latvia and Lithuania are no longer in the

lowest positions, and HR04 (Kontinentalna Hrvatska) is still on the top followed by some, mostly Slovakian and Hungarian, regions.

Romania and Bulgaria are a bit further from each other, and regions within these countries are more scattered, as well. Hungarian regions are divided into two parts, and while the two Croatian regions are closer, the two Lithuanian and Slovenian regions are further from each other. Czechia and Poland are also more separable from the other.

Further observations can be made by looking at Figure 21. The ‘Laggards’ category has not gone through significant changes, only the situation of the Romanian capital region deteriorated. In case of the ‘Average’ regions one can note that there are more regions falling into this category then in 2016. The additional elements came from the ‘Leaders’ category, meaning that the number of regions belonging here declined. It can be concluded that this category was deprived of one Hungarian, one Slovakian and one Czech regions, while only the Western Lithuanian region was added to it.



Note: ** At 95% confidence ($p < 0.050$).

Figure 22.: MDS results of CSE-11 NUTS-2 regions, 2019

Source: Own elaboration.

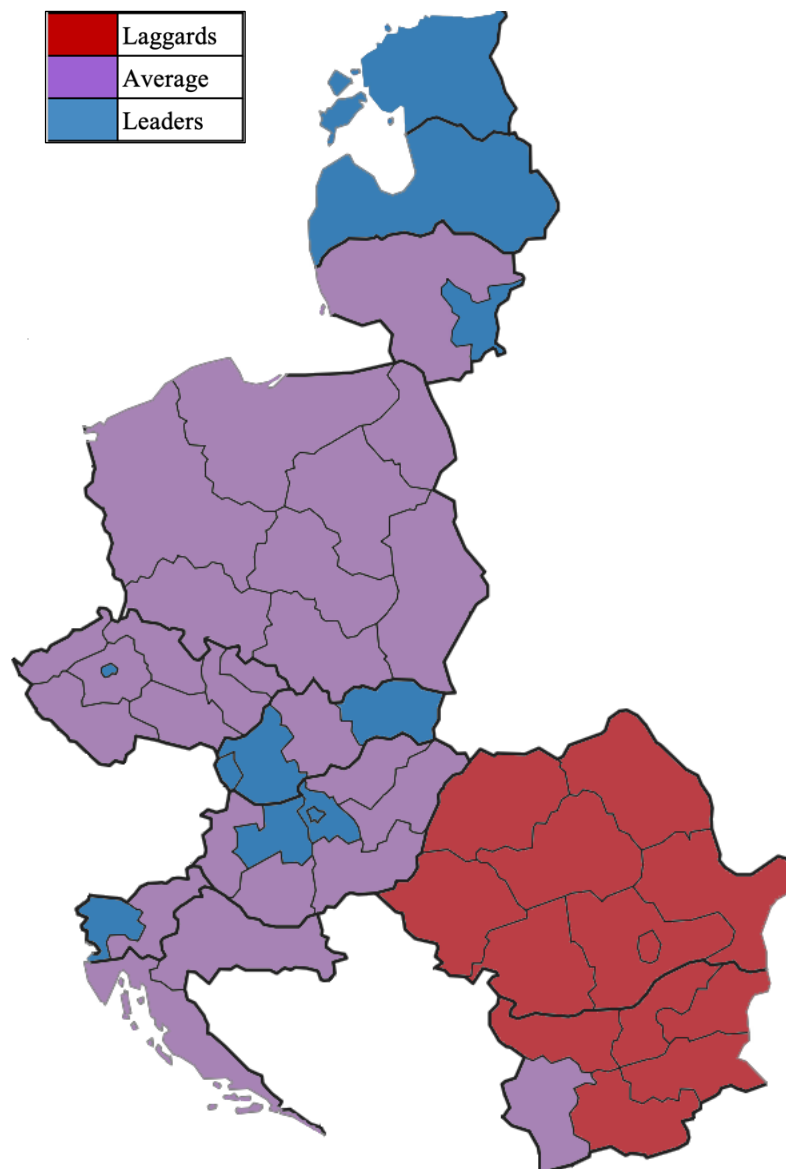


Figure 23.: Classification of CSE-11 NUTS-2 regions based on Dimension 1, 2019
Source: Own elaboration (design and cartography by the author).

