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DISPROPORTIONS IN RURAL AND URBAN LIVING CONDITIONS AND SMART VILLAGE STRATEGY FOR SUSTAINABLE AGRICULTURE

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Abstract

The purpose of the article is to analyze disparities in living conditions between rural and urban areas and to evaluate the prospects for implementing a Smart Village strategy to enhance the efficiency of agricultural development. Our results indicate that significant differences persist between rural and urban areas, affecting life satisfaction in rural communities, agricultural development, and urbanization patterns. In low-income countries, the rural population is proportionally higher than in high-income and upper-middle-income countries, whereas disparities in living conditions are less pronounced in high-income countries. We propose quantitative indicators to assess rural living standards and inform decisions regarding residence in rural areas. Also, we identify the key components of a Smart Village strategy and examine barriers to its practical implementation.

Keywords: *Disproportion, Infrastructure, Rural Development, Smart Village, Strategy, Sustainable Agriculture, Urban Development.*

JEL Codes: *O11, O18, Q18.*

Introduction

Agriculture development is the key to ensuring food security and exporting agricultural products, thereby ensuring foreign exchange earnings and replenishing the state budget. Many countries strive to have a developed food complex, which is capable not only of fully providing the country's population with food products, but also of forming an active position of the country in the international markets of key agri-food products. For effective agriculture development, it is essential to improve rural areas and the living conditions of the rural population. However, currently in most developing countries, rural development is at an insufficient level. Rural communities face persistent challenges such as low productivity, climate variability, soil degradation, water scarcity, and market inefficiencies. These issues are exacerbated in developing countries, where access to technology, finance, and knowledge is limited.

For the complex development of rural areas and increasing the efficiency of agricultural development, it is necessary to invest in the construction of modern roads, repairing of schools, medical institutions, creating new jobs, development of engineering networks and access to the Internet, which will create comfortable conditions for living and working in the village. Such changes will encourage young people to stay in rural areas or return there, reducing migration to cities and abroad. In addition, the development of infrastructure opens up opportunities for processing agricultural products on site, which increases added value and promotes the development of local businesses.

It is also important to create programs to support small and medium-sized farming, provide access to cheap loans and training projects in modern agricultural technologies, which will increase the competitiveness of agriculture and ensure stable employment for the local population. As a result, rural regions will be able to become drivers of the country's economic development, contributing not only to food security, but also to social stability.

So, the purpose of the article is to analyze the existing disparities in the development of rural and urban living conditions and to determine the prospects for implementing a strategy to create a Smart Village, thereby increasing the efficiency of agricultural development.

Literature review

Differences in the development of rural and urban areas and the living standards of rural and urban residents are discussed in the papers of Arps & Peralta (2021), Bulderberga (2011), Cyrek & Cyrek (2025), Fang (2022), Qi et al.(2008). Biegańska et al. (2018) focuse on demographic and social changes caused by peri-urban development in rural areas in Latvia, Poland, and Germany. The concept of creating smart cities and its further development is considered in the papers of Adesipo et al (2020), Aggarwal et al. (2018), Ali et al. (2025), Atkočiūnienė & Vaznonienė (2019), Aziiza & Susanto (2020), Budziewicz-Guzlecka (2019), Creineanu & Marcuta (2024), Dembovska et al. (2023), García Fernández & Peek (2023), Harakal'ova (2018), Maja et al. (2022), Malik et al. (2022), Paniagua (2023), Patnaik et al. (2020), Renukappa et al. (2024), Somwanshi et al. (2016), etc. According to Renukappa et al. (2024), key challenges hindering the implementation of the smart village agenda include limited financial resources, absence of well-defined development strategies for sustainable smart villages, insufficient stakeholder collaboration, and inadequate awareness or understanding of the smart village concept. Conversely, their findings identify smart energy, smart healthcare, smart transportation, smart education, and smart water management as the five most critical strategic priorities for smart village development.

Zhang & Zhang (2020) note that rural sustainability in China confronts multiple obstacles. In response, the Chinese government has prioritized the development of smart villages as a central strategy for achieving sustainable rural development. In their work, a smart village is conceptualized as a rural development model that leverages information and communication technology (ICT) solutions to support sustainability goals, grounded in a clear understanding of local development characteristics and needs.

Somwanshi et al. (2016) conceptualize a smart village as an integrated set of services delivered to residents and businesses in an efficient and effective manner. They emphasize that modern energy access serves as a catalyst for development across multiple sectors – including education, healthcare, security, economic enterprise, and environmental management – creating a reinforcing cycle that further enhances energy availability and access.

Adesipo et al. (2020) observes that there has been a growing focus on village development in Europe and other regions as a strategy to mitigate rural-urban migration and promote rural self-sufficiency. This shift has given rise to the smart village concept. Smart village initiatives within the European Union are also inspiring similar global efforts aimed at enhancing the quality of life and economic opportunities for rural populations. These programs often prioritize boosting agricultural productivity, recognizing that rural areas remain the primary source of global food production.

Junaidi et al. (2025), Wang et al. (2022), Gerli et al. (2022), Muhtar (2023), Bokun & Nazarko (2023) made a bibliometric analysis of smart villages research. Junaidi et al. (2025) wrote that Rice fields, coastal areas and mountainous regions each require different smart village models.

Aziiza & Susanto (2020) define the Smart Village concept as a rural development framework aimed at addressing local challenges and enhancing residents' quality of life. Key issues prevalent in rural areas include poverty, limited educational attainment, and restricted access to technology. The emergence of the Smart Village model is attributed to fundamental differences in the socio-economic characteristics of rural and urban environments. Their proposed framework comprises six core dimensions: (1) Governance, (2) Technology, (3) Resources, (4) Village Services, (5) Living, and (6) Tourism.

Ella & Andari (2018), in their study on Smart Village implementation in Indonesia, outlined a model consisting of five dimensions: Resources, Technology, Service Chains, Institution, and Sustainability. They also identified a four-phase development process,

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with collaborative governance playing a central role in facilitating implementation.

According to Zavratnik et al. (2020), the Smart Village ecosystem requires the development of innovative, technology-driven solutions across multiple domains, including education, social care, health care, food and farming, mobility and transport, energy management, governance, community building, and cultural activities.

Key dimensions of a Smart Village digital ecosystem are society, digital service, technical platform, infrastructure, organizational ecosystem (Philip & Williams, 2019). Variables describing individual dimensions of the smart village concept according Adamowicz & Zwolińska-Ligaj (2020) are: management, life quality, economy, society, natural environment.

Aggarwal et al. (2018) examined the climate-smart village approach, concluding that it holds substantial potential for scaling up climate-resilient agricultural technologies, practices, and support services in rural regions.

In the context of Lithuania, Atkočiūnienė & Vaznonienė (2019) explored the driving forces and enabling conditions necessary for the development of smart rural villages, identifying a range of socio-economic and institutional factors that contribute to rural advancement.

