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Challenges of Digital Transition in the European Union due to the Impacts of Digital Skills Levels

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ABSTRACT: To identify the challenges of the digital transition, we examined the impact of various factors on digital skills in the European Union. We found out that there is only a weak positive correlation between the share of individuals who never use the internet and the absence of a basic overall level of digital skills. In addition, it was also identified that there was a weak positive association between the level of GDP per capita and the price of fixed internet and that there is only an insignificant positive correlation between the price of the internet and the share of individuals never using the internet. On the other hand, we were able to confirm that there is a negative association between the level of GDP per capita and the absence of a basic general level of digital skills and a negative correlation between the level of GDP per capita and the share of individuals who never use the internet. There are as well significant differences across the European Union in the share of the salary that individuals have to spend on fixed-line internet access. Finally, we also confirmed that in European Union countries with lower GDP per capita, individuals have to spend a higher share of their salary to pay for internet access.

KEYWORDS: digital skills, internet use, fixed-line internet prices, GDP per capita, salary.

I. INTRODUCTION

The economic impacts of low digital skills in the European Union (EU) are multifaceted and significant since they impact labor market disruption, employment and productivity, income distribution, and economic growth in general. As regards the labor market disruption, low digital skills contribute to a labor deficit, particularly in ICT-related roles, which hampers economic growth and innovation across various industries [1] [2]. This shortage of digital specialists affects the EU's ability to compete globally, especially against tech giants from the US and China [3] [4]. Considering employment and productivity, workers with insufficient digital skills face challenges in employability and productivity. This is particularly pronounced among older workers, [5]. This lack of adaptability can be a significant obstacle to economic growth and development in certain regions [6]. Referred to income distribution, the digital economy polarizes the labor market, increasing demand for highly qualified individuals while potentially leading to job losses in roles that can be automated. This polarization leads to income inequality [7]. Since digital skills are crucial for the overall growth of the EU economy, the EU has recognized this and is investing in digital skills through initiatives like the Digital Single Market and the Digital Skills and Jobs Coalition [2]. To address the digital skills gap comprehensive policies focused on reskilling and upskilling the workforce are required. Since low digital skills in the EU lead to labor market inefficiencies, hinder economic growth, and intensify income inequality [1] [5] [6] [7], we decided to examine various factors' impact on digital skills in the EU.

II. LITERATURE REVIEW

Our literature review Section is focused on the challenges of low levels of digital skills in the EU and the impact of internet prices on access to the internet. Therefore, it is divided into two subsections.

THE CHALLENGES OF LOW LEVEL OF DIGITAL SKILLS IN THE EU

The low level of digital skills in the EU presents several significant challenges:

- Labor market impact: The shortage of digital specialists is a pressing issue. This gap hinders growth and innovation in the EU digital economy. [8][12]
- Digital exclusion: A lack of digital competences leads to digital exclusion, particularly among older workers. This exclusion hampers employability and productivity in a rapidly digitizing world. [9] [6] [10]

- Economic and social inequality: The digital divide exacerbates social inequalities, particularly for vulnerable groups with lower income and education levels. [10] [7]
- Policy and implementation gaps: While frameworks and initiatives exist to improve digital skills, their implementation is often slow and uneven across member states. This inconsistency hinders the overall effectiveness of these programs. [11]
- Therefore, addressing the low level of digital skills in the EU is crucial for fostering economic growth, social inclusion, and competitiveness in a digital age. [8] [6] [10] [11] The low level of digital skills in the EU presents several challenges, with economic, employment, and social implications:
- Economic implications: The digital transformation has a significant impact on the structure of the labor market, with over 40% of EU workers experiencing changes in the technologies they use at work. [13]
- Employment rates: There is a statistically significant correlation between digital skills and employment rates in the EU, emphasizing the importance of promoting digital inclusion and literacy for the entire workforce. [14] The study of the effects of digital transformation on employment in European countries reveals a significant deficit in digital competencies, particularly in the context of the post-COVID-19 era. [15]
- Social consequences: The digital divide in the EU is evolving into digital inequality, with significant disparities among European countries in terms of digital skills and autonomy of Internet users. [6]
- Considering the mentioned negative implications of low levels of digital skills in the EU has recognised the urgency of strengthening training in digital competence throughout Europe, aligning with the 2030 agenda and the Sustainable Development Goals (SDGs). [7] The creation of a common framework for the development and understanding of digital competence in the EU was a step in the right direction, but efforts towards its application continue to be slow in realization in some member states. [16]
- To address low digital skills in the EU, several initiatives have been implemented:
- European Skills Agenda 2020 and Digital Education Action Plan; a goal is to boost digital skills and competencies to facilitate digital transformation and promote a robust digital education system. [17]
- Digital Compass and European Pillar of Social Rights Action Plan; This plan set ambitious goals to enhance digital skills across the EU, aligning with broader socio-economic objectives. [17]
- Various EU projects (e.g. DIGITAL4Business Project [18]) and programs (e.g. Upskilling Pathways Program [19]).
- Digital Competence Framework to establish a common framework for developing and understanding digital competence, and promoting initiatives in education, training, and employment [20].
- Various national and private sector initiatives (e.g. in Spain or by Vodaphone [21]).
- Various higher education initiatives (e.g. Digital Readiness Model [22] and EDU-GATE Initiative [23]).