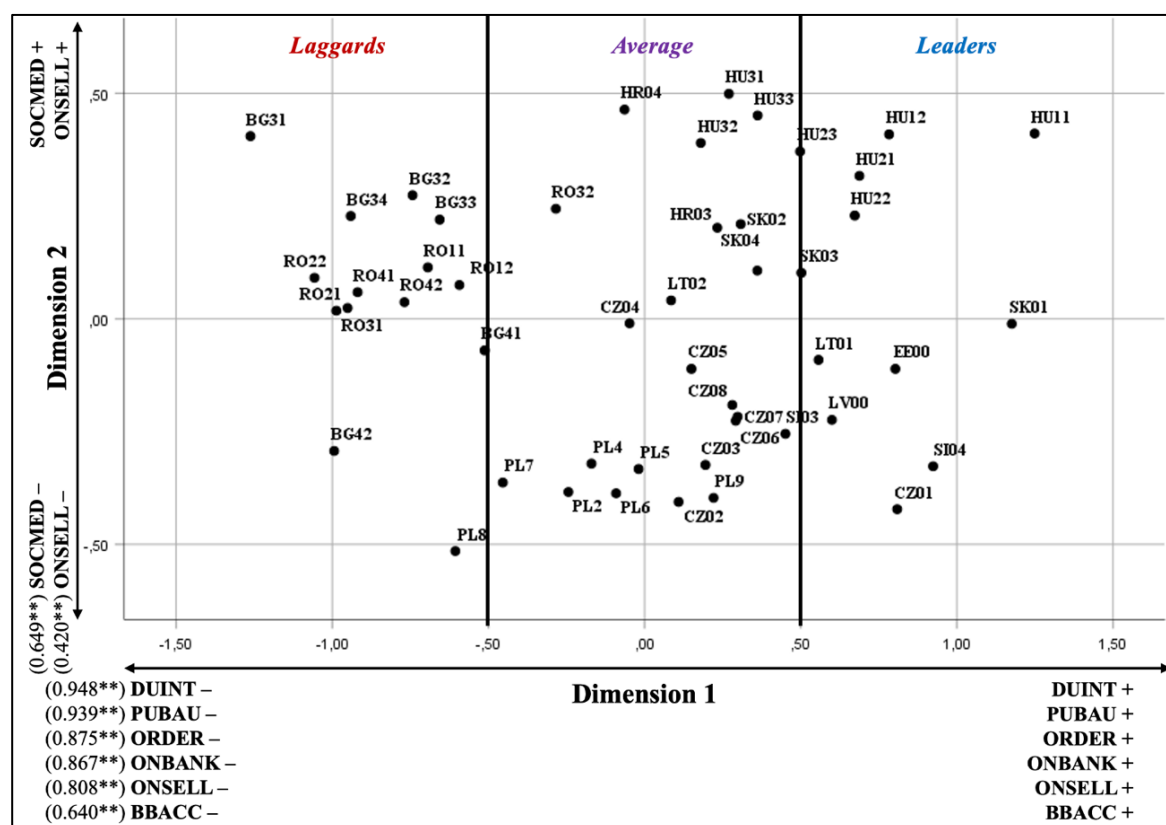
5.4.3. The 2021 MDS results

On Figure 24. and 25. the result of MDS for 2021 is shown. Regarding the set of indicators represented by the two dimensions, change can be observed in two cases: in Dimension 1 ONBANK and ORDER were switched, and in Dimension 2 ONSELL also appear together with SOCMED.

The best results within Dimension 1 are associated with one-one regions from Hungary, Slovakia, Slovenia and Estonia. The worst performances were once again provided by Bulgarian and Romanian regions. Regarding Dimension 2, highest values are connected to Hungary completed with one Croatian and one Bulgarian regions. The lowest results were provided mostly by Polish and Czech regions.

Bulgarian regions are divided into two parts influenced by their results in Dimension 2, and the country's regions are again well-distinguishable from the Romanian regions. Hungarian regions rearranged and are closer to one another. Slovenian regions converged closer to each other. Czech and Polish regions switched positions regarding Dimension 2, with Polish regions being the bottom, performers in this year.

