READINESS OF PEOPLE IN CITIES TO USE DIGITAL SERVICES IN BUILDING SMART CITIES

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Abstract

People in cities who do not have the opportunity to use established digital services may be disadvantaged. For this reason, the readiness of city residents to implement digital services is important. The aim of our study is to determine the specifics of EU countries in the readiness of city residents to use digital services from the point of view of using the internet for basic activities and from the point of view of basic digital skills in building a smart city. The method used is regression analysis. The Breusch-Godfrey test is used to determine autocorrelation. Romania and Bulgaria are the countries in the EU where the readiness of city residents to implement digital services is the weakest. Expanding digital skills training for employees could contribute not only to the digitalization of the country but also to the building of smart cities.

Key words:
smart city, smart people, internet activities, EU countries

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INTRODUCTION

Digital development is currently characteristic for all developed countries in the world. Digital development is one of the key specifics of the present era. It has a great societal impact. It allows for the improvement of services in various areas of the economy. The development of information and communication technologies and artificial intelligence affect economic growth. The proper use of digital technologies can improve the use of various natural resources. At the same time, economies can increase their efficiency and sustainability. From this perspective, it is important to monitor the connection between the use of digital technologies in the development of society and the improvement of the quality of life.

Effective use of digital technologies aimed at economic growth and quality of life is necessary in all regions. However, as stated by the World Bank Group (2024), in 2024 the degree of urbanization of the world is approaching 58%. Due to the large proportion of people living in cities, it is particularly important to monitor the use of digital technologies in the development of cities and the improvement of the quality of life in cities. The topic is also highly relevant from the point of view of demographic development. Most developed countries are addressing the issue of population ageing and reducing workforce. Within the EU, the burden on the working-age population from people of post-productive age is increasing. According to Eurostat (2025), while in 2015 there were 29 people aged 65 and over for every 100 people aged 15 to 64, in 2024 it was 33.9 people. The situation is similar in individual regions. Maintaining the size of the workforce or mitigating its decline in cities can have a positive impact on urban development. Digital development is also important, which can improve the quality of life in cities. According to Marchesani et al. (2026), the connection between the implementation of digital technologies and smart living positively affects the attractiveness of cities.

Another reason for the need to introduce a smart city is the fact that “the exponential development of the cities and increasing number of flows, causes congestion and lowers the level of quality of life in the city” (Kauf, 2019, p. 143). Innovation and new approaches are therefore essential to maintain the quality of life in cities.

Velasquez Mendez et al. (2025) point out that the introduction of digital technologies in

building a smart city should be sensitive. The authors emphasize that when introducing digital technologies, there may be a mismatch between the introduction of digital technologies and the preferences of communities. The introduction of some technologies may worsen the quality of life of people, or their implementation may fail due to inefficient management (Mora et al., 2025).

However, the most significant factor influencing the construction of a smart city is people. As stated by the Ministry of Investments, Regional Development and Informatization of the Slovak Republic (2023, p. 21, author's translation), "The success of smart city initiatives with the support of the Internet of Things largely depends on the active participation and approach of citizens." User experiences enable citizens to benefit from new approaches introduced in cities. The introduction of digital technologies in cities in many areas requires individual skills in working with the internet and access to the internet. Without them, the use of many applications could be unrealistic or ineffective.

Similarly, Manville et al. (2014, p. 86) emphasize that “above all, a smart city is a smart Similarly, Manville et al. (2014, p. 86) emphasize that “above all, a smart city is a smart community of people.” It is not possible to build smart cities without a vision, smart people and process (Manville et al., 2014, p.76). According to the authors, the term smart people refer to people with their digital skills, education, training, human resource management, which contribute to innovation and creativity.

A large share of innovation in cities requires that people living in cities have an internet connection and that they have the necessary digital skills. According to the Ministry of Investments, Regional Development and Informatization of the Slovak Republic (2023), smart self-government is becoming very necessary in cities, which affects several areas. Its implementation requires that citizens have the necessary digital skills. To do this, it is necessary to increase digital equality through educational opportunities (Shen et al., 2025).