Malik et al. (2022) highlight that the United Nations (UN) 2030 Agenda emphasizes that sustainable development and responsible resource management must extend beyond urban centers to include rural and village populations. Villages are described as integral components of national systems, contributing not only to the maintenance of ecological balance but also to economic and social well-being. The authors note that while digital technologies have already significantly transformed urban environments through the development of smart cities, similar technological approaches can be applied to promote digital and smart village initiatives. Their study provides an in-depth analysis of implementing smart and digital village concepts using emerging digital technologies and discusses potential improvements achievable through these approaches. Importantly, they conclude that such digitization efforts depend fundamentally on the deployment of reliable and robust communication and network infrastructure in rural areas.

Dembovska et al. (2023) investigate the concept of smart villages in the context of tourism development within the Baltic countries, employing an expert-based analytical approach. The selected experts – representing tourism, business, and economics – identified several key contributions of smart village development to tourism. These include fostering a creative economy, enhancing community culture and values, supporting local food production, developing distinctive natural, cultural, and recreational assets, upgrading infrastructure, and facilitating the adoption of new technologies.

Maja et al. (2022) observe that, despite advances associated with the Fourth Industrial Revolution, poverty remains widespread in many rural areas. Rural communities often experience minimal or highly constrained access to essential services such as energy and healthcare. Their research aims to establish linkages between indicators of smart rural healthcare and smart rural energy systems to address these persistent challenges.

García Fernández & Peek (2023) focus on analyzing the dimensions of the Smart Village concept to evaluate its potential in mitigating disparities between rural and urban areas. They underscore critical challenges facing rural regions, including demographic imbalances, escalating climate impacts, deteriorating infrastructure, and insufficient digital skills, all of which limit the attractiveness and resilience of rural communities. Ali et al. (2025) describe smart villages as innovative strategies aligned with the United Nations Sustainable Development Goals to address global sustainability challenges. Their work identifies and categorizes the barriers that must be considered in the planning and development of smart villages. Paniagua (2023) argues that smart villages should be understood not only within global smart development frameworks but also as a means to strengthen local territorial identities and resist global processes of rural restructuring.

Despite significant research in this area, the disparities in the development of rural and

urban areas for countries depending on their level of economic development remain insufficiently addressed. Also, the barriers to the practical implementation of the Smart Village strategy and the quantitative factors that make it possible to assess the standard of living in villages are not sufficiently systematized.

Methodology and data

The research is based on the confirmation of the following empirical hypotheses:

Hypothesis 1. In low-income countries, the number of residents living in villages is higher than in high-income and upper-middle-income countries.

Hypothesis 2. There are still significant differences between the level of development of urban and rural areas, which affects the level of urbanization, the level of satisfaction with life in rural areas, and the development of agriculture.

Hypothesis 3. Disparities between living conditions in rural and urban areas are less pronounced in high-income countries.

To identify disproportions in the development of rural and urban areas and the living conditions of their residents, the study proposes an analysis of such indicators for the period 2000–2022:

- RP – rural population;
- RPP – rural population (% of total population);
- RPG – rural population growth (annual %);
- BSR – people using at least basic sanitation services, rural (% of rural population);
- BSU – people using at least basic sanitation services, urban (% of urban population);
- SSR – people using safely managed sanitation services, rural (% of rural population);
- SSU – people using safely managed sanitation services, urban (% of urban population);
- BDR – people using at least basic drinking water services, rural (% of rural population);
- BDU – people using at least basic drinking water services, urban (% of urban population);
- SDR – people using safely managed drinking water services, rural (% of rural population);
- SDU – people using safely managed drinking water services, urban (% of urban population);
- ODR – people practicing open defecation, rural (% of rural population);
- ODU – people practicing open defecation, urban (% of urban population);
- CFR – access to clean fuels and technologies for cooking, rural (% of rural population);
- CFU – access to clean fuels and technologies for cooking, urban (% of urban population);
- AER – access to electricity, rural (% of rural population);
- AEU – access to electricity, urban (% of urban population);
- URL – exclusion by Urban-Rural Location index.

For comparison, the study included the V4 countries (Czech Republic, Hungary, Poland, Slovak Republic), the Baltic countries (Estonia, Latvia, Lithuania), and, according to the World Bank classification, high-income countries (Germany, Luxembourg, Ireland), upper-middle-income countries (Georgia, Turkey, Ukraine), lower-middle-income countries (India, Cameroon, Kenya), and low-income countries (Burundi, Liberia, Niger). Additionally, we analyzed data for the EU and for the world. Furthermore, we selected countries from around the world that exhibited the worst and best values of the analyzed indicators. The methods used in this study included descriptive analysis and comparative analysis. The data were obtained from the World Bank database.

Also, we propose quantitative indicators that assess the standard of living in villages and influence the decision to live in a rural area. We investigate barriers to creating Smart Villages and analyze how Smart Village models can improve agricultural development efficiency.

Results

Descriptive statistics of the indicators used to analyze disproportions in the development of rural and urban areas and the living conditions of their residents in the V4 countries during 2000–2022 are presented in Table 1.

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Table 1. Indicators for analyzing the disproportions in the development of rural and urban areas and the living conditions of their residents in the V4 countries

Country	Statistics	RP	RPP	RPG	BSR	BSU	BDR	BDU
Czech Republic	Minimum	2,667,547	25.62	-2.40	99.23	99.07	99.61	99.88
	Maximum	2,817,206	26.82	1.09	99.26	99.09	99.82	99.90
	Average	2,750,671	26.36	0.12	99.25	99.09	99.74	99.89
Hungary	Minimum	2,636,401	27.45	-1.79	98.57	97.76	99.90	100.00
	Maximum	3,617,236	35.43	0.10	98.57	97.76	100.00	100.00
	Average	3,098,475	31.17	-1.37	98.57	97.76	99.92	100.00
Poland	Minimum	14,608,969	38.21	-1.51	77.19	94.02	82.21	95.78
	Maximum	15,172,143	39.96	0.36	99.24	98.77	98.15	99.79
	Average	14,874,817	39.18	-0.04	90.85	96.81	92.95	98.48
Slovak Republic	Minimum	2,357,934	43.77	-0.48	96.15	98.68	96.80	98.90
	Maximum	2,524,162	46.27	0.71	99.78	99.89	100.00	99.61
	Average	2,448,904	45.30	0.26	97.51	99.13	98.52	99.19

**Source: own processing based on World Bank Open Data.*

Among the V4 countries, the Slovak Republic had the largest share of rural residents (46.27% of the total population in 2018), followed by Poland (39.96%), Hungary (35.43%), and the Czech Republic (26.82%). The largest decline in the rural population was observed in the Czech Republic (-2.40% in 2021). The highest percentage of the rural population using at least basic sanitation services was recorded in the Slovak Republic (99.78%), although this indicator was also high in the other V4 countries.

Descriptive statistics of the indicators used to analyze disproportions in the development of rural and urban areas and the living conditions of their residents in the Baltic countries during 2000–2022 are presented in Table 2.