Figure 25. shows differences from the previous years within the dispersion of regions into the three categories. To the 'Laggards' category one Polish and one Bulgarian region were added, while the Romanian capital no longer belongs here. Two Slovakian regions descended to the 'Average' category, and the region of Bucharest is also included here. Two Hungarian regions were attached to the 'Leaders' category, making the whole Western part of the country included among the high performers. The middle part of Slovakia also ascended to this category. Slovenia was consistent with its two regions belonging to different categories through the three years, and Croatian regions did not transfer either.



Note: ** At 95% confidence ($p < 0.050$).

Figure 24.: MDS results of CSE-11 NUTS-2 regions, 2021

Source: Own elaboration.

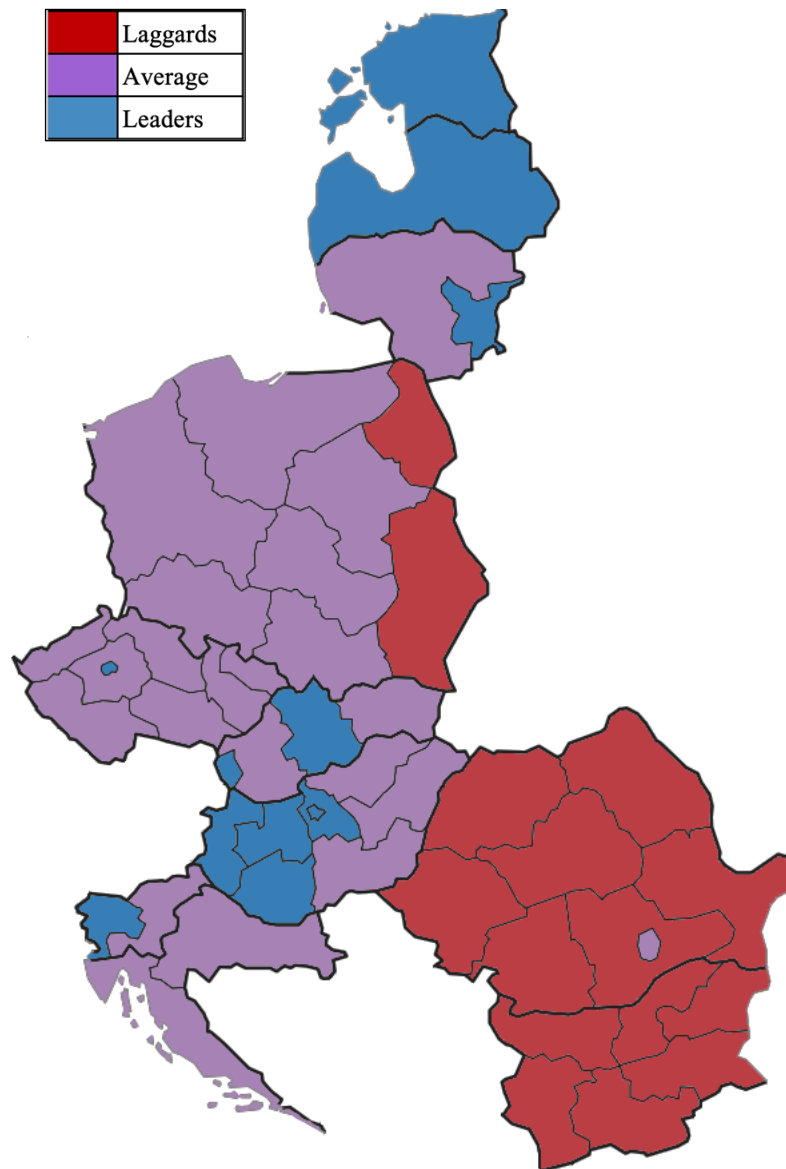


Figure 25.: Classification of CSE-11 NUTS-2 regions based on Dimension 1, 2021
Source: Own elaboration (design and cartography by the author).

5.5. EVALUATION OF RESULTS IN LIGHT OF THE COVID-19 OUTBREAK

There is no doubt that COVID-19 has had an enormous impact on several fields of the everyday life of individuals and households. One of the gravest concerns the world faced owing to the pandemic was to find digital solutions in working, education and even in social life, as well as to introduce safety measures, like social (physical) distancing. By looking at the results of the primary results, it is possible to gain information about the short-term effects of the pandemic on digitalisation. Based on the detected patterns of change, especially for the 2019–2021 period, it is possible to draw up conclusions about the direction and the extent of the short-term effects of the pandemic on the digitalisation.

