

Digitalization of Rural Areas – Bulgarian Case Study

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Abstract. *This paper investigates the environment for digital transformation in rural areas of Bulgaria with a special focus on the digital village concept. Rural regions form the backbone of society and face unique challenges that include depopulation, an ageing population, and limited access to modern services. Despite extensive studies on digitalization in urban areas, rural areas have received less attention in the scientific literature. This paper addresses this gap by exploring the potential of digital technologies to revitalize rural communities and by assessing whether the digital village model can offer a viable solution for sustainable rural development.*

The research uses a mixed methodology combining quantitative analysis of statistical data with qualitative evaluations of policy initiatives and local conditions. Two primary research questions guide the study: first, what is the current environment for digitalization in Bulgarian rural areas, and second, is the digital village concept an applicable model for digital transformation in these regions? The findings reveal that while significant infrastructural and educational challenges remain, there is an encouraging trend in digital literacy and policy support. Moreover, improvements in digital infrastructure and targeted training initiatives indicate that rural areas have untapped potential for digital growth.

The study contributes to the field by providing a comprehensive framework that synthesizes the key factors affecting rural digital transformation and by offering practical recommendations for policymakers and community stakeholders. The findings results imply that with targeted investments and strategic planning, the digital village concept could play a pivotal role in enhancing economic activity, social inclusion, and overall quality of life in rural areas of Bulgaria.

Keywords: rural areas, digitalization, digital village, digital skills, internet access.

Introduction

Rural areas are the fabric of our society and the heartbeat of our economy. They are a core part of our identity and our economic potential. (Ursula von der Leyen). Rural areas cover 83% of the Community's territory. Today, only 30% of the EU's population lives in rural areas, due to the urbanization process that began in the second half of the 20th century and the mass migration of the people to the cities. (EU). As a result of depopulation and the ageing of the population, economic activity in these regions has declined significantly, which has also led to a slowdown in their economic development. To reverse the negative dynamics and to stimulate the development of the rural areas, a change is needed. Digital technologies are one of the ways to revitalize rural areas, improve the quality of life and achieve sustainability. At a time when the world is

experiencing the convergence of progress with the transformation of information technologies, rural areas have the potential to be an 'explosion' and a catalyst for innovation. This is relevant for rural areas in Bulgaria, which are currently facing serious challenges such as depopulation of 19,85 percent between 2010 and 2023-year, economic stagnation, limited access to services and poor infrastructure.

Digitalization is an opportunity for rural areas in Bulgaria to overcome demographic and economic problems and to stimulate growth in these areas. This paper aims to investigate how rural areas in Bulgaria are affected by digitization. It provides an in-depth analysis of the situation in countryside and identifies factors and obstacles to the process of digitalization and integration of digital technologies in these areas, using a mixed approach based on quantitative and qualitative data. On this basis, the study focuses on two research questions:

RQ1: What is the environment for rural digitization in Bulgaria?

RQ2: Is the concept of the digital village, one of the applicable possibilities for digital transformation of rural areas in Bulgaria?

The results of this study will be a contribution to the understanding of the extent of digitalization in rural areas and will allow the derivation of specific recommendations for the development of effective policies and measures to support the digital transformation of rural areas.

Literature review

Today's society is more globalised and more connected to the digital world than ever before. The change is unprecedented and ground-breaking. The ones and zeros have transformed the reality in which we live, work and communicate, creating a global network of opportunities and challenges. Digitalization is a powerful catalyst with fundamental economic and societal consequences. It plays a leading role in the generation, storage, distribution and use of information. Its pervasive influence is transforming all sectors and levels of public and private life. This is now spreading to rural areas¹, where it has the potential to become a key tool in addressing challenges such as underdevelopment, population aging, poverty and isolation.

Digitization is a socio-technical phenomenon (Frenzel et al., 2021, p. 7) for a long-term transformative process of a "large technical system" that is socially constructed and has socio-spatial effects (Binder & Witting, 2021, p. 267). It encompasses the use of digital technologies and data, and networking that results in new technologies or changes to existing ones. Through process improvements, efficiency enhancement and the implementation of digital innovations. In rural areas, digitalization takes on specific forms and objectives linked to the specificities of the local economy, social environment and infrastructure. In this way, it bridges different economic and social structures, promotes digital convergence (for details see Gorenšek & Kohont, pp. 100-101) and creates new opportunities for rural development.

Digitalization in rural areas encompasses all aspects of the penetration and inclusiveness of digital technologies, considering the specifics of their location – rural areas. This is a comprehensive transformation of rural areas through the use of digital tools and connectivity to

¹ Rural areas are geographical areas with a low population density per square kilometre. The criteria for rurality vary. In Bulgaria, the Strategic Plan for the Development of Agriculture and Rural Areas of the Republic of Bulgaria (2023-2027), developed under the Common Agricultural Policy of the EU, defines a "rural area" as a municipality that does not have a settlement with a population of more than 15,000 people. According to this definition, 215 municipalities out of a total of 265 municipalities in Bulgaria are classified as rural (CAP Strategic Plan 2021 Report, 2023 p. 434).

transform rural areas. In this context, rural digitalization is a specific manifestation of it, adapted to local conditions and goals.