IMPACT OF INTERNET PRICES ON ACCESS TO THE INTERNET

The relationship between internet prices and access to the internet is influenced by various economic and competitive factors:

- **Price sensitivity and access:** High internet access prices can significantly deter households from subscribing to internet services, indicating that high prices are a barrier to internet access. [24]
- Competition and pricing: Increased competition among internet service providers (ISPs) generally leads to lower internet prices, which can enhance access. [25] [26]
- Socio-economic factors: Socio-economic variables like income and education also play a crucial role in internet access. [27]
- **Economic activity:** Lower internet access charges are associated with increased economic activity, highlighting the broader economic benefits of affordable internet access. [26]
- Since high internet prices are a significant barrier to internet access [24], particularly for low-income households [27] and in regions with limited competition among ISPs. Reducing internet costs through competition, subsidies, and targeted economic policies can enhance access and drive broader economic benefits. [26] Regarding internet prices' impact on the digital divide in different socioeconomic groups, the literature further reveals that:

- High internet prices disproportionately affect low-income households, making it difficult for them to afford basic internet access. This is evident in both developed and emerging markets, where affordability remains a significant barrier. [25] [28] In emerging markets, additional challenges such as regulatory issues and lack of infrastructure exacerbate the problem. [29]
- The digital divide is more pronounced in rural areas compared to urban areas, largely due to higher costs and less infrastructure in rural regions. [30] [31]
- Also other socio-demographic factors such as age, education, and type of residence also play a role. For instance, the elderly and those with lower educational attainment are less likely to use the Internet, partly due to cost barriers. [32] [32]
- Thus, the factors contributing to digital divide are:
- The digital divide persists along key dimensions such as income and urban-rural divide and has widened over time. [25]
- Financial constraints, particularly the relative cost of internet access, are identified as a key challenge in bridging the digital divide between lower and higher-income countries. [29]
- Socio-demographic variables such as income and education strongly influence households' decision to pay for basic internet access, with income and education being particularly strong influences. [34]
- The digital divide is influenced by a complex interaction of socioeconomic, political, cultural, social, and technological factors, with income inequality being an important influencing factor [30] leading to social exclusion. [35]

III. RESEARCH GOAL AND HYPOTHESES

We aimed to identify the impact on digital skills in the EU. We wanted to look at the impact of the share of the population using or not using the internet, the price of internet connections and, through the share of the salary that individuals have to pay to access the internet, also the impact on GDP per capita. Based on a preliminary analysis of EU statistics (Eurostat) and a literature review, we formulated the following four hypotheses:

- ✓ H1: There is a positive correlation between the share of individuals never using the internet and the absence of basic overall digital skills level in the European Union countries.
- ✓ H2: There is a moderate positive correlation between the price of the internet and the absence of basic overall digital skills level (a) or share of individuals never using the internet (b) in the European Union countries.
- ✓ H3: There is a negative correlation between the amount of GDP per capita and the price of the internet (a) or the absence of basic overall digital skills level (b) or the share of individuals never using the internet (c) in the European Union countries.
- ✓ H4: There are large differences across the European Union in the share of the salary that individuals have to spend on internet access, with individuals in countries with lower GDP per capita generally having to spend a larger share of their salary on internet access.