Table 2. Indicators for analyzing the disproportions in the development of rural and urban areas and the living conditions of their residents in the Baltic countries

Country	Statistics	RP	RPP	RPG	BSR	BSU	BDR	BDU
Estonia	Minimum	407,066	30.39	-0.82	99.07	98.92	92.94	99.32
	Maximum	427,924	32.04	1.06	99.38	99.96	100.00	100.00
	Average	419,424	31.29	-0.14	99.18	99.35	97.54	99.69
Latvia	Minimum	591,254	31.46	-2.17	72.53	94.57	95.82	98.73
	Maximum	756,030	32.20	-0.48	84.17	96.25	98.87	98.90
	Average	669,500	31.99	-1.09	79.35	95.48	97.28	98.81
Lithuania	Minimum	891,689	31.54	-2.21	66.27	93.69	75.40	96.70
	Maximum	1,155,337	33.37	0.14	90.53	97.51	93.78	100.00
	Average	1,016,204	32.84	-1.14	78.08	95.53	86.19	98.65

**Source: own processing based on World Bank Open Data.*

The indicators for analyzing the disproportions in the development of rural and urban areas and the living conditions of their residents in high-income countries during 2000–2022 are presented in Table 3.

Table 3. Indicators for analyzing the disproportions in the development of rural and urban areas and the living conditions of their residents in high-income countries

Country	Statistics	RP	RPP	RPG	BSR	BSU	BDR	BDU
Germany	Minimum	18,334,806	22.35	-2.70	98.99	99.29	100.00	100.00
	Maximum	20,581,651	25.04	0.82	98.99	99.29	100.00	100.00
	Average	19,172,447	23.33	-0.44	98.99	99.29	100.00	100.00
Ireland	Minimum	1,554,223	35.82	-0.10	93.00	86.84	97.04	95.41
	Maximum	1,867,081	40.85	2.38	93.59	88.85	97.44	97.05
	Average	1,727,149	38.29	0.83	93.35	87.67	97.20	96.09
Luxemburg	Minimum	53,025	8.12	-3.41	98.75	97.48	98.60	100.00
	Maximum	68,866	15.78	-0.41	98.84	97.50	100.00	100.00
	Average	58,849	11.39	-1.28	98.78	97.49	99.52	100.00

**Source: own processing based on World Bank Open Data.*

The indicators for analyzing the disproportions in the development of rural and urban areas and the living conditions of their residents in upper-middle-income countries during 2000–2022 are presented in Table 4.

Georgia has undergone significant economic and social changes since independence, yet notable disparities remain between urban and rural areas. These disproportions manifest in infrastructure, employment opportunities, income levels, education, and access to healthcare. Rural regions face slower development. Many villages struggle with outdated or poorly maintained infrastructure. As a result, poverty rates are higher in rural areas.

Turkey has experienced rapid economic growth and modernization over recent decades, but significant disparities remain between urban and rural areas. These differences are visible in infrastructure, income, employment opportunities, education, healthcare, and overall living standards. Agricultural productivity varies widely, many small farmers use traditional methods with limited access to modern equipment, financing, or markets.

Table 4. Indicators for analyzing the disproportions in the development of rural and urban areas and the living conditions of their residents in upper-middle-income countries

Country	Statistics	RP	RPP	RPG	BSR	BSU	BDR	BDU
Georgia	Minimum	1,473,975	39.70	-1.74	72.21	92.81	86.50	98.66
	Maximum	1,931,011	47.60	-0.73	86.82	95.51	91.63	99.22
	Average	1,681,350	44.01	-1.24	79.50	94.00	89.18	98.94
Turkey	Minimum	19,526,684	22.98	-1.77	69.26	95.95	89.10	95.99
	Maximum	23,068,540	35.26	-0.18	97.25	99.85	96.03	97.32
	Average	21,280,795	28.79	-0.73	83.78	97.98	92.72	96.72
Ukraine	Minimum	12,347,879	30.08	-8.16	88.66	97.01	94.97	90.83
	Maximum	16,281,841	32.86	-0.48	97.17	97.99	100.00	99.70
	Average	14,601,579	31.44	-1.24	93.68	97.59	97.30	94.36

**Source: own processing based on World Bank Open Data.*

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In Ukraine, even before the war, there was a situation of exhausting use of land plots by private farmers who have been growing sunflower seeds for export and foreign exchange earnings for several years, thereby depleting the land and exhausting its natural capabilities. Some private farmers, after harvesting, uncontrollably set fire in their fields to destroy waste and weeds, sometimes burning trees and other living plants located near such fields.

Some private enterprises that extract minerals from land located within or near settlements carry out such extraction without complying with all necessary standards and sanitary measures, which leads to a complete lack of water in the wells of residents of villages where such business entities are located.

Therefore, the state, represented by authorized state authorities, must ensure state supervision and control over the development of villages and agriculture, effectively interact with local authorities, village councils, agricultural producers and rural residents in order to prevent a decrease in the assimilation characteristics of the environment, ensure the development of rural areas, stable agriculture and ensure food security in the long term, and not just the receipt of foreign exchange export earnings in the short term. So, effective interaction for the development of rural areas must be carried out at all levels of the hierarchy.

Even before the war in Ukraine, some villages in Ukraine were not provided with transport links to cities, which makes it impossible for rural residents to provide for their basic needs in terms of accessibility to medical institutions, schools, pharmacies, shops, etc. In some villages, the bus that can get to the nearest city ran once a week, since its operation was unprofitable for private transport companies, because there were few passengers.

In many villages, schools, kindergartens, and medical institutions were closed, given the decline in the population of villages due to the aging of the local population of villages, the decline in the birth rate, and the movement of young people to cities.

Since the beginning of war, the situation has only worsened, in some villages the roads are completely broken, there is one school for several villages, as a result of which local children have problems getting to educational institutions on broken roads. Stable internet is also absent in some small villages.

The indicators for analyzing the disproportions in the development of rural and urban areas and the living conditions of their residents in lower-middle-income countries during 2000–2022 are presented in Table 5.