The aim of the study is to determine the specifics of EU countries in the readiness of urban residents to use digital services in building a smart city from the perspective of using the internet for basic activities and from the perspective of basic digital skills. The intention is to point out which EU countries can be considered, from the above perspectives, as countries with the weakest readiness of their residents. Part of the output of the study is to determine the approaches that are important from the perspective of urban residents' readiness to use digital services and building a smart city

1. LITERATURE OVERVIEW

As stated by Ziosi et al. (2022), there are several concepts of smart cities that characterize smart cities from different perspectives. Several authors, when defining the term smart cities, focus mainly on specifying important dimensions. According to Ulya (2024, p. 1001), the dimensions used by various authors when characterizing smart cities can be divided into six categories: 1/ smart economy, 2/ smart people, 3/smart environment, 4/ smart governance, 5/ smart living and 6/ smart branding. These categories are also called main dimensions (Ziosi et al., 2022). Manville et al. (2014) and Kumar (2020) list the following dimensions when mapping smart cities: 1/ smart economy, 2/ smart mobility 3/smart environment, 4/ smart people, 5/ smart living, 6/ smart governance. The main difference in both characteristics is in one dimension. The approach of Manville et al. (2014) emphasizes mobility. The approach of Ziosi et al. (2022) emphasizes branding.

Smart city concepts have several common characteristics. One of them is that smart cities are about development and improvement (Guenduez & Mergel, 2022). Most smart city characteristics contain words such as “optimization, improvement, enhancement, or development” (Guenduez & Mergel, 2022, p. 2). Another fact is that smart cities use advanced digital technologies in various areas. Ulya et al. (2024) citing Achmad et al. (2018) state that the use of ICT is the main idea of the smart city concept.

As already mentioned, there are different approaches to defining the term smart cities. We consider the statement given by Manville et al. (2014, p. 18) “the idea of Smart Cities is rooted in the creation and connection of human capital, social capital and information and Communication technology (ICT) infrastructure

in order to generate greater and more sustainable economic development and a better quality of life" to be a concise characteristic. The characteristic emphasizes the connection of the three basic types of capital with information and communication technologies with the aim of achieving sustainable development and improving the quality of life.

Digital technologies in building a smart city focus on optimized resource use, improving public services, increasing city resilience and improving the quality of life (Kaiser & Deb, 2025 citing Kaiser, 2024).

Based on the above, it follows that smart cities and quality of life are interconnected. Purnomo et al. (2016) state that smart living contributes to improving the quality of life with its approaches. This primarily concerns the provision of healthcare, quality housing, cultural activities and social cohesion. According to Purnomo et al. (2016), the most common indicators of smart living are indicators characterizing healthcare services, social security and safety, housing quality and public transportation system. People are the most important in innovations in these areas. The economic, social, cultural and technological performance of cities should serve the interests of city residents (Kourtit & Nijkamp, 2012).

People must have the necessary skills and must take the initiative to use innovative approaches. Smart people, according to Purnomo et al. (2016), build human capital and social cohesion. They use lifelong learning, participate in public life, use creativity and flexibility. The most common indicators of smart people are indicators characterizing the education system, facilities and creativity.

Based on the above, it follows that the basis for the use of new technologies in cities, which enable their application in the economic growth of cities and in increasing the quality of life in cities, are the skills of people living in cities. Part of the digital readiness of managers within public administration in cities are their information and digital skills. Digital management is currently becoming the basis for improving the performance of the public sector in cities through the integration of technologies (Aldhi et al., 2025). The motives for implementing smart cities are increasing the efficiency of public administration, increasing the quality of services to residents and visitors to cities, and increasing the quality of life (Kubišová, 2022). Local governments play an important role in building smart cities. Their approaches to building smart cities are often similar. De Oliveira et al. (2024) citing Chien (2008, 274) state that local governments often tend to implement similar policies in pursuit of economic growth.

Building a smart city concept promotes innovation, increases competitiveness and sustainability of development (Lin & Zheng, 2025). Cooperation with city residents and obtaining feedback from city residents in improving the quality of life becomes important in implementing effective smart city solutions (Esposito et al., 2025).

"According to the EU's Digital Decade objectives, all key public services for businesses and citizens should be fully online by 2030" (Eurostat, 2025d). Readiness is essential to achieve this goal and to make effective use of digital technologies. According to Aldhi et al. (2025), readiness is important at both the individual and organisational levels.

However, the development of smart cities also brings concerns. These are mainly related to the fact that advanced technologies will not be suitable for all citizens. The disadvantage of disadvantaged groups may increase. Disadvantaged groups, such as people on low incomes who do not have access to smart devices, will not have access to smart services (Shen et al., 2025). Limited internet access, limited access to smart devices and low digital skills can widen the digital divide and make it difficult to take advantage of digital services.