IV. RESEARCH METHODOLOGY

To identify the challenges of the digital transition, we examined various factors' impact on digital skills in the EU. The values of the factors were extracted in 2024 from the Eurostat database, specifically from the digital economy and society folder [36]. Latest data were available for the year 2023 and/or 2022. We used only the latest available data to present the most recent situation in the EU. We used the following factors:

- ❖ Individuals - internet use: never vs. last internet use in last 3 months for 2022 and 2023;
- ❖ Individuals' (%) level of digital skills; specifically, individuals who have used the internet in the last 3 months: Individuals with no overall digital skills vs. individuals with above the average digital skills for 2023;
- ❖ fixed least expensive internet price for 10 Mbps to ≥ 1 Gbps; Purchasing power parities (PPP) in euro for 2022;
- ❖ Average full-time adjusted salary per employee in euros for 2022;
- ❖ Gross domestic product (GDP) at market prices: Percentage of EU27; total per capita (based on million euro, EU27), current prices for 2022 and 2023.
- ❖ Then average fixed-line least expensive internet price for 10 Mbps to ≥ 1 Gbps speed was calculated based on prices of 5 groups of fixed internet speeds, namely ≥ 1 Gbps, 200-999 Mbps, 100-200 Mbps, 30-100 Mbps, and 10-30 Mbps. We further used the average internet price for 10 Mbps to ≥ 1 Gbps fixed-line speeds combined with the average full-time salary to calculate the share that individuals have to pay for fixed-line internet. To do so, we multiplied the average fixed-line internet price with 12, to receive the annual cost. This

cost was then divided by the annual salary to receive a share that we were looking for.To test the hypotheses also the correlation was calculated. The correlation or correlation coefficient is a numerical measure that represents the strength of a linear relationship between two variables. Correlation is used to describe how closely two variables are related. Correlation can be measured by several different coefficients, adapted to the different types of data available. Among the correlation coefficients, the Pearson correlation coefficient is the most well-known and is therefore also used in our analysis.

The correlation coefficient measures the degree of this association and ranges between -1 and 1, with different values representing:

- correlation coefficient 1: Perfect positive correlation. As the value of one variable increases, the other increases in exactly the same way.
- correlation coefficient -1: Perfect negative correlation. When the value of one variable increases, the other decreases exactly the same.
- correlation coefficient 0: No correlation. The two variables are independent and a change in one does not affect the other [37].
- An even more precise specification we used is:
- 0,00: no correlation;
- 0.01-0.19: insignificant association;
- 0.20-0.39: low/weak correlation;
- 0.40-0.69: medium/moderate association;
- 0.70-0.89: high/strong association;
- 0.90-0.99: very high/very strong association;
- 1: perfect correlation.

V. DATA ANALYSIS RESULTS

This section is divided into four subsections, each related to one of the set hypotheses. However, for the introduction, it provides a brief insight into the share of individuals using the internet in the EU in the past two years.

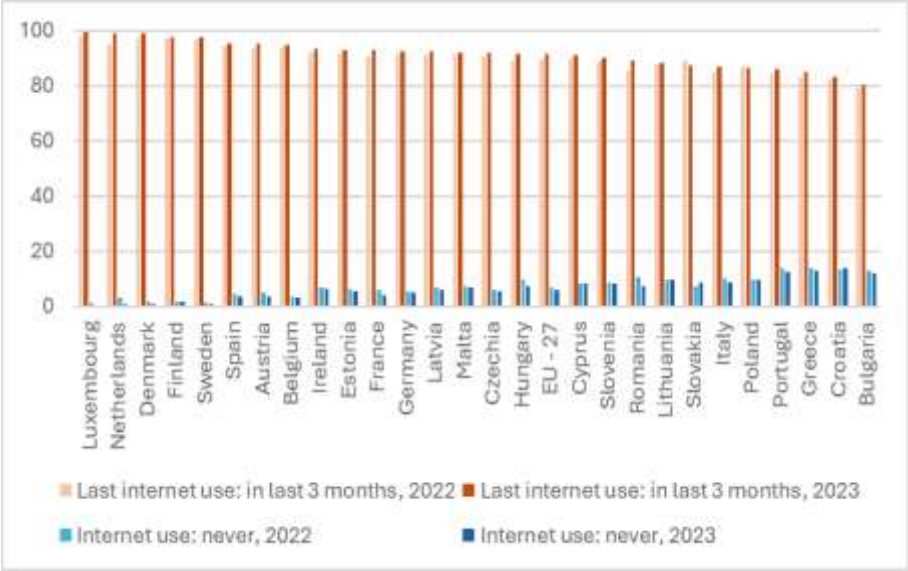

Figure 1: Individuals (%) - internet use: last internet use in last 3 months vs. never [36]