Table 5. Indicators for analyzing the disproportions in the development of rural and urban areas and the living conditions of their residents in lower-middle-income countries

Country	Statistics	RP	RPP	RPG	BSR	BSU	BDR	BDU
India	Minimum	765,227,250	64.13	0.05	1.19	47.80	75.31	91.83
	Maximum	914,095,397	72.33	1.58	74.86	84.70	91.92	95.76
	Average	857,632,802	68.55	0.84	37.42	65.32	83.58	93.79
Cameroon	Minimum	8,121,121	41.27	1.22	21.68	54.73	34.23	81.41
	Maximum	11,403,216	54.46	1.82	24.53	58.18	52.46	82.71
	Average	9,719,927	47.84	1.54	23.02	56.38	43.56	82.10
Kenya	Minimum	24,547,406	71.00	1.21	27.57	30.00	37.53	86.35
	Maximum	38,518,162	80.11	2.70	35.18	39.84	53.27	87.76
	Average	32,070,395	75.85	2.07	31.34	34.72	45.39	87.06

**Source: own processing based on World Bank Open Data.*

The minimum rural population in India during the analyzed period (2000–2022) was 765,227,250 in 2000; the maximum population was 914,095,397 in 2022. The standard of living in rural and urban areas differs significantly. The minimum value of people using at least basic sanitation services in rural areas was 1.19% of the rural population, while in urban areas it was 47.80%. On average, over the analyzed years, the share of people using at least basic sanitation services in urban areas was 27.9 percentage points higher than in rural areas. The minimum value of people using at least basic drinking water services in rural areas was 75.31% of rural population in 2000, but in urban areas it was 91.83% of the urban population, representing a difference of 16.52 percentage points.

In Cameroon, the percentage of the population using at least basic sanitation services and using at least basic drinking water services in urban areas is more than twice that observed in rural areas. In Kenya, disparities in access to at least basic sanitation services between rural and urban areas are relatively modest; however, access to at least basic drinking-water services differs substantially, with only 37.53% of the rural population covered compared with 86.35% of the urban population.

The indicators for analyzing the disproportions in the development of rural and urban areas and the living conditions of their residents in low-income countries during 2000–2022 are presented in Table 6.

Table 6. Indicators for analyzing the disproportions in the development of rural and urban areas and the living conditions of their residents in low-income countries

Country	Statistics	RP	RPP	RPG	BSR	BSU	BDR	BDU
Burundi	Minimum	5,936,662	85.58	1.37	45.63	40.56	47.84	82.05
	Maximum	11,400,594	91.75	4.78	46.44	42.78	57.69	90.67
	Average	8,566,140	88.93	2.92	46.27	42.06	53.36	86.93
Liberia	Minimum	1,630,053	46.94	0.17	3.30	23.05	49.19	78.34
	Maximum	2,521,956	55.67	4.95	9.21	34.30	65.47	84.58
	Average	2,117,223	51.61	2.03	5.63	28.47	58.17	81.98
Niger	Minimum	9,646,681	83.11	3.08	1.91	24.18	27.11	88.16
	Maximum	21,035,768	83.81	3.78	9.01	52.82	40.89	91.24
	Average	14,764,001	83.67	3.54	5.71	37.56	34.70	89.66

**Source: own processing based on World Bank Open Data.*

We analyzed the worst and best values of the selected indicators across all countries worldwide. In 2022, the lowest values of the indicator "people using at least basic sanitation services, rural (% of rural population)" were observed in Chad (4.51%), the Central African Republic (5.74%), Ethiopia (5.55%), Niger (9.01%), Togo (9.08%), Liberia (9.21%), and Benin (9.63%). The maximum value of this indicator was 100% in Andorra, Austria, Chile, Spain, Malta, and New Zealand. For urban residents in countries where the percentage of rural populations using at least basic sanitation services was minimal, the situation was significantly better than in rural areas. The value of the indicator "people using at least basic sanitation services, urban (% of urban population)" was 39.46% in Chad, 24.55% in the Central African Republic, 22.27% in Ethiopia, 52.82% in Niger, 32.12% in Togo, 34.30% in Liberia, and 29.54% in Benin. The lowest values of the indicator "people using safely managed sanitation services, rural (% of rural population)" in 2022 were observed in Korea (1.23%), Benin (1.78%), Chad and Ethiopia (4.22%), and Togo (4.68%). The highest value of this indicator was 100% in Andorra, followed by Switzerland (99.57%) and Austria (99.26%). Globally, the percentage of people in rural areas using safely managed sanitation services increased from 17.38% in 2000 to 45.86% in 2022. The percentage of people in urban areas using safely managed sanitation services rose from 49.54% to 64.77% (Figure 1).

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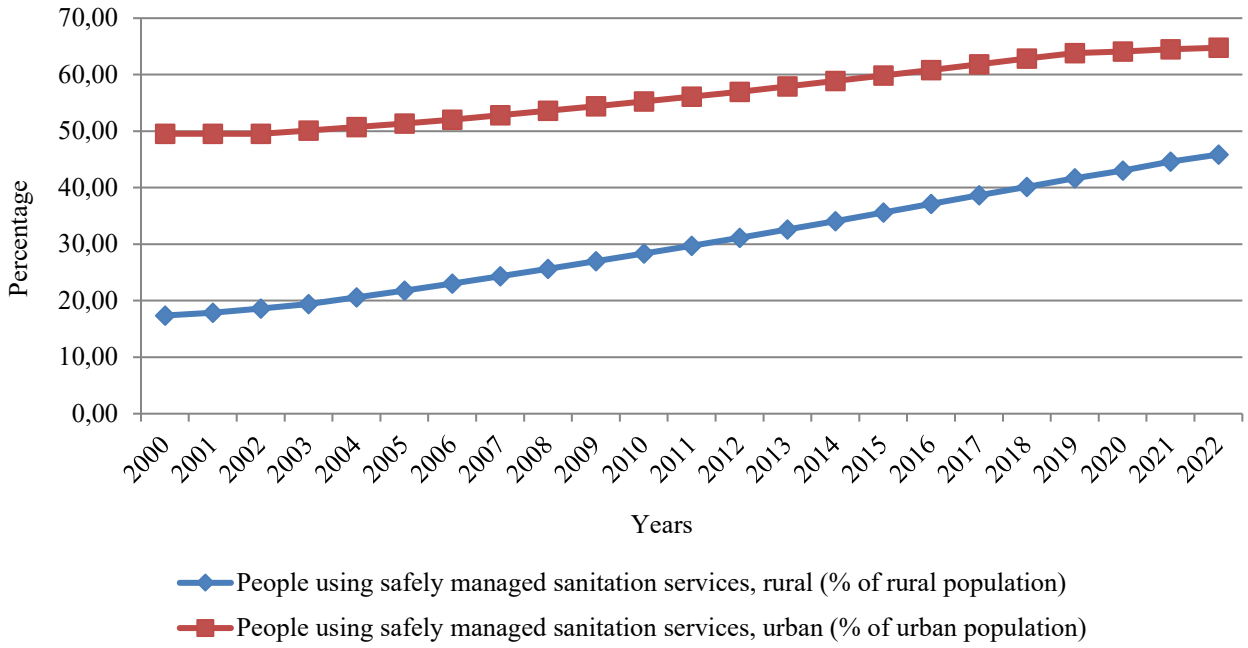

Figure 1. People using safely managed sanitation services in the world

**Source: own processing based on World Bank Open Data.*

Percentage of the people using safely managed drinking water services in the world depending on where they live in rural or urban areas also differs (Figure 2). Among the rural population, the percentage of people safely managed drinking water services in 2000 was 43.71%, and in 2022 it was 62.17%. At the same time, for urban population this indicator increased from 80.48% to 81.11% during the analyzed period.

