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Measuring the digital divide in the V4 countries using the digital divide index

Meranie digitálnej priepasti v krajinách V4 s využitím indexu digitálnej priepasti

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Abstract: This paper focuses on examining the differences in access and use of ICT in selected risk groups of the population in V4 countries. It is a question of digital inequality and the digital divide, which are a threat to the progress of the whole society because they cause digital exclusion. Based on the theoretical framework of this concept, the authors examine the extent of this exclusion in the year 2019 in the Visegrad Group countries, using a modified digital divide index. The analysis confirmed significant differences in ICT access and usage among older people, individuals with low education and low income in comparison to the average population. The extent of these inequalities varies in V4 countries, although there is no significant difference in the development of infrastructure or other social inequalities. Available data show that Hungary has the lowest level of digital equality lagging behind other countries in the level of trust in information and services provided online and in perceived security.

Key words: *Digital divide. Digital inequality. Digital skills. Digital divide index.*

JEL Classification: J24. Z13.

Introduction

The constant development of digital technologies encourages several changes. As plenty of authors state (e.g. DiMaggio, Hargittai, 2001; Robinson et al.,2015; Krištofík, Medzihorský, 2019; Vaňová, Vitálišová, Borseková, 2019; Horeháj, Marasová, 2020) the unprecedented impact of these technologies on economic development and on the entire social system will continue to grow. Undeniably, there are many positive consequences of digital technology, however this is also coupled with digital inequality and a digital divide. Digital inequality refers to the differences between individuals in terms of formal access to the internet (DiMaggio, Hargittai, 2001), the digital divide refers to inequalities between the so-called "digital" and "non-digital" people (Ertl et al., 2020). Some time has passed since the first use of these terms

and their content, as well as the characteristics of the individuals affected by the phenomena, have changed. Nevertheless, we perceive that these two concepts intersect in many aspects, and are not easily separated from each other. At the same time, especially from the point of view of national economic policy and from the European level, it is important to examine the content and extent of these phenomena to responsibly mitigate the risks arising from this.

Our paper aims to examine and characterize the current state of the digital divide in the countries of the Visegrad Group (hereinafter "V4") based on the modified digital divide index. The original index was created by Husing and Selhofer (2002). It was used to measure the digital divide in four so-called risk groups identified based on four socio-demographic variables: age, gender, education, and income. For each of the risk groups, the index considered three indicators: computer use in various locations, internet use in various locations and internet use at home. We used the logic proposed by the authors to calculate the modified digital divide index using available data from Eurostat databases, while we also calculate partial indices for individual risk groups and compare them within the V4 countries.

1. Theoretical background

The concept of the digital divide originated at the end of the 20th century. In 1995, the term was used several times in periodicals in the USA, and the very creation of the concept prompted the publication of the report Falling Through the Net by the National Telecommunications and Information Office. For the first time, this report examined the underlying digital divide between those who have access to information and communication technologies (ICT) and those who do not (van Dijk, 2020). Subsequently, this concept has spread to the European continent and has come to the attention of both academics and economic policymakers at the national and European level, as the use of digital technologies is crucial for today's developed countries and permeates all sectors of modern society, from agriculture and industry to education or health (Hunady et al., 2020).

Authors understand the term digital divide differently. Probably the most common definition, which has become established since the inception of the concept, defines the digital divide as the difference between individuals who have access to and use digital media and those who do not (van Dijk, 2020; Martinkovičová et al., 2019). According to Chen, Wellman (2004), the digital divide includes a gap between individuals and societies with the resources to be active in the information age and those who do not. Fink, Kenny (2003) see four possible interpretations of the term digital divide. The first is the difference in the access to the use of ICT, the second is the different abilities to use ICT, the third is the differences in the use of ICT

itself, which is measured by the time spent using them. According to the authors, the last interpretation is the difference arising from the use of ICT in the form of financial and economic revenues. According to Shakina et al. (2021), the digital divide manifests itself in several areas in cases where two or more interconnected processes in a digital transformation are not coherent or equally developed. This may apply, for example, to the development of ICT infrastructure at the national or regional level. The digital divide can also explain the differences in providing for digital resources and business goals at the enterprise or industry level.