As for the convergence and divergence patterns, there are no sharp changes in the case of the first level of digital divide (BBACC, DUINT) in the period of 2019–2021 as all regions are either in the upward convergence or upward divergence category (regions show downward trends only in very few cases). Concerning the second level of digital divide, one can observe a more diverse picture. In the case of indicator related to online banking (ON-BANK), the features are very similar to the indicators of first level of digital divide. In addition, upward trends are more common for indicators related to social media participation (SOCMED) and interaction with public authorities (PUBAU); however, there are also several regions that can be characterised with a decreasing share engaging in such activities during the period of the pandemic. The results in case of ordering goods and services from other EU Member States (ORDER) are not comparable to other indicators as here exclusively downward patterns (downward convergence and downward divergence) can be detected for the 2019–2021 period. It is also clear that the number of regions in which online ordering decreased is almost equal to the number of regions in which it increased. Finally, the third level of digital divide (ONSELL) shows upward patterns on both regional and EU level. In this case it can be also observed that the increase in the number of regions in which the number of people who have economic benefit from selling on Internet is similar to the number of regions in which it decreased.

Regarding two indicators, BBACC and DUINT, regions show minor differences with respect to the growth intensity; however, it is important to note that during the COVID-19 years the average increase within the CSE-11 region was higher than within the EU-27. These indicators show relatively lower, but stable growth with no extreme or outstanding regions. The widest range of regional performances can be associated with ONSELL. The only case in which the average change both at the regional and EU level were negative is ORDER. The highest average increase can be associated with ONSELL.

In summary, I can conclude that regional tendencies have probably been influenced by the COVID-19 as there are significant changes in the period of the pandemic. One can find examples of rapid growth in some areas of ICT usage (e.g. BG32 (Severen tsentralen), BG42 (Yuzhen tsentralen), RO12 (Centru), RO32 (Bucuresti – Ilfov), RO42 (Vest)).

6. CONCLUSIONS AND OUTLOOK

6.1. KEY FINDINGS

In keeping with the key research aim presented in the introduction, *this study empirically examined and evaluated the level of digital development, the status of digital transformation and spatial characteristics of digital divide on regional (NUTS-2) level among 49 regions of the 11 Central and South-East European transition countries through measuring the recent changes (2016–2021) in the ICT usage in households and by individuals through 7 ICT-related indicators with special regard to the consequences of the COVID-19 pandemic.*

To reach this aim and find answers to the research questions of the study, I provided a thorough literature review on digital divide, and pointed out its three levels and influencing factors, as well as presented existing indices that have been designed to measure digitalisation (Chapter 2). Besides, I summarised the EU's strategic actions, initiatives and financial framework related to digital transformation. I presented the DESI and provided an overview on the current state of the digital development in the EU based on factual evidence produced by Eurostat (Chapter 3). Furthermore, I classified the regions of transition countries through their progress with special regard to the convergence or divergence patterns they show with respect to two time periods (2016–2021, 2019–2021) in EU-27 and CSE-11 comparison. Moreover, I analysed the balance and imbalance patterns within the development dynamics of regions based on the mean value and the coefficient of variation (CV) with respect to all indicators. Finally, I conducted multidimensional scaling (MDS) to get an insight into the regional similarities and differences in the case study area (Chapter 5).

The most important conclusions and findings of the research can be summed up as follows.

First, I can conclude that the digital divide is a relatively recent, but urgent matter that emerged in an era when the infrastructure and usage of ICT enhanced, and the access to the 'virtual world' became crucial in everyday life. As presented, digital divide has three levels, reflecting the digital access (first level), digital capability (second level) and digital outcome (third level) one can gain from the process of digitalisation.

Besides, I can conclude that the EU's actions in the field as well as policy objectives towards building a digital Europe have been of high priorities for the last couple of decades. The institutions of the EU have already recognised the promotion of digital transformation, and policy making in the EU shifted in the focus from providing only access to the Internet for the population to the provision of high-speed Internet and connectivity throughout the

EU, together with the promotion of digital literacy and e-inclusion in order to narrow the digital gap between Member States and regions. The financial support frameworks (2014–2020 MFF, 2021–2027 MFF) also reflect the importance of digital development as great amounts of funds from the EU budget have been allocated for digitalisation purposes. I also pointed out that the DESI index is a key and common measure to capture the different aspects of digitalisation and enables the comparison of countries.