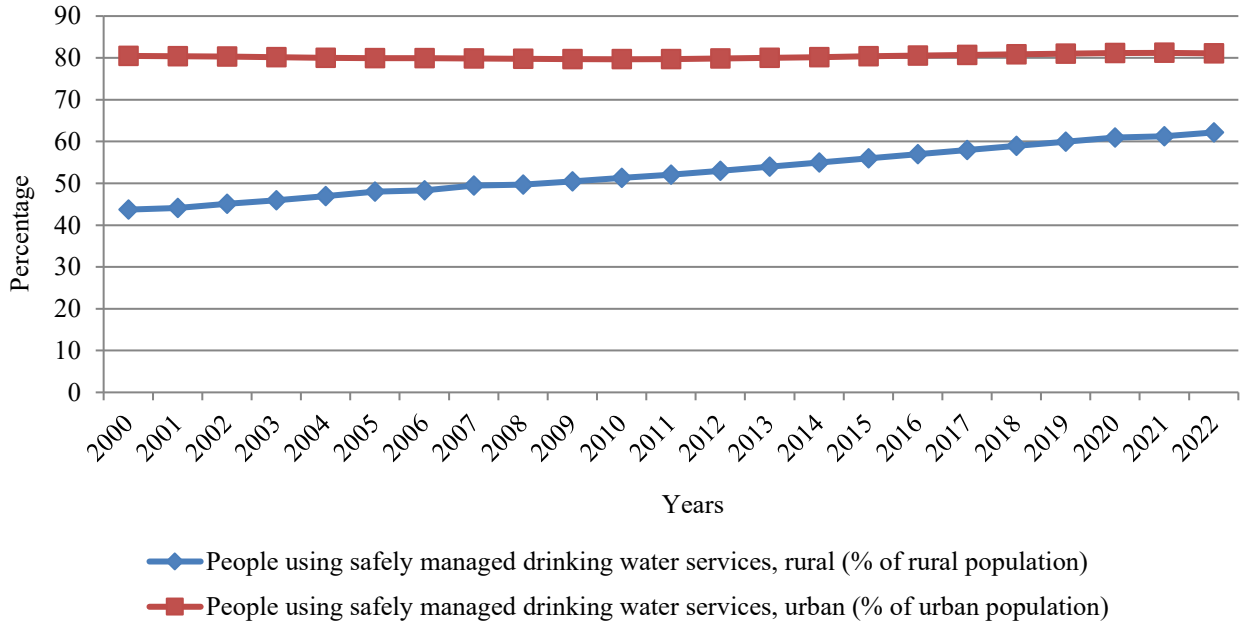

Figure 2. People using safely managed drinking water services in the world

**Source: own processing based on World Bank Open Data.*

It should be noted that such indicator as the percentage of people practicing open defecation in rural area (% of rural population) for all analyzed countries was 0% during 2000–2022, with the exception of Ukraine, where the percentage was 0.18% in 2000, and by 2022 it also became 0%. Moreover, the highest values among all countries in the world were observed in Chad (77.59%), Niger (76.25%), South Sudan (73.31%), Benin (65.48%), and Djibouti (64.13%).

For the urban population, it was 0% in all analyzed countries during 2000–2022, indicating a complete absence of people practicing open defecation.

The highest values of this indicator among all countries in the world were in Sao Tome and Principe (38.56%), Benin (31.21%), Kiribati (21.69%), Namibia (20.48%), and Madagascar (16.73%).

Access to clean fuels and technologies for cooking in the world for rural and urban population is presented in Figure 3.

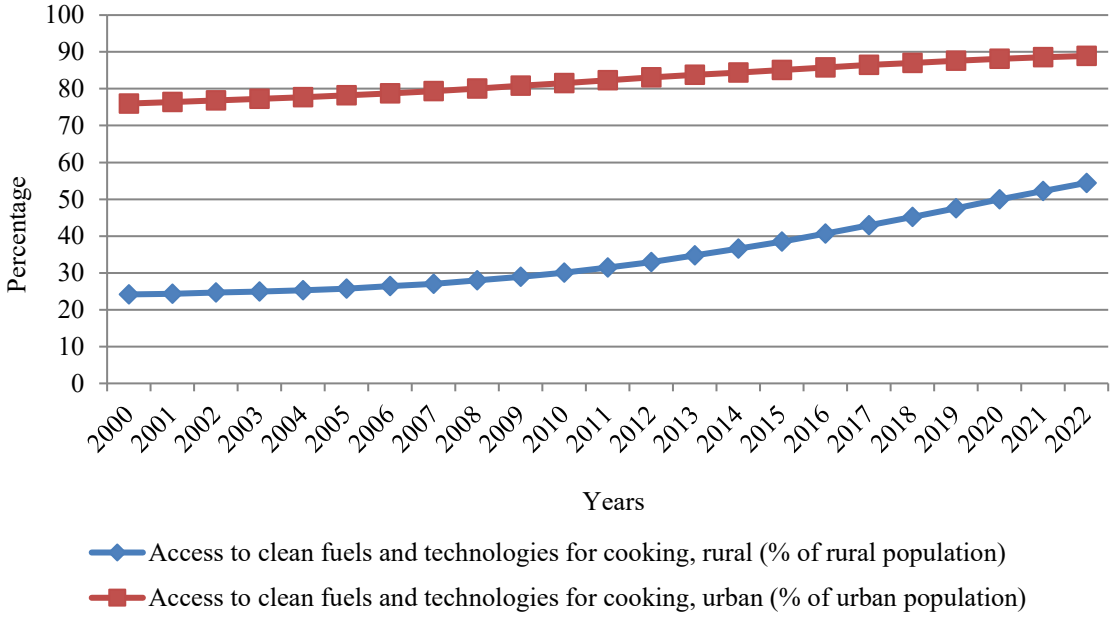

Figure 3. Access to clean fuels and technologies for cooking in the world

**Source: own processing based on World Bank Open Data.*

Access to clean fuels and technologies for cooking among the rural population (% of rural population) was 100% in all EU countries throughout the analyzed period (2000–2022). In Ukraine, this indicator increased from 24.16% in 2000 to 54.43% in 2022. The lowest values in 2022 were observed in the Central African Republic, Liberia, South Sudan, Sierra Leone, and Guinea-Bissau (0%), Burundi, Guinea, the Gambia, and Chad (0.1%), Djibouti and Mozambique (0.2%), Uganda (0.3%), Somalia (0.4%), Niger and Malawi (0.5%), and Ethiopia, Madagascar, the Marshall Islands, and Mali (0.6%).

Globally, this indicator increased from 24.16% in 2000 to 54.43% in 2022.

For the urban population, access to clean fuels and technologies for cooking was generally higher than for rural populations, with a significant gap in low-income countries. For high-income countries, this gap was not very significant.