For more than a quarter of a century of the digital divide concept and the research in this area has focused on its three levels (van Dijk, 2020). Until about 2010, the main interest of scientists and politicians was physical access to ICT and the internet. It was a focus on the first level of the digital divide, which is still the subject of the research today, not only in less developed countries. Even in countries where the possibilities of physical access combined with material equipment have been expanded, there are still differences in information and communication equipment and peripherals and the associated possibilities of working on the internet, as well as differences in the possibilities of maintenance and renewal of necessary equipment (van Deursen, van Dijk, 2019). Over time, with the diffusion of ICT and the internet, the attention of scientists and economic policymakers has focused on digital literacy, i.e. on digital skills. In this case, we are talking about the so-called second level of the digital divide. Ragnedda, Kreitem (2018) define it as various ways of support, motivation and the abilities and skills themselves used for safe and confident navigation on the internet. Skill in this context is perceived as the ability to find the necessary information efficiently and effectively on the internet (Hargittai, 2002). At the same time, some authors (van Deursen et al., 2011) distinguish between skills related to the medium itself on the one hand and content on the other. Van Laar et al. (2019) classifies the following as the 21st-century digital skills: information digital skills, communication digital skills, collaboration digital skills, critical-thinking digital skills, creative digital skills, and problem-solving digital skills. Finally, the third level of the digital divide has come to the fore since about 2015, and the research is focused on the results of computer and internet use. Van Deursen, Helsper (2015) define this level of the digital divide as differences in an individual's ability to transform internet access and use into favourable offline results. The results themselves or benefits can take many forms. Ragnedda, Ruiu (2017) characterize them as benefits in the social, cultural, economic, personal, and political spheres. This level as a subject of research seems to be particularly important in countries where almost universal access to the internet is provided for all. The three levels of the digital divide are simply defined

as the digital divide in access, the digital divide in skills, and the digital divide in outcomes (Aydin, 2021).

The concept of the digital divide is directly related to the concept of digital inequality. The term includes not only differences in access to ICT, but also inequality between people with formal access to the internet (DiMaggio, Hargittai, 2001). The digital divide and digital inequality are not easy to separate. Nevertheless, the digital divide, such as the different access of people to the internet and ICT, is well distinguished between different countries, and digital inequality is common within a country and results from the socio-demographic characteristics of its people. In this regard, Robinson et al. al. (2020) think that it is important that digital inequalities need to be examined not only in individual countries but also to compare them with each other, because only in this way can we understand the problem of global digital inequality from a micro and macro perspective.

With the onset of the internet, the equality of access to information was expected to increase while significantly reducing information costs. After the retreat of initial enthusiasm, it was observed that some groups of people were more likely to use the internet than others, which was mainly and most often due to demographic and socioeconomic determinants (van Laar et al., 2020). In most countries, women, members of ethnic minorities, the less educated and the poor are among those who do not use the internet or use it to a limited extent (Ono, Zavodny, 2007). Ragnedda, Kreitem (2018) point out that the second level of the digital divide depends to a large extent on socio-economic and demographic variables such as gender, age, education, income, space, race and social capital. Robinson et al. (2015) added health and healthcare to these variables. In the past, income seemed to be the most important factor in this respect, followed by age and education (van Dijk, 2006). But declining ICT prices have recently reduced the importance of income, which remains the most important factor in terms of the so-called material approach.

According to van Dijk (2012), in examining the digital divide and digital skills, the most important distinction is the categories of employers and employed or unemployed, managers and executives, individuals with high and low levels of education, women and men, young and old, parents and children, white and black people, natives and migrants. In defining these different groups, it is necessary to take into account the fact that many determinants may overlap. For example, the category of older people (most commonly defined as 60 and older) represents a highly diverse group of users of ICT technology, due to their diverse previous work experience, different motivation to use technology, and different computer experience (Hargittai et al., 2019). It follows that our past significantly determines how we access the

internet, how we use it (the first and second levels of the digital divide), and how we reinvest valuable information in the social area (the third level of the digital divide) to increase our life chances (Ragnedda, Ruiu, 2017).

The issue of the digital divide and digital inequality is a serious societal problem. At first, they seemed to be just simple technological and economic difficulty in accessing digital media, but over time they have become a broad-spectrum social problem that affects all domains and aspects of today's society. The differences that existed between the various social groups, which were generally perceived as inequalities, deepened with the oncoming and development of digital media. According to van Dijk (2006), this was due to the fact that the control of individuals' positions in an increasingly complex society and the ownership of the information and digital skills needed to acquire and maintain those positions are increasingly unevenly distributed. In this way, the use of digital media contributes to new types of absolute and relative inequalities that exacerbate existing "traditional" inequalities.