Rural digitalization is a process of reshaping the physical environment, economic form, social network and spatial organization of rural areas with the wide application of digital technology in vast rural areas. It promotes the digital transformation of rural economic and social forms and spatial organizational structure, including the process, role and effect of digital technology in the following four aspects:

- Bridging the digital divide by providing access to the internet and digital tools.
- Supporting rural economies through digital technologies that enhance agriculture, tourism, and rural trade.
- Improving the quality of life in rural areas by using digital solutions and social platforms in health, education, and social services.
- Building digital skills and increasing digital literacy. (Yang & Lin, 2023).

On the one hand, it improves access to technology, but on the other, it leads to profound changes in the governance, economy, social life and infrastructure of rural areas. The rural digitalization a multifaceted process, implemented through various initiatives, programs and actions. The digital village is one of its specific manifestations, integrating digital technologies into the socio-economic development of rural communities.

Digital village is a concept of social entity formed by community awareness and the desire to think beyond and build a new form of cooperation and alliances using advanced digital technologies (Agusta, 2023, p. 3). It is the process of using information technology and digital technology to make targeted transformations based on the needs and characteristics of the village and ultimately achieve a change in the development model of the village. (Zhao, et al, 2022, p. 1).

The digital village concept is an opportunity for rural areas to create a digital infrastructure, reduce the digital divide, improve the digital literacy of residents, stimulate local economic development, solve social and environmental related issues and promote sustainability. (Agusta, 2023, p. 4). At the macro level, it is implemented through programs that use technology to improve government systems and services, and to help empower communities. The digital village concept is an approach to overcoming challenges and removing barriers by offering comprehensive solutions to stimulate economic activity, achieve social well-being and ensure the sustainability of rural areas and their inhabitants. Depending on the level of scientific and technological progress, there are three levels of implementation: basic, intermediate and advanced.

Basic level: The Digital Village concept is about connectivity and access to digital technologies; it is associated with the building of digital infrastructure. The aim is to ensure broadband internet access, 4G/5G mobile networks. This level is covered by the idea of the digital village as a connotation of rural areas becoming digitally enabled. In a sense, the digital village is related to the internet and the creation of a digital infrastructure that can be used as a utility for every rural resident (Agusta, 2023, p. 4) and is built upon the digitalization of rural infrastructure.

Intermediate level: The Digital Village concept aims to improve and optimize efficiency through smart digital solutions. The focus is on the application of digital technologies (precision farming, smart weather stations, GPS navigation of animals, etc.); smart resource management; use of platforms to improve social services (e-services, distance learning, etc.). This level is associated with the concept of the smart village as a paradigm shift in rural development (Emerllahu & Bogataj, 2024, p.268). It is an approach to encouraging local development in a village, covering heterogeneous activities, mainly supported and empowered by technology, which act as tools to improve services in rural areas and make rural functioning easier and smoother, leading to the

overall enhancement of rural dwellers (Stoyanova, 2021, p. 2). A smart village can be defined as a community that seeks to develop current strengths and resources while making futuristic development plans based on technology. (Adesipo et al, 2020, p.2)

The *advanced level* is characterized by using Artificial Intelligence (AI) to optimize processes, Internet of Things (IoT) blockchain technologies, drones, autonomous self-driving cars, collecting and analyzing large amounts of data, etc. to build sustainable systems. It is associated with the concept of Village 4.0, which incorporates Industry 4.0 into rural development (Malik et al., 2022) and further develops the concept of smart villages and their digital transformation (Sampetoding & ER, 2024).

Each of the three levels - Digital Village, Smart Village and Village 4.0² - is a separate stage in the digitalization process, reflecting the level of implementation and use of digital technologies in rural areas and revealing the three aspects of the Digital Village concept. (Fig.1).