The worst access to clean fuels and technologies for cooking for urban population in 2022 was in South Soudan (0% of urban population), Burundi (0.2%), Uganda (1.2%), Liberia (1.4%), Sierra Leone (1.7%), the Central African Republic and Guinea-Bissau (1.8), the Gambia (2.4%), Guinea (2.6%).

Access to electricity in the world for rural and urban population is presented in Figure 4. Even in modern times there are villages in the world that do not have access to electricity. In 2000, only 66.38% of the world's rural population had access to electricity. In 2022, 83.88% had access to electricity.

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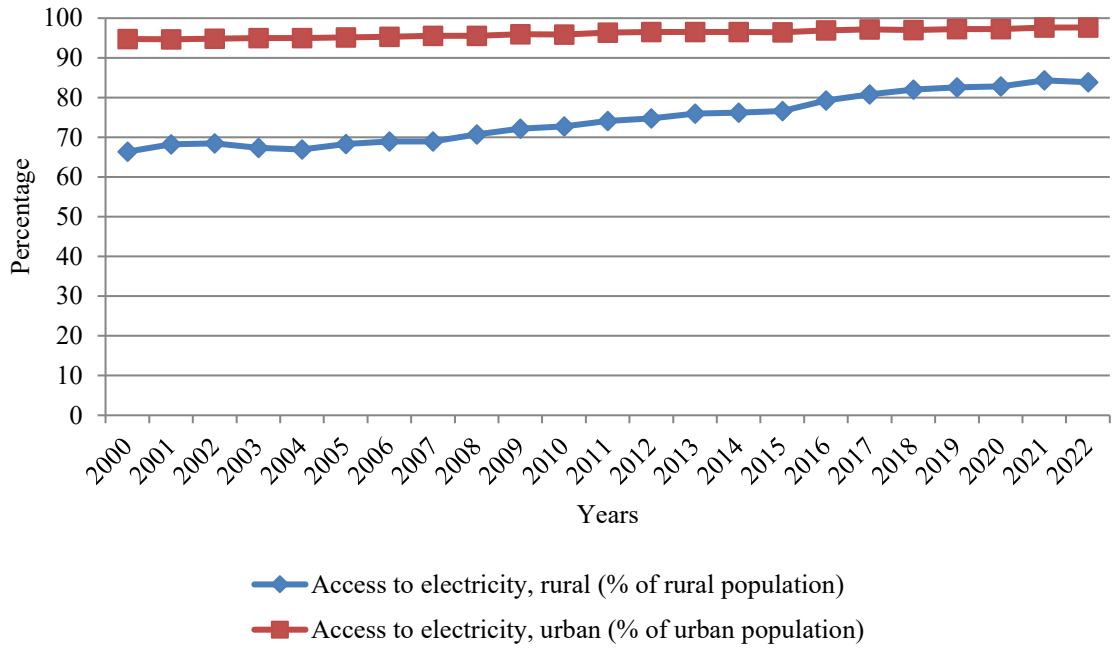
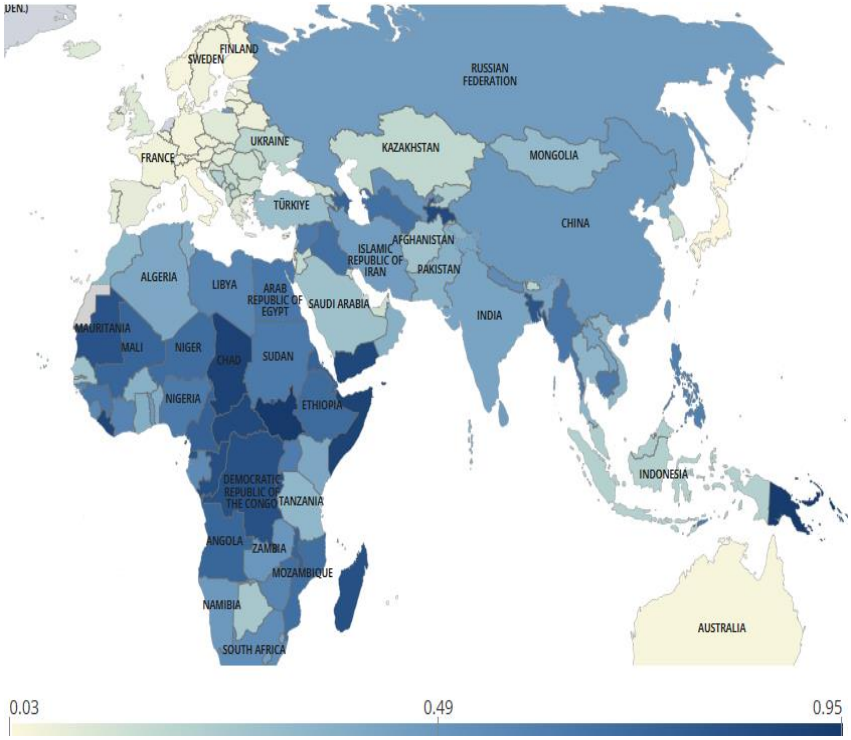


Figure 4. Access to electricity in the world

**Source: own processing based on World Bank Open Data.*

We also analyzed Exclusion by Urban-Rural Location index (Figure 5). Exclusion refers to the denial of individuals' access to services or their participation within regulated public domains – areas that fall under governmental oversight and responsibility. This definition specifically pertains to public spaces and governance structures, excluding private spaces and organizations unless exclusion in those private contexts directly contributes to exclusion within the public sphere.

The index shows the extent to which a rural population is excluded, disadvantaged, or has poorer access (to services, income, opportunities, etc.) compared to the urban population. It is a metric for measuring the gap or discrimination between rural and urban groups. The lower index values correspond to normatively preferable conditions (e.g., more democratic), whereas higher values indicate less desirable outcomes (e.g., less democratic).



Country	Year		
	2000	2022	2023
Czech Republic	0.06	0.07	0.06
Hungary	0.07	0.09	0.11
Poland	0.11	0.11	0.10
Slovak Republic	0.11	0.10	0.10
Estonia	0.07	0.06	0.07
Latvia	0.07	0.06	0.06
Lithuania	0.07	0.08	0.07
Germany	0.05	0.05	0.05
Ireland	0.06	0.09	0.09
Luxemburg	0.04	0.04	0.03
Georgia	0.32	0.16	0.15
Turkey	0.32	0.30	0.31
Ukraine	0.15	0.17	0.20
India	0.51	0.51	0.51
Cameroon	0.05	0.05	0.06
Kenya	0.88	0.80	0.81
Burundi	0.63	0.81	0.86
Liberia	0.89	0.88	0.88
Niger	0.54	0.65	0.69

Figure 5. Exclusion by Urban-Rural Location index

**Source: Exclusion by Urban-Rural Location index (2023).*

There were no significant changes in exclusion by Urban-Rural Location index in 2022 compared to 2000 among the analyzed countries. The situation worsened and the disparities became larger in such countries as Hungary, Ireland, Ukraine, Burundi, Niger.