Fig. 1 reveals that in 2023 in all EU member states (except in Poland) internet use increased compared to 2022 and that Luxembourg, Netherlands and Denmark lead in internet use of individuals, as 99% of individuals used the internet in the last 3 months. On the other hand, less than 85% of individuals in Bulgaria and Croatia used the internet in the last 3 months. EU-27 average is 91% in 2023. Fig. 1 also shows that in 2023 in almost (except in four countries) all EU member states the number of individuals never using the internet decreased compared to 2022 and that Croatia, Greece, Portugal and Bulgaria lead in these statistics, as more than 10% of individuals never used the internet in 2023. On the other hand, in Sweden, Netherlands, Denmark, and Luxembourg the share of individuals who never used the internet is less than 1%. EU-27 average is 6% in 2023.

DIGITAL SKILLS LEVEL : In this subsection, which is related to the H1 hypothesis, we first focus on the two most different indicators from the database [36] for the digital skills level considering individuals who have used the internet in the last 3 months, namely individuals with no overall digital skills and individuals with above the basic digital skills.

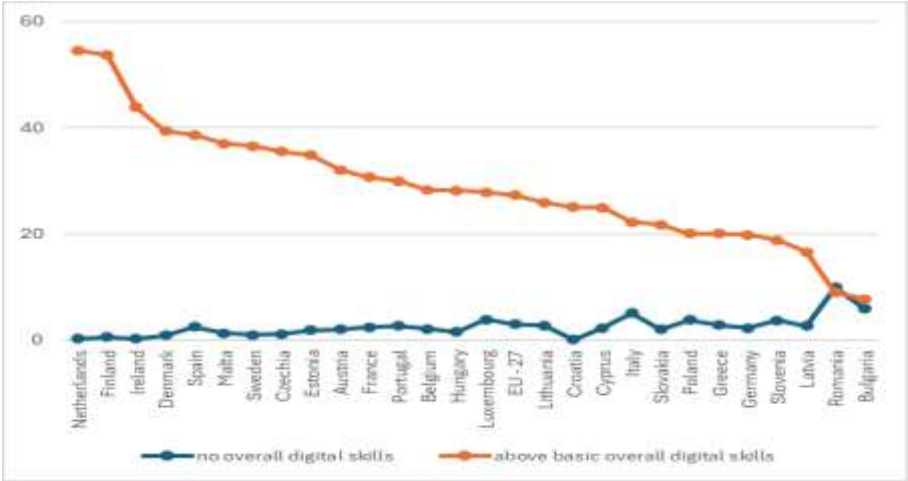

Figure 2: Individuals' level of digital skills in 2023; individuals (%) who have used the internet in the last 3 months [36]

Fig. 2 clearly shows that in 2023 (the most recent available data) only in the Netherlands and Finland did the shares of individuals with above the basic overall digital skills exceed 50%, while the EU-27 average is 27%. On the other hand, there are two countries, Bulgaria and Romania, in which the share of individuals with above the basic overall skills is smaller than 10 % but are also among countries that have the largest share of individuals with no overall digital skills. Calculations of the correlation coefficient showed that H1 could be confirmed. Nonetheless, there is only a low positive correlation (in the precise value of 0,28659) between the share of individuals never using the internet in 2023 and the absence of a basic overall digital skills level in 2023 in the EU countries.

INTERNET PRICES : This subsection, related to H2 hypothesis, focuses first on the fixed broadband internet prices by type of offer (least expensive) which is calculated as average based on prices of 5 groups of fixed internet speeds, namely ≥ 1 Gbps, 200-999 Mbps, 100-200 Mbps, 30-100 Mbps, and 10-30 Mbps.