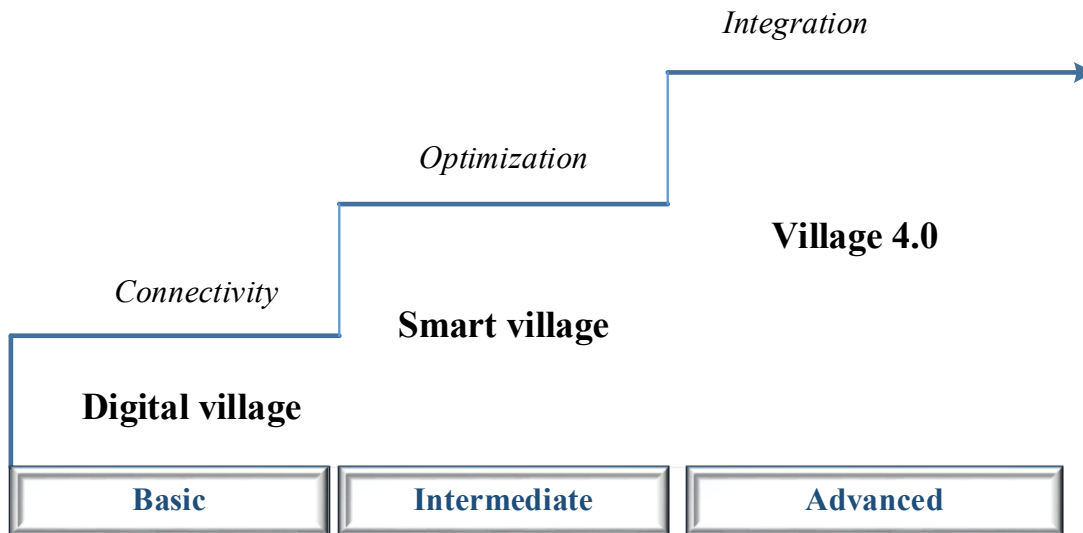


Figure 1. Digital village concept: development stages

Source: Authors.

These three stages represent the gradual evolution from basic digital connectivity to integrated smart solutions, ultimately leading to the complete digital transformation of rural areas. The Digital Village concept has various applications, including strategies, projects and initiatives at local or regional level. It has become a key tool for stimulating economic activity, improving social well-being and promoting the sustainability of rural areas and their communities through digital technologies. This development has been driven by the active policies of international organisations and initiatives - such as the Food and Agriculture Organisation (FAO), the European Union (EU), the United Nations (UN), the Asian Development Bank and the African Union - as well as national governments.

As a result, scientific interest and research on the topic has grown significantly. A study by Emerllahu and Bogataj (2024, p. 269) highlights this trend, pointing out that "smart villages" are referenced in 930 journal articles and conference papers indexed in the Web of Science.

² These three concepts are often treated as synonyms in the literature. While all are concerned with rural digitization, they differ in terms of focus, technologies used and expected impacts.

In Bulgaria, publications on this topic are limited. Bachev (2020) analyses the degree of digitalization in agriculture and examines the factors hindering digital transformation in the sector. Nikolov et al. (2022) extend the analysis by focusing on digital solutions, their impact on competitiveness and opportunities for new business models. Emin et al. (2023) outline the main problems and prospects for the digitalization of municipalities and regions in Bulgaria, including rural areas. Despite these studies, there is no assessment of the potential of rural areas in Bulgaria for the implementation of the digital village concept. The dynamic development of digital technologies requires an up-to-date analysis of the environment and challenges for the digitalization of rural areas.

Methodology

Analysing digitalization in rural areas in Bulgaria involves the application of both quantitative and qualitative research methods. It refers to data after 2020, due to the exceptional dynamics in the field, especially after the AI introduction into business processes. The object of study - rural areas in Bulgaria, is assessed through the prism of outlining the possibilities for implementing the concept of the digital village as an option for increasing economic activity, achieving social well-being of residents of rural areas. The steps in this analysis include:

- Availability of the Internet and digital infrastructure in rural areas. In order to outline the initial parameters of the possibilities for digitalization, the study started with the availability of the necessary infrastructure and Internet coverage in rural areas of Bulgaria. Without these prerequisites, any subsequent actions could not be carried out, including analyses of opportunities regarding the introduction of the concept of digitalization.

- General status and trends in the population in rural areas (villages), including age and educational structure. An objective circumstance for Bulgarian rural areas, related to their digitalization, is the human factor. The presence, specificity, as well as the educational level of the population are a significant and irresistible factor and argument for implementing one or another policy in the field of digitalization.

- Digital skills among the population in rural areas. The implementation of digitalization and digital village strategies is unthinkable without the availability of digital skills adequate to the concept, even if they are at a basic level. The information from DESI index also shows the “big picture” and is used as a summary index for the readiness to digital village concept.

These key aspects of rural areas are outlined from the point of view of implementing the concept of digital villages, namely infrastructure and the human factor. The analysis uses data sources such as: national and international reports on Bulgarian agriculture, state statistics and academic literature. They allow identification and categorization of opportunities for digitalization at these specific areas.

Results and discussions

The digitalization of rural areas is not a one-time act, but a sequence of multiple steps in the chosen direction with a view to achieving the set goal. This requires the study of the parameters of environment for these areas, outlining their specific characteristics and, on this basis, carrying out activities to implement the best solutions for each region.