Among the important skills at the individual level are people's access to the internet in the city and their use of the internet. According to Eurostat (2025g), the number of households with internet access is growing and approaching saturation. The share of households with internet access in cities was highest in Luxembourg (99.9%) in 2023. The Netherlands was second (99.0%) (Eurostat, 2025g). From the above facts, it can be concluded that households in cities have the possibility to connect to the internet. However, whether their current situation and knowledge allow them to do so is a different

question. According to Hernandez and Faith (2023), people with low education may have low digital skills and use the internet less. According to Eurostat (2025i), there was a significant difference in the level of basic digital skills between people with low formal education and high formal education in Ireland, Greece and Malta.

Other groups of people who use the internet to a lesser extent are economically inactive people and people who have not worked in the last four weeks or have not been able to start working within two weeks. These groups of people may have difficulties using digital services and accessing the internet in cities. Access to the internet at home is particularly important, as internet access at employers may have various restrictions.

The study consists of the following sections. The literature review is followed by a section describing the aim and objectives of the work. It also includes an overview of the methods used. This is followed by a section in which the results and discussion are formulated. At the same time, this section contains the limitations of our research. The main approaches are summarized at the end of the study.

2. GOAL AND METHODOLOGY

As part of building a smart city, cities focus on expanding digital services. A group of residents who do not have the opportunity to use established digital services in cities may be disadvantaged. Therefore, in the digitalization of services in cities, residents' access to the internet and their digital skills are important aspects in terms of urban population readiness

It is obvious that people in cities in individual EU countries differ in their readiness to use digital services, and therefore also to promote the concept of a smart city. We assess the readiness of city residents from two perspectives:

1/ from the perspective of the share of people who can use the internet for basic activities, 2/ from the perspective of acquiring basic digital skills.

The aim of our study is to determine, based on the analysis, the specifics of EU countries in the readiness of city residents to use digital services when building a smart city from the perspective of using the internet for basic activities and from the perspective of basic digital skills. Our intention is to point out which EU countries we consider to have the weakest population readiness from the above-mentioned perspectives Building smart cities can be challenging in these countries and measures need to be taken to improve the readiness of city dwellers to adopt digital services. We will also aim to gain insights into which approaches are important in terms of urban readiness.

Our aim is to highlight the importance of urban readiness in individual EU countries and to promote the smart city concept. The disadvantage of some city dwellers could be further increased by the introduction of digital services.

The period analysed is 2014 to 2024. We are aware of the short time series. We have chosen the length of the time series from a year from which data are available for all EU countries.

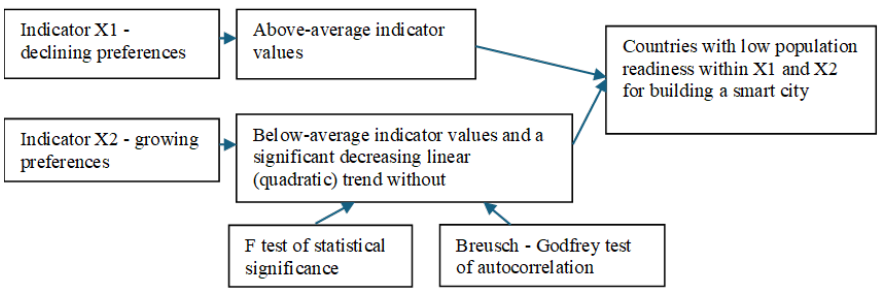


Figure 1: Conceptual model

As an indicator of internet use we chose the indicator Percentage of individuals who used internet in the last 3 months. Individuals living in cities. Internet use: sending/receiving e-mails (Eurostat, 2025a). The values of the indicator are obtained from the EU survey.

According to Eurostat (2025c) "The survey population of individuals consists of all individuals aged 16 to 74".

As an indicator assessing digital skills we chose an indicator with negative preferences, namely ignorance of digital skills "Individuals living in cities. Individuals with no overall digital skills" (Eurostat, 2025b). The activities used to calculate skills are "Finding information about goods or services (IUIF); Seeking health-related information (IHIF); Reading online news sites, newspapers or news magazines (IUNW1); Activities related to fact-checking online information and its sources (TICCSFOI, TICIDIS, TICNIDIS, TICXND)" (Eurostat, 2025e). According to Eurostat (2025h), by 2030, up to 80% of the population should have at least basic digital skills.