2. Material and methods

Our paper aims to examine and characterize the current state of the digital divide in V4 countries, based on the modified digital divide index inspired by Husing and Selhofer (2002). The index enables the measurement of the digital divide from the point of view of disadvantaged social groups. Originally, the authors used it to measure the digital divide in the 15 EU Member States between 1997 and 2002. The index itself is designed to depict how ICT is used in four so-called risky or disadvantaged social groups compared to the average of the population (Beynon-Davies, Hill, 2007). It quantifies the differences between these disadvantaged groups and the population average. Husing, Selhofer (2002) used four socio-economic variables to construct the index: gender, age, income, and education and following three indicators:

- percentage of computer users (in various places, e.g. at home, at work, at school);
- percentage of internet users, including e-mail (in various places, e.g. at home, at work, at school);
- percentage of internet and email users at home.

The original digital divide index was designed to capture primarily the first level of the digital divide – differences in access to ICT. A contemporary alternative to this index is the Digital Economy and Society Index (DESI) provided by Eurostat. DESI combines individual, household and country-level indicators to offer a comprehensive image of the state of digitalisation in a country, however, it does not explicitly deal with digital inequalities. Our

modification of the digital divide index has the ambition to describe all three levels of the digital divide – in addition to the difference in the access, also differences in digital skills and use of ICT and to stress the social inequalities in this area. Therefore, we combine the complexity of DESI with the approach of Husing and Selhofer index focusing on inequality and proposed a modified digital divide index. We used individual-level indicators of DESI, and calculate a sub-index Di for three risk groups i – individuals older than 55, individuals with no or low formal education and individuals living in a household with income in the first quartile. We decided to omit the female gender as a risk factor, as this disadvantage has been lost during the progress of digitalisation (Beynon-Davies, Hill, 2007, Robinson et al., 2020).

$$D_i = 100 * \sum_{j=1}^{m} w_j * \frac{p_{ij}}{p_j} \quad (1)$$

w_j = weight of indicator j (j =1, 2, 3; Sw = 1)

p_{ij} = value of indicator j in the risk group i (i = 1, 2, 3)

p_j = value of indicator j for the whole population

The following table describes the indicators grouped to dimensions of digitalisation. DESI uses 5 dimensions - in addition to those in the table, there is a dimension of Integration of Digital Technology, which captures only company and country-level data, therefore cannot be used to describe individual inequalities. The table also states the year of measurement of individual indicator, original weights of the dimensions used by DESI (which reflect the relative importance of the individual dimension considering the level of digitalisation) and new recalculated weights, which keeps the original proportion of the dimensions after skipping the dimension of Integration of Digital Technology (as it does not include individual-level data). In this case, when the dimension consists of more indicator, the value of the indicator describing dimension is calculated as an arithmetic mean.

Table 1 Composition of modified digital divide index

Dimension	Indicator	Year	Original weight	New weight
Connectivity	Individuals used a mobile phone to access the internet	2019	25%	31,25%
Digital skills	Last internet use: in the last 12 months	2019	25%	31,25 %
	At Least Basic Digital Skills	2019		
Use of Internet	Reading online news sites/newspapers/news magazines	2019	15%	18,75 %
	Playing/downloading games, listening to music or watching videos	2018		
	Watching video on demand from commercial services	2018		
	Telephoning or video calls	2019		
	Participating in social networks	2019		
	Internet banking	2019		
	Last online purchase: in the 12 months	2019		
Digial Public Services	eGovernment Users	2019	15%	18,75 %

Source: Own elaboration.