We propose the quantitative indicators that assess the standard of living in villages and influence the decision to live in a rural area (Table 7).

Table 7. Quantitative indicators for assessment the standard of living in villages

Category	Quantitative factor
Economic factors	Average monthly household income (EUR/month)
	Unemployment rate (%)
	Housing cost (EUR/m² or rent/month)
	Cost of living index
	Land price per hectare
	Share of income spent on food (%)
	Direct subsidies or rural grants (EUR/person)
Infrastructure factors	Distance to the nearest city (km)
	Road network density (km/100 km²)
	Number of public transport trips per day
	Internet speed (Mbps)
	Mobile network coverage (%)
	Share of households with centralized water supply (%)
	Road quality (average score)
Healthcare access	Number of hospitals per 1,000 people
	Number of doctors per 1,000 people
	Travel time to the nearest hospital (minutes)
	Availability of rural health posts (per 1,000 people)
	Pharmacy availability (distance in km)
	Share of population with health insurance (%)
	Preventable mortality rate (per 1,000)
Education	Number of schools per 1,000 children

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	Average distance to school (km)
	Student–teacher ratio
	Adult education level (% with higher education)
	Education quality (average National Test score)
	Number of kindergartens per 1,000 children
	Share of children attending school (%)
Social and cultural services	Number of cultural centers per 1,000 people
	Number of libraries per 1,000 people
	Number of sports facilities per 1,000 people
	Number of NGOs per 1,000 people
	Share participating in community events (%)
	Number of festivals and fairs per year
	Availability of elderly care services (% of needs covered)
Environment and natural resources	Air quality (PM2.5, PM10)
	Green space per capita (m²)
	Forest area (% of territory)
	Availability of water bodies (number/area)
	Water quality (chemical indicators)
	Emissions per capita (tons/person)
	Number of illegal dumpsites
Safety	Overall crime rate (per 1,000 people)
	Number of serious crimes per 1,000 people
	Number of police stations per 1,000 people
	Police response time (minutes)
	Number of fire stations per 1,000 people
	Number of road accidents per 1,000 people
	Share of population feeling safe (%)
Demographic	Average age of population (years)
	Share of youth (% aged 15–29)
	Share of elderly (% aged 65+)
	Birth rate (per 1,000)
	Mortality rate (per 1,000)
	Net migration rate (per 1,000)
	Average household size (persons)
Labor factors	Share employed in agriculture (%)
	Share employed in industry (%)
	Share employed in services (%)
	Employment seasonality index
	Rate of labor migration (% working abroad)
	Average weekly working hours
	Informal employment rate (%)
Other factors	Historical attractiveness (number of heritage sites)
	Tourist flow (number of visitors per year)
	Availability of natural resources
	Number of new buildings per 1,000 people
	Investment per capita (EUR/person)
	Share of land for agricultural use (%)
	Government support programs (EUR/person)

**Source: own processing.*

So, despite decades of policy interventions and economic growth, significant gaps continue to exist in infrastructure, access to essential services, economic opportunities, and overall quality of life. Urban areas tend to benefit from concentrated investment, diversified economies, advanced healthcare, quality education, and modern amenities. By contrast, many rural regions face limited infrastructure, under-resourced services, lower income levels, and

reduced opportunities for social mobility. These disproportions not only reinforce socio-economic inequality but also drive patterns of rural-to-urban migration that create challenges for both settings: urban areas face overpopulation, pressure on housing and services, and environmental degradation, while rural communities often experience depopulation, aging demographics, and declining local economies. Addressing these imbalances is essential for achieving inclusive and sustainable development goals, reducing poverty, and fostering social cohesion. To minimize the differences between the level of development of rural and urban areas, it is necessary to implement a Smart Village strategy.

The Smart Village initiative, introduced in 2017 as part of the European Union's efforts, serves as a strategic approach to enhance the socio-economic structure of rural communities. It focuses on revitalizing agriculture and rural regions through the promotion of knowledge exchange, innovation, and the integration of digital technologies (EU action for Smart Villages, 2019).

The Smart Village strategy proposes an integrated solution combining: information and communication technology, which helps rural residents get better information, make better decisions, reduce waste, and connect to markets and services they couldn't access before, as well as renewable energy, smart sustainable infrastructure, and participatory planning to enable sustainable rural transformation. In agriculture, Smart Villages promote precision farming, climate-adaptive practices, data-driven decision-making, sustainable resource management, improved market access, digital financial inclusion, etc. Smart Village strategy based on technology adoption increases yield, reduces inputs, and enhances livelihoods (European Commission, European Network for Rural Development, EU Rural Review 26 "SmartVillages: Revitalising Rural Services" (2018), Smart Rural 27 Conference (2024). The proposed components of the Smart Village strategy are presented in Figure 6.

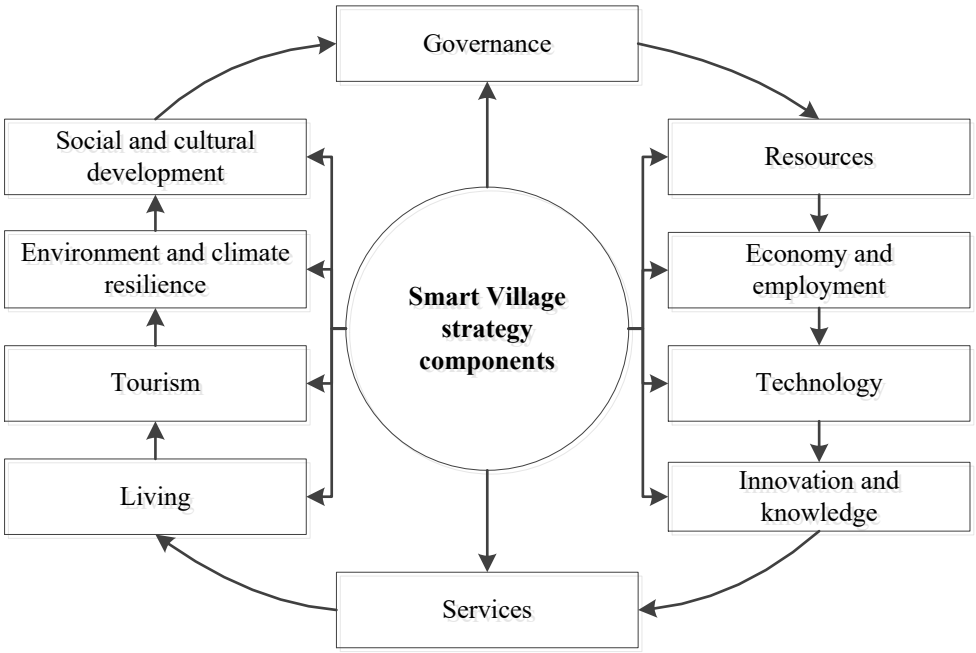

Figure 6. Smart Village strategy components

**Source: own processing.*

But, several interrelated barriers limit the practical implementation of the Smart Village strategy and effectiveness in promoting sustainable and efficient agricultural development. These barriers span financial, infrastructure, social, technical, institutional, and environmental dimensions (Table 8).