Undoubtedly, digitalization is impossible without access to the Internet and the supporting structure as a key factor and prerequisite for this process. In the European union (EU), the share of households with internet access was 94% in 2024, up from 80% in 2014. More than 80% of EU internet users sent or received e-mails in 2024, as well as 70% of EU internet users interacted with

public authorities in 2024. In the same 2024, 72% of EU internet users ordered or bought services or goods online. In Denmark, Luxembourg, the Netherlands, Ireland, Sweden, Belgium, Malta, and Germany in 2024, the internet access of rural areas is comparable with the internet access in cities. The difference in internet access between cities and rural areas was highest in Greece and in Bulgaria with 15 percentage points (pp) in 2024.

The second factor related to the digitalization of rural areas is the human factor. Bulgaria, like most of EU countries, is in depopulation and for the period 2020-2023 we had a decrease of almost half a million (Fig. 1). The population in villages³ is also decreasing and by the end of 2023 it is 166,342 people less than in 2020. However, in 2023 there is a slight increase in the rural population, although it is only 6,020 people, which corresponds to the population of several average Bulgarian villages. It is noteworthy that regardless of the dynamics in absolute numbers, in percentage terms the total population to the rural population retains the same – 79/21% (Fig. 2), and the urban-rural population ratio is 73/27% for 2020-2021, but for the next two years 2022-2023 it is 74/26%, which again indicates a decline. In total, for the country in a four-year period the population decreased by about 7%, while the decrease in the population in villages was 9%.

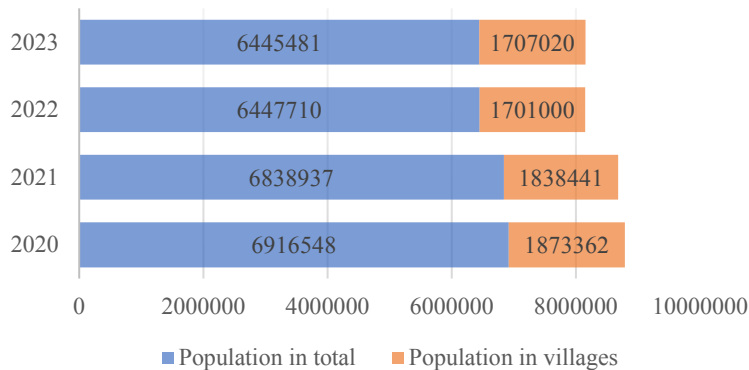


Figure 1. Population in total and in villages for the period 2020-2023

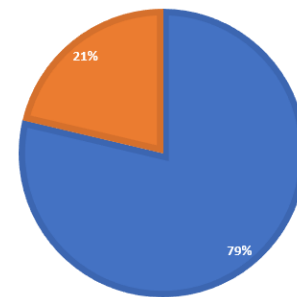


Figure 2. Ratio of population in total and in villages for the period 2020-2023

Source: Based on National Statistical Institute data, <http://www.nsi.bg>.

The age structure of village population is also an indicator of certain opportunities and limitations in terms of adopting the digital village concept. For the analyzed period 2020-2023, there are no serious changes, as the overall status points to a very low share of population under age of 14 - it remains constant at 13% of the total rural population. Fluctuations in the values are observed in the other two groups: the population aged between 15 and 64, which could be perceived with some conditionality as the population of working age, shrank from 60% to 58% during the period at the expense of an increase in the population aged 65+, which in 2023 was 28%. The data indicate that the human resources that are still needed to implement the capabilities of the digital village, namely people under age of 14, are 2.15 less than people aged 65+, and in the analyzed period the last are increasing. This suggests a serious villages' population aging in the coming years, which is a trend with more of a negative charge in terms of digitalization than a positive one.

³ The village is a cornerstone for successful digital transformation of each rural area. This essence is crucial for digital village and should be accompanied by variety of EU cohesion policies as well as national measures.