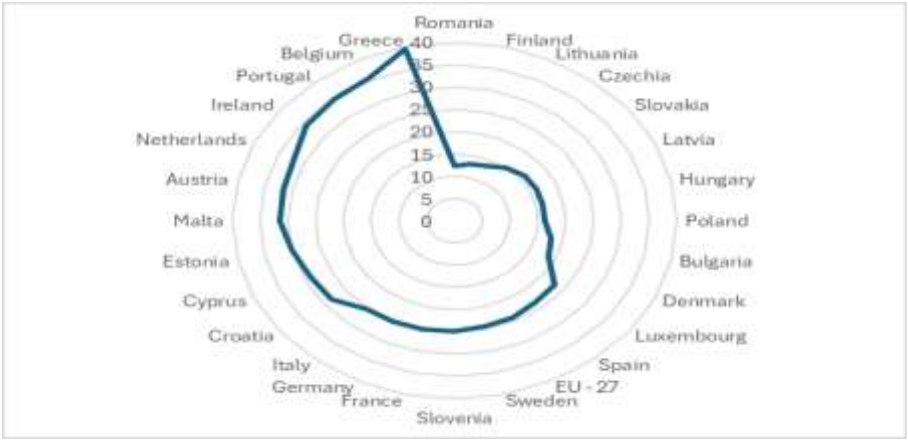

Figure 3: Average fixed least expensive internet price in euros for 10 Mbps to ≥ 1 Gbps in 2022 [36]

Fig. 3 reveals that the average least expensive price of fixed internet for 0 Mbps to ≥ 1 Gbps speed in 2022 in EU countries (EU-27) on average exceeds 24 euros. The lowest average prices can be found in Romania, Finland and Lithuania, where the price is below 15 euros, while the highest prices are in Greece and Belgium,

where the average price exceeds 35 euros. Calculations of the correlation coefficient do not confirm H2. There is no moderate positive correlation between the absence of basic overall digital skills level in 2022 and the price of the fixed internet in 2023, as there is a weak negative correlation (in the precise value of -0,31807) in the EU countries (a). Furthermore, there is only an insignificant positive association (in the precise value of 0,10920) between the price of the internet and the share of individuals never using the internet (b). Nonetheless, we acknowledge that a comparison of 2 different years is not appropriate but was still done due to the absence of the most recent (2023) data for digital skills level, since there was no data for the year earlier, for the year 2022. However, since we found out that changes are not an average significant year-on-year considering other digital society statistics, we still tried to verify the H2.

GDP PER CAPITA : Considering the H3 hypothesis, this subsection presents GDP per capita in the past two years (in 2022 and 2023) in the EU countries, which enabled us to make calculations for correlations of this indicator in relation to internet prices, digital skills level and the share of individuals using internet.

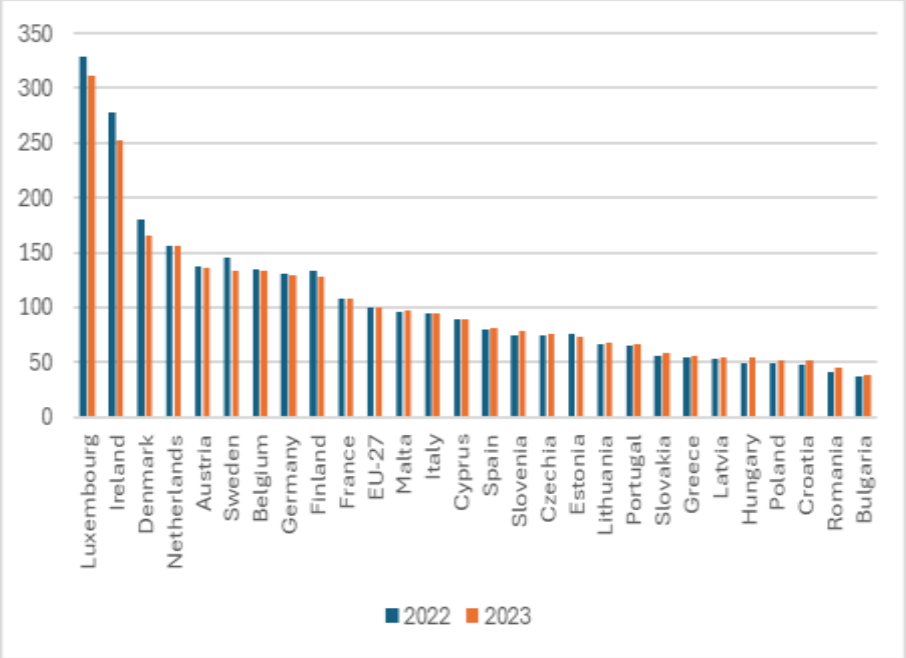

Figure 4: GDP per capita in % of EU-27 at market prices in million euro current prices. [36]

