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SCHOOL OF ECONOMICS AND BUSINESS

MASTER'S THESIS

SMART VILLAGE CONCEPT AS A SOLUTION FOR PROBLEMS IN RURAL AREAS: THE CASE OF A SERBIAN VILLAGE

Ljubljana, May 2024 MIRJANA TRIFUNOVIĆ

AUTHORSHIP STATEMENT

The undersigned Mirjana Trifunović, a student at the University of Ljubljana, School of Economics and Business, (hereafter: SEB LU), the author of this written final work of studies with the title Smart village concept as a solution for problems in rural areas: The case of a Serbian village, prepared under supervision of Anton Manfreda

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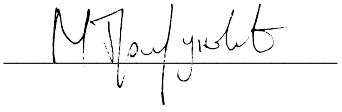
Author's signature: 

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ENRD - European Network for Rural Development
EU – European Union
ICT – Information Communication Technology
IoT – Internet of things
IT – Information technology
ITU – International Telecommunication Union
IESE - Fraunhofer Institute for Experimental Software Engineering
LAN - National Institute of Public Administration Indonesia
OECD - The Organisation for Economic Co-operation and Development
RRI - Responsible Research and Innovation
SORS - Statistical Office of the Republic of Serbia

1 INTRODUCTION

In recent years, we can often hear the word "smart". People began to associate this word with different terms. So, we have smartphones, smart watches, smart cars, smart agriculture, smart buildings, smart homes, smart cities, and recently smart villages, ie. smart rural areas.

Smart villages were created as a solution to the problems of rural areas. One of the main problems of rural areas is depopulation, i.e., urbanization. Due to the difficult living conditions in recent decades, the progressive depopulation of villages has been noticed. People migrate to the cities, the rural population is not renewed and there are almost no inhabitants in the villages (Ristić & Bošković, 2020).

The villages are a very important part of one country and their development has a crucial impact on economic, social, and environmental sustainability of the country. However, the problems faced by people in the villages are numerous. The road infrastructure in the villages is worse than in the cities, while mobility is more limited. Therefore, the connection is worse, and people are more isolated. The possibility of employment is limited, there is almost no diversification of jobs, and services are limited to basic ones. All this reduces the quality of life in the rural areas and leads to the depopulation (Morrison, 2021).

Modern technologies have a great potential for solving these mentioned problems and improving life in rural areas and are seen as an enabler of positive changes, whether through their application in business or in non-business activities. However, the rural population generally benefits least from modern technological innovations (Ristić & Bošković, 2020). The digital divide between rural and urban areas is present all over the world. There are even twice as many Internet users in urban areas than in rural ones at the world level, while in Europe, that gap is much smaller. In rural European areas, 80% of the population uses the Internet, while in urban areas it is 87% (Bogdan-Martin, 2021).

Serbia is not an exception either in terms of depopulation or the digital divide between urban and rural areas. The percentage of poverty is higher, the population is less literate, and infrastructure and access to services are much worse than in the cities. Poor infrastructure means poorer services, education, social protection and even health care. Rural areas show a greater degree of economic inferiority compared to urban areas. Cultural manifestations available in cities are rare in villages, and social life is at a disadvantage (Veličković & Jovanović, 2021).

According to the report of the SORS (2023), in the Republic of Serbia only 66.1% of households in rural areas have a computer and 79.8% have a broadband Internet connection. There are many examples of the application of smart technologies in rural areas in the world, but this is not the case in Serbia (Ristić & Bošković, 2020). The advantages that technologies provide are not used at all by most villages or are not used sufficiently.

One such village is Mrsać. Mrsać is located in the region of Šumadija and Western Serbia and belongs to the municipality of Kraljevo. Despite the potential that the village has, such as good location, proximity to the city, proximity to the airport, built road and railway infrastructure, potential for tourism development, small businesses, potential for agricultural development etc., young people still leave and there is plenty of room for improving the quality of life of the locals, and thus preventing depopulation.

The utilisation of technologies has the potential to improve life in rural areas, to decrease the gap between rural and urban areas and therefore to increase motivation among people to organize their lives in rural areas. Therefore, the purpose of this master's thesis is to explore how the smart village concept and utilising the technologies can improve life quality in rural areas, in order to further motivate its inhabitants to organize their lives in the village and to prevent them from leaving.

The main research question this thesis will try to answer is "How can technology and the concept of smart village help harness the potential and overcome the challenges of the selected village?"