In addition, based on the results of the primary research, I managed to identify regions with relatively low and high progress in the observed periods. Regarding the 2016–2021 period, one can find regions of Romania among the top performers, followed by Bulgarian and Czech regions. Regarding regions of relatively low-level progress in the observed period, the most underperforming regions can be reported from Slovakia, Poland, as well as Estonia and Czechia. In the 2019–2021 period, the highest number of top performers can be associated with Romania; however, there are several cases with high performances in Bulgaria, too. The highest number regarding low-level performance can be found in Czechia.

Furthermore, based on the analysis of patterns of balance and imbalance regarding the growth dynamics of regions, I can conclude that CSE-11 regions have a lower mean value than EU-27 regions together; however, the coefficient of variation seems to be constantly higher for this group than for the whole common market. Moreover, the regions belonging to the same country tend to group together. Bulgarian and Romanian regions almost exclusively form a separate group with relatively low mean values and high coefficients of variation.

MDS revealed that there is a relationship between the 7 ICT-related indicators, and the dimension reduction resulted in solutions that do not differ significantly for the three years (2016, 2019, 2021). Dimension 1. embraces six indicators out of the original seven indicators, while Dimension 2 consists of the SOCMED in 2016 and 2019, as well as SOCMED–ONSELL relation in 2021. I can conclude that mostly Bulgarian and Romanian regions can be assigned to the ‘Laggards’ category along Dimension 1. Estonia and Latvia can be defined as ‘Leaders’. Regions of Poland, Czechia, Lithuania and Croatia can be mostly associated with the ‘Average’ category, but partly with the ‘Leaders’ category, too. In the case of Hungary, Slovakia and Slovenia, there is a remarkable number of regions belonging to the ‘Leaders’. One can also notice that there is a clear dichotomy between the capital regions and the countryside, as capital regions tend to overperform the rest of the countries in general. This phenomenon can be witnessed in, for example, Bulgaria, Romania, Hungary and Czechia.

An important conclusion is that there has been convergence in all ICT-related indicators within several regions of the European transition economies, but a sharp divide is still visible among regions. Also, regions belonging to the same country are more similar than different, and regions of relatively low capacities in digitalisation tend to be the same ones with respect to all indicators. Finally, I can conclude that regional tendencies have probably been influenced by the COVID-19 as there has been rapid growth in the period of the pandemic.

6.2. MAIN LIMITATIONS

During the assessment process I came across some shortcomings that deserve mention and further analysis. First, there are some other ICT-related indicators provided by Eurostat that could have been involved in this study; however, I had to exclude them from this research as data were not available for some years (e.g. individuals who have never used a computer). Second, my original intention was to create an analysis focusing on every region in the EU-27 context; however, data service delays in some Western and Southern European countries. Accordingly, I had to narrow down the case study area. Besides, ICT indicators are not available at NUTS-2 (regional) level in some cases; in the case of Poland data on NUTS-1 level were available. In addition, indicators available in Eurostat are not perfect for monitoring and evaluating digitalisation-related objectives as they are not in line with the priorities of the EU with respect to digital transformation. Therefore, the impacts of the actions of EU level are harder to be detected. Accordingly, the entire measurement system can be amended and improved. Greater efforts in terms of data collection should be made to test other elements and features of digitalisation in the future.

6.3. FUTURE RESEARCH AGENDA AND POLICY IMPLICATIONS

I have found several possible further directions for a more detailed elaboration of the subject.

First, ICT-related indicators can be correlated with other indicators or indexes that capture economic prosperity, competitiveness, social exclusion and sustainable development. Out of these, analysing linkages between social exclusion, social aspects and digitalisation should be particularly crucial areas of study as digital transformations always have, mainly negative, side effects on society.

Another possible extension of the current research could be carrying out empirical investigations at lower territorial units. For instance, cities or functional urban areas may serve as good case study fields for further primary research. Further investigations at LAU1

or LAU2 levels would reflect the existing dichotomies more precisely, and results derived from such investigations can be applied to practice and help policy makers design a creditable and sustainable ICT policy to empower the countryside as well as rural and peripheral areas, including sub-regions and settlements.