As presented in Fig. 4 there are great differences among GDP per capita within the EU. Luxembourg even exceeds 300 euro at market prices as % of EU-27 total per capita in 2023, while Bulgaria stands at 39 euro in the same year. But what is interesting is an observation that among ten above the EU-27 average countries, eight of them exhibited a GDP per capita decrease compared to 2022, while on the other hand among the other seventeen countries that are below the EU-27 average, fifteen of them managed to increase their GDP per capita year-on-year. As regards the H3, calculations of the correlation coefficient only partially confirm the hypothesis, as only two (b and c) parts are confirmed. Namely, there is no negative correlation between the amount of GDP per capita in 2023 and (a) the price of the internet in 2023, as calculations reveal a low positive correlation (in the precise value of 0,25673). On the other hand, the second (b) part of the hypothesis is confirmed since the calculations reveal a low negative correlation (in the precise value of -0,28244) between the amount of GDP per capita and the absence of a basic overall digital skills level in 2023. Moreover, the last (c) part of H3 is confirmed, since there is a moderate negative correlation (in the precise value of -0,64922) between the amount of GDP per capita in 2023 and the share of individuals never using the internet in the EU countries.

SALARY : In relation to the H4 hypothesis, this last subsection presents the calculation of the average full-timed salary per employee concerning the average fixed least expensive internet price in 2022 (the latest available data for full-timed salary per employee were for 2022 and 2023, but for the fixed internet prices was only for 2022).

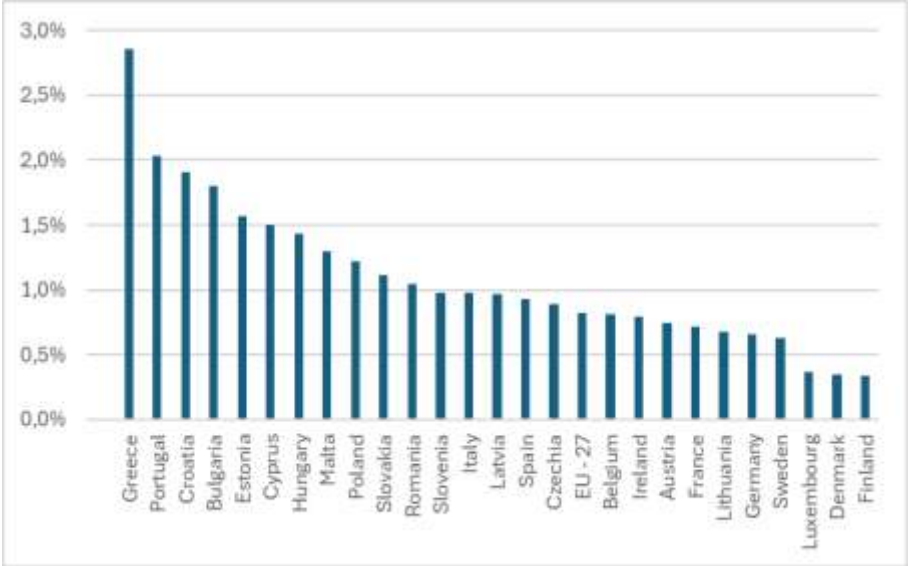

Figure 5: % of average full-time salary per employee in relation to the average fixed least expensive internet price for 10 Mbps to ≥ 1 Gbps in 2022 [36]

Fig. 5 presents that in the EU (excluding the Netherlands as there is no data on average full-time adjusted salary per employee for the Netherlands) there is a significant difference between the countries in the % of annual salary per employee in relation to the average monthly fixed internet price multiplied by 12 (for 12 months in a year) for 10 Mbps to ≥ 1 Gbps in 2022, namely the variance is from 0,3% in Denmark and Finland to 2,9% in Greece, which confirms the first part of the H4. The average in the EU-27 is 0.8%. Concerning the H4 hypothesis, calculations of the correlation coefficient also confirm that in EU countries with lower GDP per capita generally, individuals have to spend a larger share of their salary to pay for internet access, as there is a moderate negative correlation calculated (in the precise value of -0,55409) taking into account GDP per capita in 2022 and share of salary in relation to the average fixed least expensive internet price in 2022.