The results of the study will include, in addition to the findings obtained from the analysis of indicators, an assessment of approaches that are important from the perspective of the readiness of city residents to implement digital services in building a smart city.

To achieve the goal, we used secondary data from the Eurostat database (2025a, 2025b).

The analysis will include the answer to the following research questions:

1/ Which countries lag behind others in digital skills?

2/ Which countries lag behind others in internet use in cities?

3/ In which countries is there a negative trend in the development of internet use in cities?

4/ What measures can be introduced for lagging countries and countries with an unsatisfactory trend of the indicator? The conceptual model is in Figure 1.

Regression analysis, model quality verification

Regression analysis was used to achieve the goal. It included verification of the quality of the model. We used regression analysis to express the trend of the time series of the indicator in individual EU countries.

$$y_t = b_0 + b_1 t + e_t,\ t = 1, 2, \ldots, T. \quad (1)$$

We verified the statistical significance of the model with an F-test.

If the linear trend was not statistically significant, we determined the statistical significance of the quadratic trend.

$$y_t = b_0 + b_1 t + b_2 t^2 + e_t,\ t = 1, 2, \ldots, T, \quad (2)$$

where t is the time variable. T is the number of periods, e_t represents the error.

Breusch-Godfrey test

Bűrger (2023) points out that estimating the trend of a time series in which there is autocorrelation is difficult. "If $\rho > 0$, ordinary least squares (OLS) estimate of β no longer have a known distribution, so that assertions about trend significance are not possible" (Bűrger, 2023, 1). For this reason, we also focused on verifying autocorrelation in the time series. In the case of statistical significance of the linear model, we determined the autocorrelation of the residuals using the Breusch-Godfrey test. We determined the autocorrelations of the first, second, third and fourth orders.

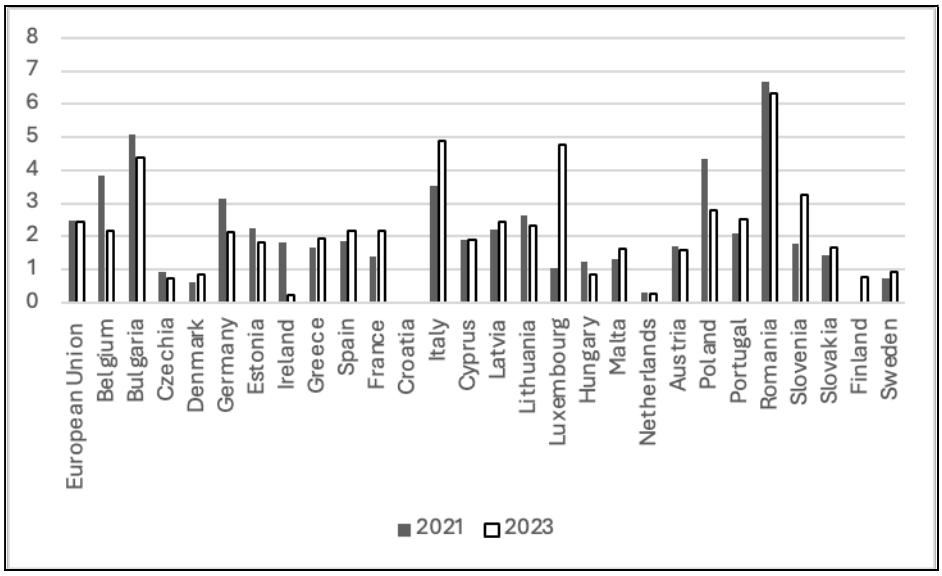
3. FINDINGS AND DISCUSSION

3.1 Individuals with no overall digital skills

The indicator characterizing the share of individuals living in a city without overall digital skills / percentage of individuals allows for the alignment of the country based on the digital skills of residents living in cities. It has decreasing preferences. That is, the higher its value, the more unfavourable its development.

The values of the indicator allow for assessing what share of the city population in the country is not ready to use digital technologies. Data are available for 2021 and 2023.