The modified digital divide index itself is calculated as follows:

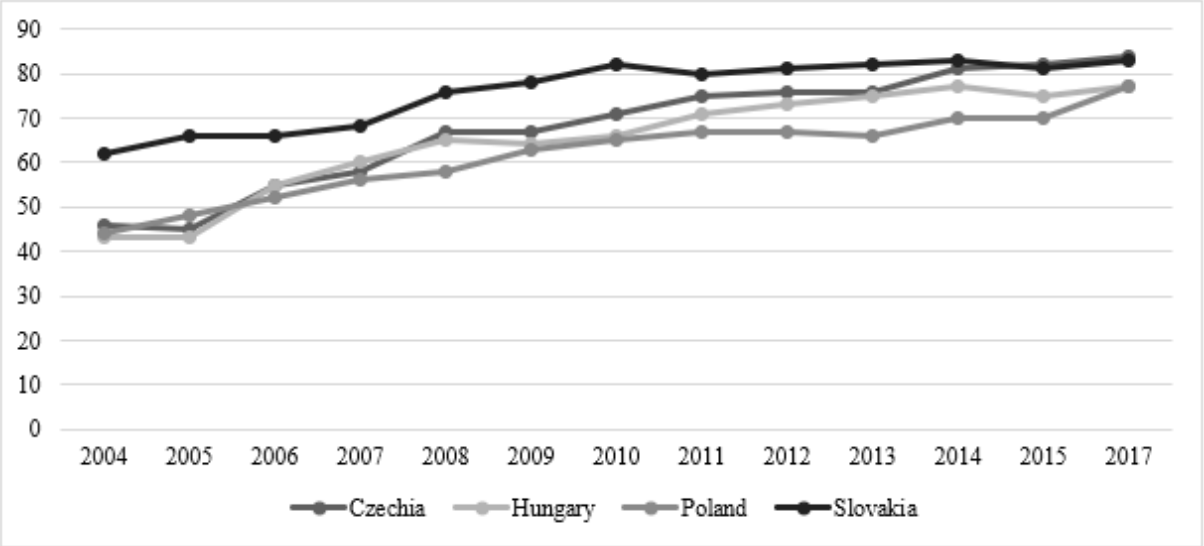
$$Didix = \frac{1}{n}\sum_{i=1}^{n} D_i \tag{2}$$

The maximum value of the digital divide index is 100 and would indicate that each risk group would be characterized by the same level of internet and computer use as the population average. Hypothetically, the indicator can also be greater than 100, if the risk group achieves better results in the use of the internet and computers than the average for the entire population.

Regarding the selection of countries for our analysis, we chose the V4 countries because of their similar historical context in many areas. Based on the calculated values of the digital divide index, it is possible to assess the extent to which the procedures for the introduction of the internet and ICT were in general similar in these countries, and whether this was reflected in same or different levels of the digital divide.

3. Results and discussion

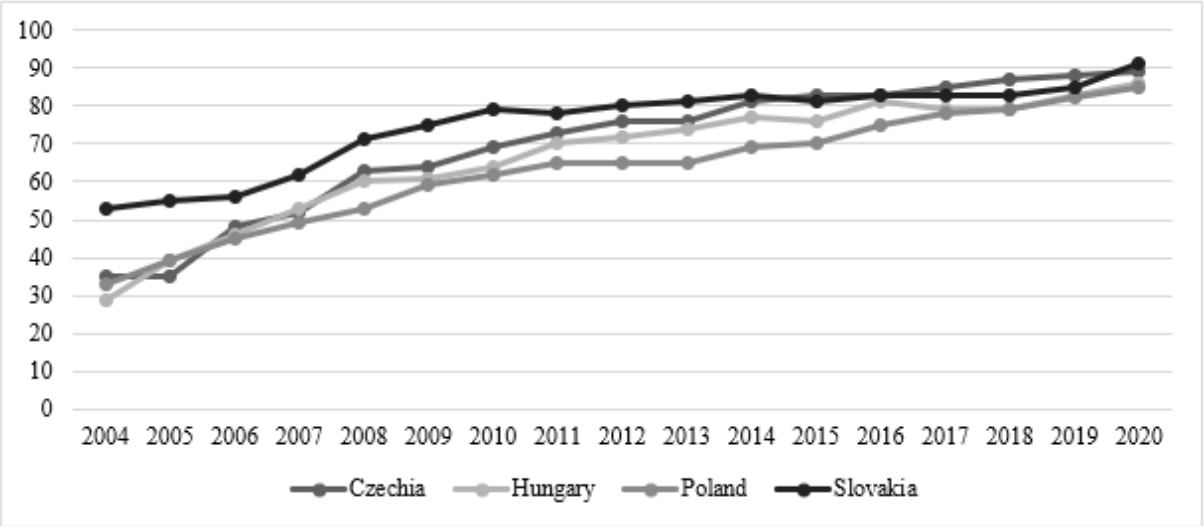
We introduce the analysis with data on the development of digitalisation in the V4 countries. Graph 1 shows the percentage of computer users since 2004, when the V4 countries joined the European Union and the last available data are for 2017, while 2016 is missing.