VI. DISCUSSION

Our analysis showed that only 2 hypotheses could be confirmed, 1 could be partially confirmed and 1 had to be rejected. The first hypothesis (H1), stating "There is a positive correlation between the share of individuals never using the internet and the absence of basic overall digital skills level in the European Union countries.", was confirmed, although Pearson's correlation coefficient showed only a low positive correlation between the share of individuals never using the internet and the absence of a basic overall digital skills level in 2023. The second hypothesis (H2), "There is a moderate positive correlation between the price of the internet and the absence of basic overall digital skills level (a) or share of individuals never using the internet (b) in the European Union countries.", could not be confirmed. Calculations of the correlation coefficient showed that there is a weak negative correlation between the absence of basic overall digital skills level and the price of the fixed internet (a). Besides, there is only an insignificant positive association between the price of the internet and the share of individuals never using the internet (b).

This disapproves the literature, claiming that financial constraints, particularly the relative cost of internet access, are identified as a key challenge in bridging the digital divide between lower and higher-income countries. [29] The third hypothesis (H3): "There is a negative correlation between the amount of GDP per capita and the price of the internet (a) or the absence of basic overall digital skills level (b) or the share of individuals never using the internet (c) in the European Union countries.", was only partially confirmed since only two (b and c) parts out of three were confirmed. Namely, Pearson's correlation coefficient calculations reveal a low positive correlation between the amount of GDP per capita and the price of the fixed-line internet (a). This contradicts the literature stating that internet access charges are associated with increased economic activity. [26] On the other hand, there is only a low negative correlation between the amount of GDP per capita and the absence of basic overall digital skills level (b). As well the last (c) part of H3 is confirmed since there is

a moderate negative correlation between the amount of GDP per capita and the share of individuals never using the internet. The last hypothesis (H4), stating: "There are large differences across the European Union in the share of the salary that individuals have to spend on internet access, with individuals in countries with lower GDP per capita generally having to spend a larger share of their salary on internet access.", is confirmed in full. It is proven that there are large differences (variance from 0,3% to 2,9%) across the EU in the share of the salary that individuals have to spend on internet access. Also, calculations of the correlation coefficient confirm that in EU countries with lower GDP per capita, individuals have to spend a larger share of their salary to pay for internet access, as there is a moderate negative correlation calculated between GDP per capita and share of salary in relation to the average fixed internet price.

VII. CONCLUSION

There are some limitations of the presented research, the most challenging is the absence of data for 2023 for the two indicators under consideration (internet prices and average salary per employee). For this reason, comparison and correlation calculation could be problematic, as already acknowledged in subsection 5.2 with a clarified reason for making this comparison. Nonetheless, the strengths of the relocated research results are that they are based on the most up-to-date data and that they address a pressing problem in EU society that affects economic and social development. Namely, low digital skills significantly hinder access to employment in the EU due to several interconnected factors: labor market demand, employment outcomes, older workers and economic impact. As regards labor market demand, over 40% of EU workers have experienced changes in the technologies they use at work, emphasizing the need for digital competencies. [21] The lack of these skills creates a labor deficit, particularly in ICT-related roles. [38] As regards to employment outcomes, digital skills are crucial for securing employment, while the COVID-19 pandemic has further highlighted this requirement. [39] Since especially older workers often lack digital skills, this hampers their employability and productivity. This demographic is particularly affected by the digital divide, making it essential to invest in their digital education to keep them active in the labor market. [6] And finally, as regards to economic impact, countries with lower levels of digitalization, face significant challenges in labor productivity and economic growth. [40] To conclude, since low digital skills in the EU negatively impact the economic and social well-being of individuals and, indirectly, individual countries, research on the most current situation in this area and the impact of various factors, presented in this research is very welcome and requires attention since it highlights the need to consider about calculated correlations to implement more informed decisions in targeting training and education initiatives to bridge the digital skills gap across the region.

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