Figure 2: Individuals with no overall digital skills



Source: Eurostat (2025b)

As Figure 2 shows, the highest values of the indicator were in Romania in both periods. In 2023, there was a slight decrease in the indicator, but the values were still among the maximum. In 2021, Bulgaria was second. In 2023, the indicator value in Bulgaria decreased slightly. However, the indicator value was still among the first four maximums. Luxembourg has a specific position among EU countries. It is among the states with the largest increase in the indicator values between 2021 and 2023. In 2023, it was even the third with the highest value. This means that the share of people who did not have digital skills increased significantly. One reason could be the large number of immigrants in Luxembourg. Immigrants are concentrated mainly in cities, due to job opportunities. According to Eurostat (2025f), more than 50% of immigrants live in Luxembourg. In 2023, the share of immigrants from outside the EU was more than 18% of the total population.

The group of countries with above-average values of the indicator in both years consists of: Bulgaria, Italy, Poland and Romania. In 2021, Belgium, Germany and Lithuania had values above the average. In 2023, Luxembourg, Latvia, Portugal and Slovenia also had values significantly above the average. The lowest values were in Croatia. In 2021, Finland and the Netherlands also had low values.

3.2 Percentage of individuals who used internet in the last 3 months. Individuals living in cities

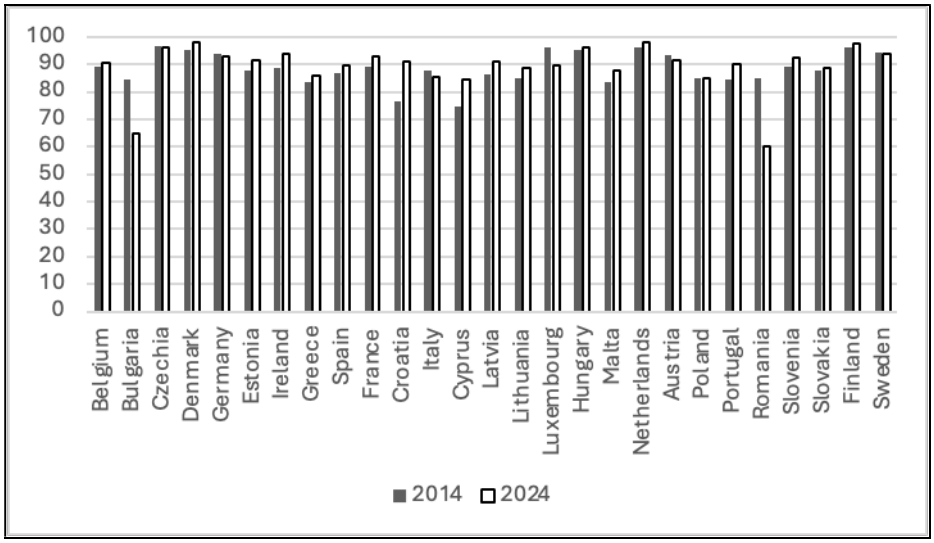
The indicator, Percentage of individuals who have used the internet in the last 3 months - individuals living in cities, has a growing preference. That is, the higher its value, the more favourable its development. The values of the indicator allow us to assess what proportion of the city population in the country uses the internet for basic activities.

We focused on comparing countries and assessing trends. Based on the trend, we can divide EU countries into three groups: countries with a growing trend of the indicator, countries with a decreasing trend of the indicator and

countries here neither a growing nor a decreasing trend.

The first three countries with the highest value of the indicator in 2014 were the Czech Republic, Finland and the Netherlands. On the contrary, the countries with the lowest values of the indicators were Cyprus, Croatia and Malta. In 2024, the Netherlands, Denmark and Finland had the highest value of the indicator. The countries with the lowest values were Romania, Bulgaria and Cyprus. In addition to these three countries, Greece, Italy, Lithuania, Malta, Poland and Slovakia had below-average values at the beginning and end of the period. The values of the indicator in 2014 and 2024 are shown in Figure 3.

Figure 3: Percentage of individuals who used internet in the last 3 months. Individuals living in cities



Source: Eurostat (2025a)

Based on the indicator values, we expressed the linear trend of the indicator in each EU country. We verified the statistical significance of the models. We then checked whether there was first, second, third and fourth order autocorrelation. A positive statistically significant linear trend of the indicator was in eight countries. These are countries where the share of individuals who used the internet in the last 3 months in the city has been growing in the long term. They are listed in Table 1. Among these countries, the Netherlands has a specific position. Not only is the indicator value among the top three countries with the highest values, but the linear trend of the time series has been growing and reaching a maximum in 2024. If the current trend of the indicator were to be maintained, the value in the Netherlands would approach saturation in approximately nine years. The Netherlands therefore significantly exceeds the EU average in basic digital skills and in ICT specialists. “The Netherlands has long been a leader in digital innovation thanks to its strong research base” (European Union, data not specified, a). Building a strong research base focused on innovation currently appears to be a positive step in the Netherlands. The country can be an example for other EU countries.