Graph 1 Percentage of individuals, who used a computer within the last 12 months
Source: Eurostat.

The percentage of computer users in all analysed countries have increased during the period under review. In 2017, this indicator ranged from 77% (Hungary, Poland) to 84% (Czech Republic). It was the Czech Republic that experienced the largest increase in computer users within this period, as the average annual increase was 2.7 percentage points. On the contrary, the slowest pace was the number of computer users in Slovakia, where the average annual increase was 1.5 percentage points. However, it should be emphasized that the initial share of computer users was much higher in Slovakia than in the other countries, namely at 62% in 2004.

Graph 2 shows the development of the indicator of the percentage of internet users within the population in the V4 countries. The available data, in this case, cover the whole period from 2004 to 2020.



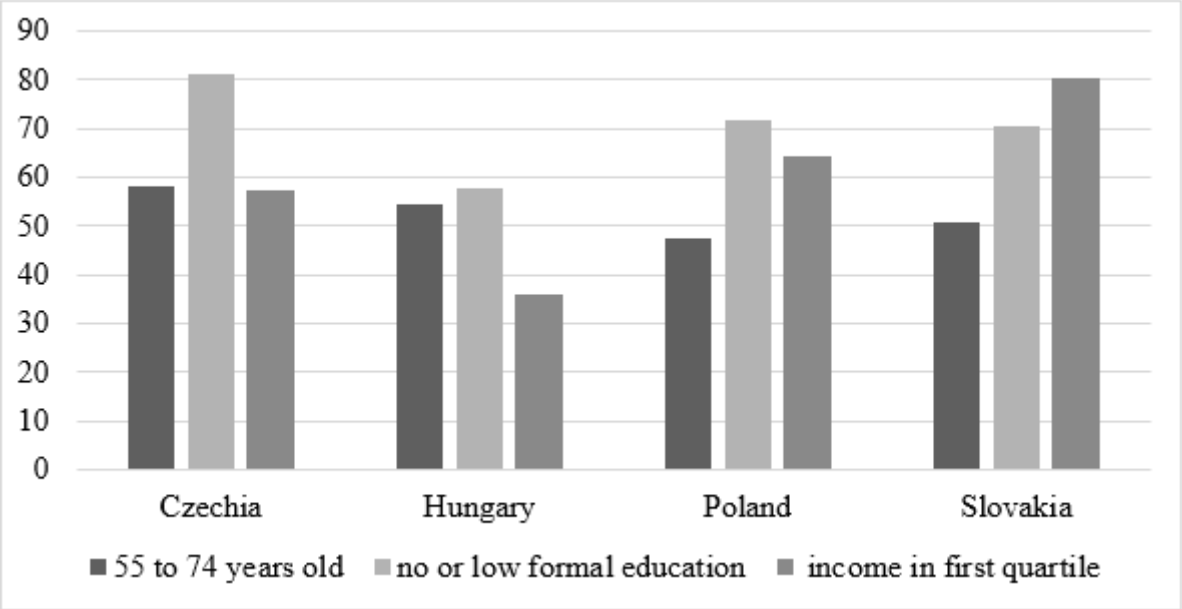
Graph 2 Percentage of individuals, who used the internet within the last 12 months
Source: Own elaboration based on Eurostat data

Similarly, as the share of computer users, the percentage of internet users increased during the observed period. In 2020, this indicator ranged from 85% (Poland) to 91% (Slovakia). As for the average annual growth of the indicator, the highest was in Hungary - 3.35 percentage points and the lowest in Slovakia - 2.23 percentage points. Again, it is necessary to point out the initial value of the analysed indicator was the highest in Slovakia at 53%. The high share of internet users on total population is evidence of the positive development within the first level of the digital divide, which is physical access to ICT and the internet, as more people not only have this access but also make greater use of it (Ragnedda, Kreitem, 2018).