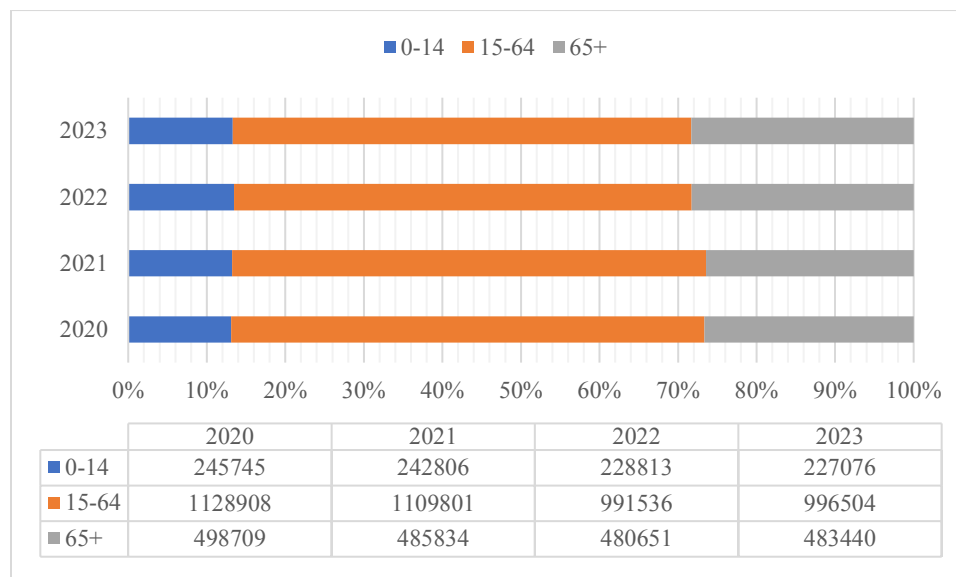


Figure 3. Rural population by age groups for the period 2020-2023

Source: Based on National Statistical Institute data, <http://www.nsi.bg>.

The education is crucial for successful digitalization and transformation of rural areas in the EU, as well as in Bulgaria. The data in Figure 4. examines the participation rate (%) in formal and non-formal education and training among individuals aged 25 to 64 years in rural areas of the EU-27, EA-20, and Bulgaria from 2007 to 2022. This metric is essential for understanding trends in lifelong learning and workforce upskilling. The analysis is deducted not only for Bulgaria and EU-27, but also for EA-20 to deepen the results with the richest and highest cohesion part of the EU. This could help us to clarify where Bulgaria's rural areas stand among the other euro area countries on the brink of national adoption of the euro.

The key observation and trends in the EU-27 could be featured as consistent growth (+13.2 percentage points) in the period of 2007 to 2022. The highest growth occurred between 2007 and 2016, with an increase of 10.9 percentage points. The next sub period from 2016 to 2022 is characterized with moderate growth where participation increased by only 2.3 percentage points, indicating possible saturation or slowing improvements in rural education access.

The same observation period but for Euro Area (EA-20) analyses reveal the higher Participation Rates than EU-27. Education and training participation was consistently higher than the EU-27 average. It increased from 31.1% in 2007 to 45.6% in 2022 (+14.5 percentage points). There are too the same sub periods - strong growth from 2007 to 2016 where participation grew 14.1 percentage points in just nine years and minimal growth from 2016 to 2022 when the increase was only 0.4 percentage points, suggesting a plateau in education engagement.

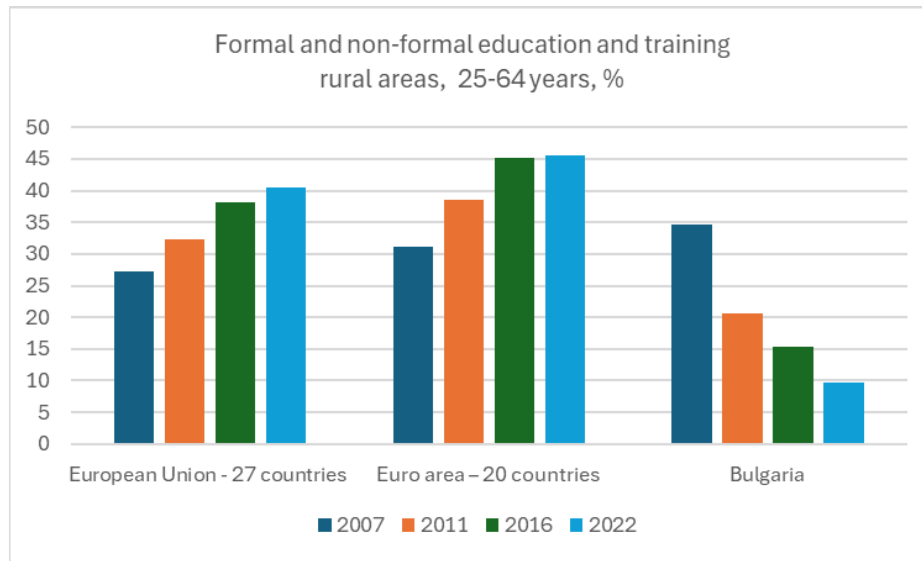


Figure 4. Formal and non-formal education and training, rural areas, 25-64 years

Source: Autor's own research based on <https://ec.europa.eu/eurostat/databrowse>
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Meanwhile Bulgaria rural areas facing sharp decline in participation dropped from 34.6% in 2007 to just 9.8% in 2022 (-24.8 percentage points). The most significant drop (2007-2011) occurred where participation fell from 34.6% to 20.7% (-13.9 percentage points), possibly due to economic, policy, or migration factors. Unfortunately decrease continue after 2011:

- ✓ By 2016, participation dropped further to 15.3% (-5.4 percentage points).
- ✓ By 2022, it reached 9.8%, reflecting a severe lack of participation in lifelong learning.