Table 1: Positive linear trend and Breusch-Godfrey test of Autocorrelation

	C	RC	CD	BGT
France	87.6555***	0.5223***	69.1%	0.178
Croatia	80.1353***	0.9897***	52.6%	0.207
Portugal	83.3913***	0.7583***	85.4%	0.846
Estonia	89.6931***	0.3305**	33.2%	0.286
Ireland	86.4782***	0.5750***	50.2%	0.748
Spain	83.1851	0.4631**	41.3%	0.191
Latvia	84.6893***	0.4544**	42.4%	0.241
Netherlands	**96.192*** **	**0.1857*** **	**72.9%**	**0.163**

Source: own processing according to Eurostat (2025a)

C - constant, RC - regression coefficient, CD - coefficient of determination, BGT- Breusch-Godfrey test of Autocorrelation, LMF, first-order, p-level

Italy has a specific position within the EU, which has a statistically significant quadratic trend. Since 2017, the trend in Italy has been increasing.

A negative statistically significant linear trend of the indicator is in four countries. Of these, two countries have above-average indicator values and two countries have below-average indicator values. These were Bulgaria and Romania.

Graphical representations of developments in countries with a linear statistically significant downward trend are in Figure 4. Parameter estimates are in Table 2.

Table 2: Negative linear trend and Breusch-Godfrey test of Autocorrelation

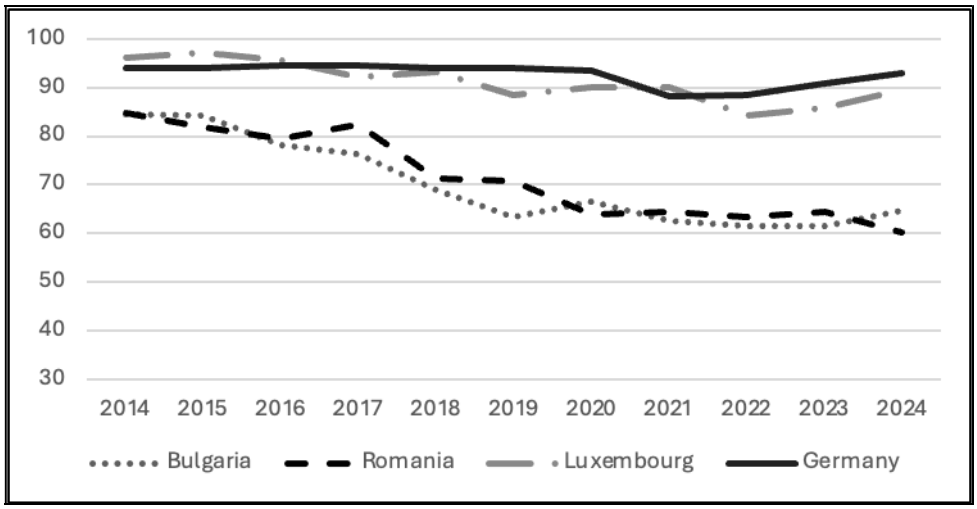
	C	RC	CD	BGT
Bulgaria	84.9184 ***	−2.44518***	80.4%	0.119
Luxembourg	97.7498***	-1.0880***	71.5%	0.475
Romania	87.0796	-2.59282***	88.6%	0.888
Germany	95.3047	-0.4438**	32.0%	0.298

Source: own processing according to Eurostat (2025a)

C - constant, RC - regression coefficient, CD - coefficient of determination, BGT- Breusch-Godfrey test of Autocorrelation, LMF, first-order, p-level

Bulgaria and Romania are also among the countries with above-average values of the indicator Individuals with no overall digital skills (in cities). Based on our criteria, we consider these two countries to be the countries within the EU where the readiness of urban residents to implement digital services is the weakest. It is important that changes occur in both countries that would lead to a reversal in trends.