The differences in growth rate both in computer and internet use in the V4 countries during the observed period can be a result of various level of computer and internet penetration in 2004. Hilbert (2011) explains that the cumulative number of adopters of certain technology with time has a typical S-shaped curve. The growth of users of the technology is slow when it diffuses among innovators and early adopters. The growth rate speeds up when the early and late majority starts to use technology. As the technology spreads through social networks (e.g. through personal or labour relations) the more people use it, the faster is the spreading. When penetration of the technology is relatively high, the growth rate slows down as it takes more time until so-called late adopters and laggard become familiar with the technology. We assume that Slovakia came to the phase of quick spreading of ICT earlier and therefore in the observed period, it experienced slower growth with higher initial values. The reason for Slovakia's lead in internet adoption could be initiatives to decrease prices of the internet from the early 2000s and adoption of aDSL technology in 2002 by major internet provider Slovenské telekomunikácie (inet.sk).

Based on the methodology explained in part 2, we calculated the digital divide indices for individual V4 countries. We derived summary indices from sub-indices calculated for individual risk groups. Graph 3 shows these sub-indices of the digital divide for individual risk groups in the surveyed countries, calculated according to the latest available data from Eurostat for 2018-2019.

For individuals over the age of 55, the sub-indices of the digital divide range from 48 to 58. The lowest value of the index was found in Poland. In a more detailed analysis of the given value, we can state that Poland has a low proportion of the population in this age group over 55 years who use the internet on a mobile phone or smartphone - only at the level of 25%. Polish seniors also had the lowest values in digital skills and using performing various activities using the internet. At the same time, we can observe that age is a key factor in the percentage of internet users on a mobile phone or smartphone in all four countries analysed. Some authors even consider age to be a major factor in the digital divide (Ertl et al., 2020).



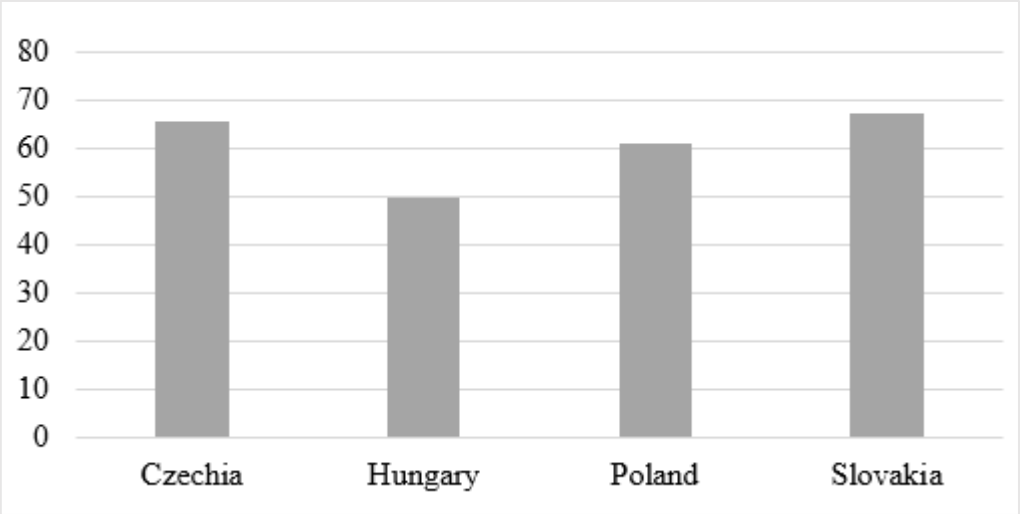
Graph 3 Sub- indices of digital divide index for the individual risk groups and the V4 countries in 2019
Source: Own elaboration.

The second risk group are individuals with no or low formal education. The values of sub-indices for this group range from 58 in Hungary to 81 in the Czech Republic. This is a significant variance in values, suggesting that the socio-economic variable education (and education systems as well) has its justification in examining the digital divide across countries.

At the same time, other research shows that education and the related use of computers and other ICT, as well as the internet, are very closely linked to income (Robinson et al., 2020).

The last risk group is the lowest income quartile. The partial index of the digital divide in this group achieves values from 36 in Hungary to 80 in the Slovak Republic. This means that income is an important determinant of the digital divide, especially in Hungary, where less than half of low-income individuals are internet users. This conclusion is also confirmed by a study by Ono and Zavodny (2007), in which they came to the same results that low-income individuals are more likely to use information technology less often than higher-income individuals.