The analysis of Figure 4. guide us to the following short conclusions for EU-27 and EA-20 which could be summarized as follows:

- *Policy Initiatives:*
 - ✓ Investments in *adult education and lifelong learning programs* have likely contributed to steady growth.
 - ✓ The European Skills Agenda and digital education strategies support participation in training.
- *Economic Factors:*
 - ✓ Workforce demand for new skills, especially *digital and technical competencies*, has increased motivation for training.
- *Slower Growth Post-2016:*
 - ✓ A *saturation point* may have been reached, where most willing individuals have already enrolled in training.
 - ✓ Remaining gaps may be due to *accessibility issues, aging populations, or resistance to education in rural areas*.

When we look at the same time to Bulgaria – three words could describe the situation - *Drastic Decline in Participation*. Targeted policy interventions, digital education opportunities, and workforce development programs are necessary to close the rural education gap. So, the summarize for Bulgaria is:

- *Economic and Policy Challenges:*
 - ✓ Possible *reduced funding for adult education* or *lack of targeted policies for rural education*.
- *Demographic Changes:*
 - ✓ Rural depopulation and migration to urban areas could explain the decline, as younger, more educated individuals leave rural regions.
- *Workforce Trends:*
 - ✓ A lack of demand for *higher education in rural job markets* may discourage participation in training.

Urban and rural areas are often opposed in political, economic, social, cultural and other aspects. With the advent of digitalization, another opposition of these areas has begun - along the axis of digitalization. The challenges are numerous and encompass inequalities in terms of limited access to technology, education and training, as well as awareness. The realization of the digital village concept is inextricably linked to the possession of digital skills by people in rural areas. In a general sense, we associate these skills with the safe and effective use of digital technologies in the sense of using various smart devices and their functions, navigating the internet, communicating online, managing information, creating content, etc. Table 1. presents the percentage of individuals in rural areas with digital skills in the European Union (EU-27), the Euro Area (EA-20), and Bulgaria for the years 2021 and 2023.

Individuals in this category have met all five component indicators at a basic or above-basic level, indicating a high level of digital competency.

Table 1. Digital skills of individuals, living in rural area, percentages

Region	2021	2023	Change (2021-23)
<i>Individuals with basic or above basic overall digital skills (all five component indicators are at basic or above basic level)</i>			
European Union - 27 countries	45,72	47,50	+1,78
Euro area – 20 countries	50,51	51,55	+1,04
Bulgaria	17,42	20,93	+3,51
<i>Individuals with low overall digital skills (four out of five component indicators are at basic or above basic level)</i>			
European Union - 27 countries	17,97	19,13	+1,16
Euro area – 20 countries	17,78	18,76	+0,98
Bulgaria	11,83	12,21	+0,38
<i>Individuals with narrow overall digital skills (three out of five component indicators are at basic or above basic level)</i>			
European Union - 27 countries	11,09	11,11	+0,02
Euro area – 20 countries	10,63	10,33	-0,30
Bulgaria	13,79	15,56	+1,77
<i>Individuals with limited overall digital skills (two out of five component indicators are at basic or above basic level)</i>			
European Union - 27 countries	6,66	6,68	+0,02
Euro area – 20 countries	5,50	5,88	+0,38
Bulgaria	14,37	12,20	-2,17
<i>Individuals with no overall digital skills</i>			
European Union - 27 countries	3,73	3,51	-0,22
Euro area – 20 countries	2,71	2,67	-0,04
Bulgaria	7,97	9,23	+1,26

Source: Authors' own research based on <https://ec.europa.eu/eurostat/databrowse>.
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Analyses of Table 1. are focused on all five levels of digital skills. The percentage of rural individuals in EU-27 with basic or above basic digital skills increased from 45.72% to 47.50% (+1.78 percentage points). This suggests gradual improvement in digital literacy levels in rural areas. Meanwhile the Euro Area percentage also rose from 50.51% to 51.55% (+1.04 percentage points), indicating that rural digital skills continue to improve but at a slightly slower pace than the overall EU. The most significant increase was observed in Bulgaria, where the percentage jumped from 17.42% to 20.93% (+3.51 percentage points). This outpaces the EU-27 and EA-20 growth rates, suggesting strong progress in rural digital skills acquisition.

The steady increase suggests that ongoing digital education programs, improved infrastructure, and wider technology adoption are gradually boosting digital literacy in rural areas. The slightly slower growth in the Euro Area may indicate diminishing returns, as many individuals were already in this category, leaving fewer people transitioning into basic or above-basic skill levels. In Bulgaria the notable improvement in digital skills suggests that digital literacy initiatives, government programs, and increased internet access are having a positive impact. The higher increase in Bulgaria compared to the EU average may indicate a catch-up effect, as Bulgaria starts from a lower baseline but is now making faster progress.

The overall trend is positive, with rural digital literacy improving across all regions. Bulgaria, despite starting from a lower level, has seen the most significant progress, which is a promising sign for reducing the digital divide. However, continued efforts in training, internet accessibility, and infrastructure development are needed to sustain and accelerate this trend.