Furthermore, a possible direction for future research is in creating an empirical analysis with respect to every region of the European Union. In this study, the EU-27 average emerged as a reference point. However, examining digital divide and digital transformation throughout the 27 Member States along with their regions would be crucial.

The findings of the study are of strong political relevance as they have important implications for European sectoral and spatial development policies and policy areas. The results obtained might provide a reference for assessment and analysis of situation for European Union's sectoral and territorial policies and agendas (e.g. cohesion policy, digital economy, digital society, digital finance, e-commerce, e-government, e-inclusion, lifelong learning), especially to take advantage of ICT infrastructure (access) and usage (competence). Adequate knowledge about the state of digital divide helps policy makers identify further actions for improvement. I believe that my findings have the potential to contribute significantly to the ongoing discussion and evolving research on the subject.

LIST OF REFERENCES

Literature

- Agostino, D. – Arnaboldi, M. – Lema, M. D. (2021): New development: COVID-19 as an accelerator of digital transformation in public service delivery. *Public Money & Management*, Vol. 41, No. 1, pp. 69–72, <https://doi.org/10.1080/09540962.2020.1764206>
- Bánhidi, Z. – Dobos, I. – Nemeslaki, A. (2020): What the overall Digital Economy and Society Index reveals: A statistical analysis of the DESI EU28 dimensions. *Regional Statistics*, Vol. 10, No. 2, pp. 42–62, <https://doi.org/10.15196/RS100209>
- Bannykh, G. – Kostina, S. (2022): Measuring Digital Capital: Methodological Approaches. *KnE Social Sciences*, Vol. 7, No. 3, pp. 96–103, <https://doi.org/10.18502/kss.v7i2.10282>
- Boikova, T. – Zeverte-Rivza, S. – Rivza, P. – Rivza, B. (2021): The Determinants and Effects of Competitiveness: The Role of Digitalization in the European Economies. *Sustainability*, Vol. 13, Art. 11689, <https://doi.org/10.3390/su132111689>
- Bruno, G. – Esposito, E. – Genovese, A. – Gwebu, K. L. (2011): A Critical Analysis of Current Indexes for Digital Divide Measurement. *The Information Society*, Vol. 27, No. 1, pp. 16–28, <https://doi.org/10.1080/01972243.2010.534364>
- Capello, R. (2016): *Regional Economics*. Routledge, New York–Abdingdon. 354 p.
- Capello, R. – Nijkamp, P. (1996): Telecommunications Policy for Regional Development: Theoretical Considerations and Empirical Evidence. *The Annals of Regional Science*, Vol. 30, No. 1, pp. 7–30, <https://doi.org/10.1007/BF01580535>
- Dusek, T. (2012): Bidimensional Regression in Spatial Analysis. *Regional Statistics*, Vol. 10, No. 2, pp. 61–73, <https://doi.org/10.15196/RS02105>
- Eurofound (2018): Upward convergence in the EU: Concepts, measurements and indicators. Publications Office of the European Union, Luxembourg. 74 p.
- European Commission (EC) (2010a): *A Digital Agenda for Europe*. European Commission, Publications Office of the European Union, Luxembourg. 41 p.
- European Commission (EC) (2010b): *EUROPE 2020. A European strategy for smart, sustainable and inclusive growth*. European Commission, Publications Office of the European Union, Luxembourg. 32 p.