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Table 8. Barriers to the practical implementation of the Smart Village strategy

Category of barriers	Description
Financial	– high upfront costs of precision agriculture technologies, renewable energy systems, and information and communication technology devices; – limited access to credit and insurance for smallholder farmers; – inadequate public funding and private investment in rural innovation
Infrastructure	– limited broadband internet and mobile network coverage in rural areas; – inadequate roads and transport access; – unreliable electricity supply hindering information and communication technology and renewable energy systems
Technical	– low digital literacy among farmers and rural youth; – shortage of skilled personnel for the maintenance of information and communication technology, renewable energy, and precision farming equipment; – lack of local adaptation of technologies to diverse agro-ecological zones
Institutional	– fragmented policies across agriculture, energy, information and communication technology, and rural development sectors; – weak coordination among government agencies, non-governmental organizations, and the private sector; – limited extension services and weak capacity of local institutions
Social and cultural	– resistance to change due to traditional practices and skepticism toward new technologies; – income inequality and gaps in access to training, resources, and decision-making; – uneven participation of different groups in planning and implementation
Environmental	– risks of environmental degradation if technology use is not well-managed (e.g., overuse of inputs with precision farming); – climate variability complicating planning and infrastructure investments; – need for careful water resource management for solar irrigation systems.

**Source: own processing.*

Despite the promising potential of the Smart Village concept, the research identifies several barriers to its practical implementation, which include limited funding, technological infrastructure gaps, and insufficient institutional support, especially in low-income settings. Overcoming these barriers will require coordinated efforts from governments, local communities, and international stakeholders.

Discussion

Our results, which show persistent and significant disparities between rural and urban living conditions and highlight the opportunity for a Smart Village strategy to support agricultural development, correspond well with academic research in this field. First, consistent with the findings reported by OECD, the rural regions in many countries continue to face structural disadvantages in economic welfare, productivity and employment, compared to urban areas. In its report "Rural Well-being: Geography of Opportunities" (2020), OECD shows that in rural regions, GDP per capita, labour productivity and employment rates remain significantly lower than in more urbanized areas. This aligns with our findings that rural living conditions, particularly in lower-middle-income and low-income countries, lag behind urban ones, which in turn influences rural to urban migration and the composition of the rural population.

Second, quality of life and well-being disparities between rural and urban areas are well documented in European contexts. The survey "Foundation Findings – Quality of life in urban and rural Europe" highlights that large part of Europeans still live in rural or small town settings, but over time the share living in larger towns or cities has increased mirroring urbanization trends (Eurofound, 2014). Moreover, Eurofound's analysis points out differences in income, deprivation, employment, access to services, and subjective well-being between rural and urban population, which

echoes our finding about significant differences that affect satisfaction with life in rural areas.

Yet rural living is not uniformly disadvantaged because in some aspects such as housing costs, home ownership, and possibly lower cost burden, rural households may have advantages. The report "Bridging the rural-urban divide: Addressing inequalities and empowering communities" documents that while income, employment, and access to services remain lower in rural areas, rural residents often benefit from lower housing cost burden and greater home ownership rates compared to urban households (Eurofound, 2023). This complexity corresponds with our multidimensional quantitative indicator approach for assessing the standard of living in villages, because disparities are not entirely one-sided, and different components of "living standard" may point in different directions.

Third, our argument for a "Smart Village" and rural smartness strategy resonates strongly with recent research literature such as Malik et al. (2022), Renukappa et al. (2024) that emphasizes the potential of digitalization, infrastructure, governance, and integrated rural development to close rural-urban gaps. The adoption of IT infrastructure and services in rural areas, when combined with participatory governance and community empowerment, may significantly improve rural economic welfare and living conditions. Similarly, Mukti et al. (2022) demonstrate empirically that "rural smartness" (readiness and implementation of organizational, environmental, technological innovations, etc.) has a positive impact on rural economic welfare and may help reduce the flow of migration to cities.

Thus, our findings not only confirm previously documented rural-urban disparities, but also reinforce and support the growing consensus that Smart Villages constitute a promising policy-oriented response. Our research contributes meaningfully by providing fresh empirical evidence of persistent rural-urban disparities in living conditions, confirming findings from OECD and Eurofound reports. Also, we offer a set of quantitative indicators to assess rural living standard and to inform decisions to settle or remain in rural areas – a useful methodological contribution given the recognized difficulty in measuring complex welfare and quality of life outcomes across rural settings. While previous authors have described general trends and theoretical frameworks for Smart Villages, our study contributes by proposing quantitative indicators to evaluate rural living standards.

However, as also highlighted in the literature, important questions remain open and discussible, in particular, scalability and context dependence. While rural smartness has been shown to improve welfare in certain empirical cases, it remains unclear to what extent such strategies can be scaled across countries with different socio-economic, institutional, cultural, and geographic contexts. What works in South-East Asia may not map directly to rural Eastern Europe or Sub-Saharan Africa. This context-dependence calls for more comparative, cross-country empirical studies. Also, how Smart Village interventions perform under varying economic cycles, demographic shifts (e.g., population aging, outmigration), climate change pressures, or constrained financial resources remains an open empirical question. Therefore, our further research will be aimed at identifying the specific features of the implementation of the Smart Village strategy in different groups of countries.

Conclusions

This research highlights the persistent disparities between rural and urban living conditions, particularly in low and middle income countries, where rural populations are more prominent and often face lower standards of living. These disparities influence levels of urbanization, life satisfaction in rural areas, and the overall development of agriculture. In contrast, high-income countries exhibit less pronounced differences between rural and urban areas, suggesting the potential for more balanced regional development.

To address these challenges, the study proposes a strategy for the development of Smart Villages – an integrated approach aimed at improving the efficiency and sustainability of rural development. Key components of this strategy include the introduction of digital technologies, infrastructure enhancement, improved access to education and healthcare, and

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the promotion of agricultural innovation. Quantitative indicators have also been identified to objectively assess rural living standards and support policy decisions regarding rural settlement and development.

The Smart Village is an integrated rural development model that leverages digital infrastructure, renewable energy, e-governance, and community-led planning. It emphasizes access to information and communication technologies, renewable energy solutions, E-services in health, education, governance, sustainable resource management, inclusive economic opportunities, etc.

The implementation of the Smart Village strategy involves the development and realization of social, economic, organizational, legal, scientific and innovative, informational, environmental and other measures aimed at protecting the vital interests of rural residents from the point of view of ensuring physical, economic and social accessibility of sufficient needs, stability of digital and information provision for the population, which simultaneously contributes to increasing the standard of living and comprehensive development of the rural population; reducing the level of inequality between urban and rural residents, ensuring access to services sufficient for a quality life in rural areas.

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