The next dataset in Table. 1 presents the percentage of individuals in rural areas with low overall digital skills in the European Union (EU-27), the Euro Area (EA-20), and Bulgaria for period 2021 - 2023. Individuals are classified as having low digital skills if they meet at least four out of five component indicators at a basic or above-basic level. The percentage of rural individuals (EU-27) with low digital skills increased from 17.97% to 19.13% (+1.16 percentage points). This suggests an improvement in digital literacy, as more individuals have progressed from having narrow skills to low skills. A similar increase is observed in Euro Area (EA-20), from 17.78% to 18.76% (+0.98 percentage points), indicating a positive trend in digital skills acquisition in rural areas of the Eurozone. At the same time in Bulgaria this indicator increased slightly from 11.83% to 12.21% (+0.38 percentage points). While this suggests progress, Bulgaria remains below the EU and EA averages, indicating a slower rate of skill development compared to other regions.

Possible explanations for trends visible in EU-27 and EA-20 are that the increase in low digital skills suggests a positive shift in rural digital literacy, as individuals who previously had only narrow or limited skills are now achieving a higher level of competence. This may be due to investments in digital education, infrastructure improvements, and targeted digital upskilling programs. On the contrary in Bulgaria the slower increase in low digital skills suggests that while digital literacy is improving, rural populations may still face challenges in moving beyond narrow skill levels. Factors such as economic barriers, education levels, and internet accessibility could be limiting the rate of progression.

In the Table. 1 is presented data of individuals in rural areas with narrow overall digital skills in the European Union (EU-27), the Euro Area (EA-20), and Bulgaria for the years 2021 and 2023. Individuals are classified as having narrow digital skills if they meet at least three out of five component indicators at a basic or above-basic level. In the European Union (EU-27) we can observe that the percentage of rural individuals with narrow digital skills remained almost unchanged, increasing marginally from 11.09% to 11.11% (+0.02 percentage points). This suggests that progress in digital skill acquisition has been slow. Meanwhile, within the Euro Area (EA-20)

a slight improvement was observed, with the percentage decreasing from 10.63% to 10.33% (-0.30 percentage points). This indicates a small but positive shift towards better digital skills in rural areas of the Eurozone. The positive trend in Bulgaria is represented due to individuals with narrow digital skills increased significantly from 13.79% to 15.56% (+1.77 percentage points). This suggests a growing number of individuals in Bulgaria transitioning from limited digital skills to narrow digital skills, possibly reflecting an improvement in digital literacy.

The percentage of rural individuals in European Union (EU-27) with limited digital skills remained relatively stable, increasing marginally from 6.66% to 6.68% (+0.02 percentage points). This suggests that digital literacy in rural areas has neither significantly improved nor deteriorated in this period. At the same time in Euro Area (EA-20) we can observe increasing from 5.50% to 5.88% (+0.38 percentage points), indicating a slight decline in digital skill acquisition among individuals in rural areas of the Eurozone. According to Bulgaria there is experienced a notable improvement, with the percentage decreasing from 14.37% to 12.20% (-2.17 percentage points). This suggests significant progress in digital literacy among rural residents in Bulgaria.

Digitalization is impossible without people with the appropriate digital skills. The lowest level of individuals in rural areas with no overall digital skills in the European Union (EU-27), the Euro Area (EA-20), and Bulgaria for the years 2021 and 2023 are also presents the percentage. Individuals in this category do not meet any of the five component indicators at a basic or above-basic level, meaning they lack essential digital competencies.

In the EU-27 the percentage of rural individuals with no digital skills declined slightly from 3.73% to 3.51% (-0.22 percentage points), indicating a small but positive shift in digital inclusion. A marginal improvement is observed within EA-20, with the percentage decreasing from 2.71% to 2.67% (-0.04 percentage points). This suggests stability in digital skill acquisition, with minimal movement in or out of this category. At the same time unlike the EU and EA-20, Bulgaria met a notable increase in individuals with no digital skills, rising from 7.97% to 9.23% (+1.26 percentage points). This is a concerning trend, indicating a growing digital divide in rural areas.

In the EU-27 and EA-20 the small reduction in individuals with no digital skills suggests continued digital inclusion efforts, but the slow progress may indicate barriers such as age, education, or lack of digital infrastructure in rural areas. The Euro Area saw only minimal improvement, possibly due to stagnation in digital literacy programs or already high skill levels, leaving little room for improvement. The increase in digitally unskilled individuals in Bulgaria is alarming and suggests that some rural populations are being left behind in digital transitions. Possible causes include insufficient rural digital education, economic constraints, and lack of internet access. The rise could also reflect population shifts, where younger, digitally skilled individuals migrate to urban areas, leaving behind older generations with lower digital competencies.

RQ1: What is the environment for rural digitization in Bulgaria?