From the sub-indices of the digital divide, we calculated a summary index, the values of which are shown in Graph 4.



Graph 4 Digital divide index for the V4 countries for the year 2019
Source: Own elaboration.

The digital divide index in the V4 countries in 2017 reached 49 in Hungary and 67 in Slovakia. The structure of the index shows that the higher its value, the closer the risk groups are to the average values of the population in the observed indicators. Our results show that the closest to the population average are risk groups in the Slovak Republic, followed by the Czech Republic. The furthest from the population average are individuals from risk groups in Hungary, and the situation in Poland is slightly better.

The analysis does not allow us to identify exact reasons for the difference in the state of the digital divide in V4 countries. Based on the indicators used, it is possible to say, that the differences in the overall level of digitalisation (indicators for the whole population) are not high with Czechia and Slovakia typically sharing first or second place and Poland and Hungary third and fourth. Also, DESI puts Slovakia in second place among V4 countries after Czechia

and followed by Hungary and Poland. All the V4 countries are below the EU average. As to the inequality, Hungary achieves much worse values than Poland as the risk groups are much worse off than the population average (e.g. only 13% of people living in the first income quartile have at least basic digital skills compared to 49% of all individuals). Many authors (e.g. Helsper, 2012; Van Deursen et al. 2017; Chipeva et al. 2018) states that digital inequalities replicate other social inequalities, predominantly income inequalities. In this case, the difference in income distribution measured by the Gini index cannot explain differences in ICT distribution, as it is generally low and nearly identical (Gini index for Czechia is 0.252; Hungary 0.268; Poland 0.288 and Slovakia 0.236. Source: Luxemburg income study).

There are several studies, which attempt to explain the digital divide in Hungary. Jakobi (2012) points out significant regional differences between the urban west of the country and the rural east. Harindranath (2008) stresses the high cost of internet usage in the 2000s and the weak infrastructure in rural areas. These studies, however, do not allow comparison with other V4 countries. The study, which shed some light on the problem was elaborated by Economist Intelligence Unit Limited (2021). It compares selected aspect of Internet inclusiveness in 120 countries. While V4 countries do not differ significantly in availability and affordability of internet connection, Hungary lags behind the other three countries in dimensions of relevance and readiness. The Relevance dimension covers the existence and extent of local language content and relevant content while the Readiness category depicts the capacity of individuals to access the internet, including skills, cultural acceptance, and supporting policy. The worst result (101st place in the ranking among 120 countries) Hungary achieves in the indicator Trust and Safety, which is the dimension of Readiness. This indicator examines trust in online privacy, trust in the governmental and non-governmental web app, trust in information from social media and perceived safety of e-commerce. These data support the idea presented by Chipeva et al. (2018) that technology adoption is a much wider issue than the issue of access and education and many psychological and attitude variable matters.

Conclusion

The aim of our paper was to is to examine and characterize the current state of the digital divide in the V4 countries based on the modified digital divide index inspired by Husing and Selhofer in 2002. To meet this aim, we firstly focused on monitoring the development of two basic indicators of digitalisation: the percentage of computer users and the percentage of internet users. According to the detailed methodology for the construction of the modified digital divide index, we first calculated the values of sub-indices of the digital divide for

individual risk groups within the V4 countries and then we also calculated the total digital divide index of the V4 countries for 2019. Regarding the risk group of individuals over 55 years we found that the most vulnerable risk group is in Poland, where the sub-index of the digital divide was 48. Socio-economic variables education and income were confirmed to be relevant variables for the study of the digital divide in the V4 countries, as a significant variance of values was observed in the sub-indices of the digital divide. Hungary had the lowest values in both sub-indices.

The calculated values of the summary digital divide index show that addressing the digital divide should be a constant priority in all surveyed countries and that their economic policies to bridge the digital divide should focus on three risk groups: people over 55, people in the lowest income quartiles and individuals with little or no education. According to the value of the overall digital divide index, its overcoming is particularly important in Hungary, which lags Slovakia as the country with the highest value of the digital divide index by more than 17 points. It is noteworthy, that Hungary does not differ from other V4 countries by quality of infrastructure, education, or affordability of internet connection. The only difference is in the relevance of the content for the local population and most importantly, trust in information and services provided electronically and perceived safety.

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