- European Commission (EC) (2013): *Multiannual Financial Framework 2014–2020 and EU budget 2014. The figures*. European Commission, Publications Office of the European Union, Luxembourg. 24 p.
- European Commission (EC) (2021): *2030 Digital Compass: the European way of for the Digital Decade*. European Commission, Publications Office of the European Union, Luxembourg. 20 p.
- European Commission (EC) (2022): *Digital Economy and Society Index (DESI) 2022. Thematic chapters*. European Commission, Publications Office of the European Union, Luxembourg. 88 p.
- Fuchs C. – Horak E. (2007): Informational Capitalism and the Digital Divide in Africa. *Masaryk University Journal of Law and Technology*, Vol. 1, No. 2, pp. 11–32.
- Ha, L. T. (2022): Effects of digitalization on financialization: Empirical evidence from European countries. *Technology in Society*, Vol. 68, Art. 101851, <https://doi.org/10.1016/j.techsoc.2021.101851>
- Ketskemény L. – Izsó L. – Könyves Tóth E. (2011): *Bevezetés az IBM SPSS Statistics programrendszerbe*. Artéria Stúdió Kft, Budapest. 579 p.
- Lengyel I. (1999): Mért a mérhetetlent? A megyei jogú városok vizsgálata többdimenziós skálázással. *Tér és Társadalom*, 13. évf., 1–2. sz., pp. 53–73.
- Lucendo-Monedero, A. L. – Ruiz-Rodríguez, F. – González-Relaño, R. (2019): Measuring the digital divide at regional level. A spatial analysis of the inequalities in digital development of households and individuals in Europe. *Telematics and Informatics*, Vol. 41, pp. 197–217, <https://doi.org/10.1016/j.tele.2019.05.002>
- Lukovics M. – Lóránd B. (2010): A versenyképesség és a pályázati forrásallokáció kistérségi szinten. *Tér és Társadalom*, 24. évf., 4. sz., pp. 81–102.
- Mérő, L. (1986): A többdimenziós skálázás alapelvei. *Pszichológia*, 6. évf. 3. sz., pp. 399–433.
- Mondejar, M. E. – Avtar, R. – Baños Diaz, H. L. – Dubey, R. K. – Esteban, J. – Gómez-Morales, A. – Hallam, B. – Mbungu, N. T. – Okolo, C. C. – Prasad, K. A. – She, Q. – Garcia-Segura, S. (2021): Digitalization to achieve sustainable development goals: Steps towards a Smart Green Planet. *Science of The Total Environment*, Vol. 794, Art. 148539, <https://doi.org/10.1016/j.scitotenv.2021.148539>
- Nevado-Peña, D. – López-Ruiz, V.-R. – Alfaro-Navarro, J.-L. (2019): Improving quality of life perception with ICT use and technological capacity in Europe. *Technological*

- Forecasting and Social Change*, Vol. 148, Art. 119734,
<https://doi.org/10.1016/j.techfore.2019.119734>
- Norris, P. (2001): *Digital Divide: Civic Engagement, Information Poverty, and the Internet Worldwide*. Cambridge University Press, Cambridge. 320 p.
- Organisation for Economic Co-operation and Development (OECD) (2001): *Understanding the Digital Divide*. OECD Publishing, Paris. 32 p.
- Øverby, H. – Audestad, J. A. (2021): *Introduction to Digital Economics. Foundations, Business Models and Case Studies*. Springer, Cham. 353 p.
<https://doi.org/10.1007/978-3-030-78237-5>
- Park, S. (2017): *Digital Capital*. Palgrave Macmillan, London. 247 p.
- Ragnedda, M. (2018): Conceptualizing digital capital. *Telematics and Informatics*, Vol. 35, No. 8, pp. 2366–2375, <https://doi.org/10.1016/j.tele.2018.10.006>
- Riggins, F. J. – Dewan, S. (2005): The Digital Divide: Current and Future Research Directions. *Journal of Association for Information Systems*, Vol. 6, No. 12, pp. 298–337, <https://doi.org/10.17705/1jais.00074>
- Scheerder, A. – van Deursen, A. – van Dijk, J. (2017): Determinants of Internet skills, uses and outcomes. A systematic review of the second-and third-level digital divide. *Telematics and Informatics*, Vol. 34, No. 8, pp. 1607–1624.
<https://doi.org/10.1016/j.tele.2017.07.007>
- Stimson, R. J. – Stough, R. R. – Roberts, B. H. (2006): *Regional Economic Development. Analysis and Planning Strategy*. Springer, Berlin – Heidelberg – New York. 452 p.
- Székelyi M. – Barna I. (2008): *Túlélőkészlet az SPSS-hez. Többváltozós elemzési technikákról társadalomkutatók számára*. Typotex, Budapest. 454 p.
- Takács Sz. (2013): Többdimenziós skálázás. *Psychologia Hungarica Caroliensis*, 1. évf., 1. sz., pp. 140–149.
- van Deursen, A. J. A. M. – Courtois, C. – van Dijk, J. A. G. M. (2014): Internet Skills, Sources of Support, and Benefiting From Internet Use, *International Journal of Human–Computer Interaction*, Vol. 30, No. 4, pp. 278–290,
<https://doi.org/10.1080/10447318.2013.858458>
- Várallyai L. – Herdon M. – Botos Sz. (2015): Statistical Analyses of Digital Divide Factors. *Procedia Economics and Finance*, Vol. 19, pp. 364–372,
[https://doi.org/10.1016/S2212-5671\(15\)00037-4](https://doi.org/10.1016/S2212-5671(15)00037-4)