The environment for rural digitization in Bulgaria is characterized by both significant challenges and emerging opportunities. Key points can be summarized as:

- ✓ **Infrastructure Gaps:** While internet access has improved, rural areas in Bulgaria still lag behind urban centers and EU averages—with a noted 15 percentage point gap compared to cities.

- ✓ **Demographic Challenges:** Rural Bulgaria faces substantial depopulation and an aging demographic. The population decline, with a sharper decrease in villages compared to urban areas, coupled with a rising share of older residents, creates difficulties for digital adoption and innovation.

✓ **Educational and Digital Literacy Issues:** Lifelong learning and participation in digital education programs have sharply declined in rural regions. Although there has been some progress—with a notable catch-up in basic digital skills—the low baseline and concerning increase in the proportion of individuals with no digital skills suggest that many residents are still left behind in the digital transformation process.

✓ **Potential for Digital Transformation:** Despite these obstacles, the steady increase in basic and narrow digital skills, along with targeted government and EU initiatives, indicates that rural digitization is gaining traction. The concept of the **Digital Village**—which evolves from basic connectivity to smart solutions and eventually a fully integrated digital ecosystem (Village 4.0)—offers a strategic framework to leverage digital technologies for local economic revitalization, improved public services, and enhanced quality of life.

In summary, The current state of rural digitization in Bulgaria is characterized by a combination of advancements and persistent challenges: existing infrastructural and demographic challenges impede rapid digital adoption, but ongoing improvements in digital literacy and the potential offered by innovative concepts like the digital village point toward a promising path for revitalizing rural communities if tailored, targeted policies and programs are implemented.

RQ2: Is the concept of the digital village, one of the applicable possibilities for digital transformation of rural areas in Bulgaria?

The digital village concept is indeed an applicable possibility for the digital transformation of rural areas in Bulgaria. It offers a structured framework that:

✓ **Enhances Connectivity and Infrastructure:** It prioritizes establishing robust digital infrastructure, a critical first step given the current internet access gaps in rural regions.

✓ **Boosts Digital Literacy:** By promoting digital education and training, the concept addresses the significant challenges posed by low digital skills and the growing digital divide.

✓ **Stimulates Local Economic Development:** It integrates digital tools into everyday activities, paving the way for improvements in agriculture, local businesses, and public services.

✓ **Improves Quality of Life:** The model supports targeted social interventions, which are essential in areas affected by depopulation and an aging population.

In conclusion, the Digital Village framework offers a promising way to revitalize rural Bulgaria through tailored, technology-driven initiatives, although challenges such as demographic decline and limited digital literacy remain.

Conclusion

This study has provided a comprehensive analysis of the environment for digitalization in Bulgaria's rural areas and has explored the applicability of the digital village concept as a pathway for digital transformation. The main contributions of this paper include:

- **Holistic Assessment:** An in-depth synthesis of the current state of digital infrastructure, demographic trends, and digital literacy in rural Bulgaria, with comparative insights from EU-27 and Euro Area data.

- **Framework Evaluation:** A detailed exploration of the digital village concept across its developmental stages—from basic connectivity to advanced smart solutions—demonstrating its potential to address local socio-economic challenges.

- **Policy Implications:** Identification of key challenges, such as infrastructural gaps, demographic decline, and low participation in digital education, alongside emerging opportunities driven by targeted digital initiatives and increasing digital skills among rural residents.

The findings underline that, despite persistent challenges such as depopulation, an aging population, and limited access to digital services, the digital village model offers a promising strategy for revitalize rural communities. By gradually enhancing digital infrastructure, investing in lifelong learning, and adopting innovative digital technologies, rural areas in Bulgaria can overcome socio-economic disparities and stimulate sustainable growth.

Importance and Applications: This research is significant for policymakers, regional planners, and community stakeholders. It provides a data-driven foundation to design targeted interventions aimed at bridging the digital divide, fostering local economic development, and enhancing public service delivery. The digital village framework can serve as a blueprint not only for Bulgaria but also for other regions facing similar digital transformation challenges.

Limitations and Future Extensions: Despite its contributions, the study has some limitations. The analysis primarily relies on aggregate quantitative data and existing literature, which may not capture the nuanced experiences and local dynamics of digital transformation in every rural community. Additionally, the rapidly evolving nature of digital technologies necessitates continual updates to the analysis. Finally, while the focus on Bulgarian rural areas provides in-depth insights, the findings may have limited generalizability to other national or regional contexts.

Future research could address these limitations by incorporating longitudinal studies, qualitative case analyses, and comparative research across different regions. Such extensions would further refine the digital village model and evaluate its long-term impact on rural development.

In summary, while significant challenges remain, the digital village concept represents a viable and adaptable framework for catalyzing digital transformation in Bulgaria's rural areas, paving the way toward a more inclusive and digitally empowered future.

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