Figure 4: Negative linear trend of the indicator



Source: Eurostat (2025a)

The lack of readiness of citizens to use digital services in Bulgaria and Romania when building smart cities may have several reasons. According to the European Union (2024a), which refers to the National Statistical Institute (2023), only 9.1% of enterprises in Bulgaria provide their employees with ICT training. The implementation of digitalization in small and medium-sized enterprises in Bulgaria is stagnating. The share of ICT specialists is below the EU average. At the same time, according to the European Union (data not specified, b), Bulgaria lags behind in research and development.

The share of ICT specialists in Romania is lower than average. According to the European Union (2024b), the number of ICT specialists in Romania was below the EU average in 2023 and decreased further in 2024. Digitalization in Romania is at a low level. Digital public services are also not widely used. At the same time, there are frequent changes of government in the country. This makes the situation even worse.

Both countries are characterized by a below-average share of ICT specialists. At the same time, training focused on digital skills for employees in enterprises is not widespread. In both countries, there are frequent changes of government. Political instability worsens the situation in the country. Improving political stability would contribute to improving Bulgaria and Romania in the development of digitalization and in the readiness of the population in cities for the introduction of digital services. In both countries, improving research and development would be a great positive.

Why is the situation more positive in the Slovak Republic? We consider the growing share of young people with digital skills and the increasing share of ICT specialists (European Union, data not specified, c) to be positive. It is important for the Slovak Republic to maintain the growing trend in both above indicators. Research and development also need to be improved. The political stability of the country is also important for further positive development.

Our study has several limitations. The first limitation is the disadvantage of the internet usage indicator. Hernandez and Faith (2023) state that during the Covid pandemic, it turned out that the databases on internet users in Eurostat databases did not fully reflect people's ability to use the internet connection. Users who are below certain thresholds (for example, in terms of frequency of use) are also included in the group of "internet users". The authors point

out the need to supplement the published data with, for example, new categories. However, Eurostat databases are currently the most comprehensive databases allowing for comparison of internet usage in EU cities. The second limitation is the use of secondary data. Obtaining primary data from all EU countries using the same methodology would be very demanding in terms of financial resources and time. The secondary data used come from a trusted source. Therefore, we consider their use to be correct.

In further ongoing research, it is important to monitor groups of residents in cities who may be disadvantaged in using digital services. These are mostly disadvantaged groups, whose further disadvantage could be further exacerbated. At the same time, we consider it important to monitor progress in digitalization in all EU countries in connection with building a smart city. After all, building a smart city is not possible without the development of digitalization.

CONCLUSION

People in cities who do not have the opportunity to use established digital services are disadvantaged. Therefore, access to the internet by city dwellers is important in the digitalisation of services in cities, and the digital skills of city dwellers are important.

The aim of our study was to determine, based on an analysis, the specificities of EU countries in the readiness of city dwellers to use digital services when building a smart city in terms of using the internet for basic activities and in terms of basic digital skills.

The aim of the study was to point out which EU countries have the weakest readiness of city dwellers, based on selected perspectives. Building smart cities can be more challenging in these countries, and taking measures to improve the readiness of city dwellers to introduce digital services is most urgent within the EU. At the same time, we tried to obtain findings on approaches that are important in terms of the readiness of city dwellers to use digital services.

We used the following indicators in the analysis: 1/ Percentage of individuals who used internet in the last 3 months. Individuals living in cities. Internet use: sending/receiving e-mails, 2/ Individuals living in cities. Individuals with no overall digital skills.

The analysis included the following research questions: Which countries lag behind others in digital skills? Which countries lag behind others in internet use in cities? In which countries does the indicator have a negative trend? What measures can be implemented in lagging countries or in countries with an unsatisfactory trend of the indicator?

In the study, we focused on comparing countries and analyzing the trend of the indicator characterizing internet use. We used regression analysis and verified the quality of the model. We used the Breusch-Godfrey test to determine autocorrelation.

Based on our criteria, we consider Romania and Bulgaria to be the countries within the EU where the readiness of urban residents to implement digital services is the weakest. It is important that changes occur in both countries that would lead to a turnaround in development. Both countries are characterized by a below-average share of ICT specialists. Both countries experience frequent changes of government. Political instability worsens the situation in the country. Improving political stability would contribute to Bulgaria and Romania's progress in digitalisation and the readiness of urban populations to adopt digital services. In both countries, improving training in digitalisation and improving research and development would be key positives.

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