- Vicente, M. R. – López, A. J. (2011): Assessing the regional digital divide across the European Union-27, *Telecommunications Policy*, Vol. 35, No. 3, pp. 220–237, <https://doi.org/10.1016/j.telpol.2010.12.013>
- Vu, K. – Hanafizadeh, P. – Bohlin, E. (2020): ICT as a driver of economic growth: A survey of the literature and directions for future research. *Telecommunications Policy*, Vol. 44, No. 2, Art. 101922, <https://doi.org/10.1016/j.telpol.2020.101922>
- Wei, K. K. – Teo, H. H. – Chan, H. C. – Tan, B. C. Y. (2011): Conceptualizing and Testing a Social Cognitive Model of the Digital Divide. *Information Systems Research*, Vol. 22, No. 1, pp. 170–187, <https://doi.org/10.1287/isre.1090.0273>
- World Bank (2002): *Transition. The First Ten Years. Analysis and Lessons for Eastern Europe and the former Soviet Union*. The World Bank, Washington D.C. 128 p.
- Yilmaz, S. – Dinc, M. (2002): Telecommunications and Regional Development: Evidence from the U.S. States. *Economic Development Quarterly*, Vol. 16, No. 3, pp. 211–228, <https://doi.org/10.1177/08942402016003002>

Sources from the Internet

A new comprehensive Digital Skills Indicator:

<https://digital-strategy.ec.europa.eu/en/library/new-comprehensive-digital-skills-indicator> (downloaded on 24 April 2022)

Commission of the European Communities (CEC) (2005): *i2010 – A European Information Society for growth and employment*. Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions, Brussels. 12 p. Available at <https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52005DC0229&from=EN> (downloaded on 20 April 2022)

Data Visualization Tool – Data & Indicators:

<https://digital-agenda-data.eu> (downloaded on 26 April 2022)

Digital economy and society statistics – households and individuals:

https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Digital_economy_and_society_statistics_-_households_and_individuals#Internet_access (downloaded on 20 April 2022)

European Commission (EC) (2020a): *Shaping Europe's Digital Future*. European Commission, Publications Office of the European Union, Luxembourg. 9 p. Available at

- https://ec.europa.eu/info/sites/default/files/communication-shaping-europes-digital-future-feb2020_en_4.pdf (downloaded on 15 April 2022)
- European Commission (EC) (2020b): *EU's next long-term budget & NextGenerationEU: Key Facts and Figures*. European Commission, Publications Office of the European Union, Luxembourg. 3 p. Available at https://ec.europa.eu/info/sites/default/files/about_the_european_commission/eu_budget/mff_factsheet_agreement_en_web_20.11.pdf (downloaded on 15 April 2022)
- European Union priorities 2019–2024:
- https://european-union.europa.eu/priorities-and-actions/eu-priorities_en (downloaded on 30 March 2022)
- Global Cybersecurity Index:
- <https://www.itu.int/en/ITU-D/Cybersecurity/Pages/global-cybersecurity-index.aspx> (downloaded on 9 May 2022)
- ICT usage in households and by individuals:
- https://ec.europa.eu/eurostat/cache/metadata/en/isoc_i_esms.htm (downloaded on 13 May 2022)
- International Monetary Fund (IMF) (2000): *Transition Economies: An IMF Perspective on Progress and Prospects. International Monetary Fund Issues Briefs*, November 3. <https://www.imf.org/external/np/exr/ib/2000/110300.htm> (downloaded on 2 September 2022)
- The Digital Competence (DigComp 2.2) Framework:
- https://joint-research-centre.ec.europa.eu/digcomp/digital-competence-framework_en (downloaded on 15 May 2022)
- The Digital Economy and Society Index (DESI):
- <https://digital-strategy.ec.europa.eu/en/policies/desi> (downloaded on 15 May 2022)
- The ICT Development Index (IDI):
- <https://www.itu.int/en/ITU-D/Statistics/Pages/IDI/default.aspx> (downloaded on 9 May 2022)

ANNEXES

**Please find Annexes 1–9.
in a separate document**