Finally, the main goals of the thesis are:

- to present the smart village concept
- to contribute to the understanding of the smart village concept and its role in rural areas
- to analyse the already existing smart villages and the applied solutions
- to analyse the current state of the development of smart villages in the Republic of Serbia
- to identify some of the main challenges and assets of the selected village
- to analyse motivation for smart solution adoption by inhabitants of the selected village
- to propose the possible technology solutions for prioritized problems and opportunities in the selected village

Regarding the research methodology, for the preparation of this paper, I conducted both theoretical and empirical researches. The theoretical research is based on a review of the literature, including books, research and scientific papers, and documentation. In this part I relied on scientific databases such as ScienceDirect, IEEE Xplore, EBSCOhost, Emerald, etc. The goal of theoretical research is for me, to get acquainted with the topic and to gain the necessary knowledge that will help me conduct the empirical research. Also, literature review will introduce readers to the topic and will be the basis for understanding and writing an empirical work.

In the empirical part, to obtain the necessary information, I conducted an interview and the questionnaires and reviewed the documentation about the village.

In the first chapter, through the review of the literature, I will present several views on the topic of smart villages. In the second chapter, I will write more about the role of smart technologies in the smart village concept, as well as the challenges that come with

technologies. In the third chapter, I will analyse the already existing smart villages and current state and possibilities for the development of smart villages in the Republic of Serbia. The fourth chapter will present the empirical analysis of the selected village, where the main problems and opportunities of the village will be investigated through the survey questionnaire and interviews. Later, based on the experiences of already existing worldwide smart villages, I will propose smart solutions for prioritized issues and present it in the fifth chapter. The final sixth chapter is about the implications and future research recommendations.

2 THE SMART VILLAGE CONCEPT

2.1 Definition of the smart village

There is no generally accepted definition of rural areas, and it can vary depending on the context and the country. However, rural areas are mostly defined as small communities or areas with low population density, the lack of infrastructure and economic development, with limited access to educational and health services, and more agrarian-based economy. (OECD, 2020). A concept that was created as a proposed solution to improve the wellbeing and the quality of life of rural areas residents, by utilising the technology, is known as smart village concept (Muke et al., 2017).

Although there is no comprehensive and generally accepted definition of a smart village in the literature, two things must be highlighted in regard to this concept. First, becoming a smart village is not the goal of a specific village, but rather a model, and framework for solving the existing problems or preventing the potential ones. The idea is not for a community to just acquire the designation of a "smart village" as an ultimate goal. By presenting the concept of a smart village as a model and framework, the emphasis moves away from a superficial aspiration to achieve a specific status to a strategic approach focused on enhancing the quality of life, sustainability, and overall progress within the village. Second, the transformation into a smart village is not an unavoidable outcome, but it is presently the most auspicious approach to accomplish the objectives of a village. Communities should make the decision, considering their specific circumstances, needs, and ambitions (Zhang & Zhang, 2020).

According to the ENRD (2019) “smart villages are rural communities that use innovative solutions to improve their resilience, relying on their strengths and capabilities.” In order to develop their strategy for improving economic, social and environmental conditions, smart villages rely on digital technologies, and the approach they take is participatory. This means that the active participation of the local community is essential for decision-making. Some authors think about smart villages in the context of sustainability and define a smart village

as the "village that is able to provide all services to the villagers through independent, efficient, effective, and sustainable resources management" (Ella & Andari, 2018).

According to the World Bank (2021), the smart village concept is about „enabling communities, in partnership with local government and the private sector, to identify opportunities and solutions that are right for their own areas based on demand (bottom-up/participatory needs assessment), on transferring knowledge and innovation, and on policy incentives." One more definition I will be referring to in my master's thesis is the one that sees smart villages as a project that aims to create such environment in rural areas, where people would like to live, because innovative technological solutions make their lives less difficult and more pleasant (Vaishar & Šťastná, 2019).

It is difficult to say which one of the definitions of a smart village is the most correct, since the concept and the planning of the smart village is directly impacted by the needs of the village itself (Stojanova et al., 2021). However, most of them rely on the utilising of technologies to improve the quality of rural life. Even though the word smart is usually associated with technology, when it comes to the concept of smart village, it is not enough to think only about technology. Digitalisation, i.e., utilising technologies, is never an ultimate goal, but it rather serves as a means to achieve other goals. However, technology and innovations are seen as the most common strategies for achieving smart village objectives (Mishbah et al., 2018).

However, when creating a smart village development strategy, the specificity of the village or rural area must be considered, as well as its inhabitants' needs and issues. Based on this understanding, the main challenges and opportunities that exist in a particular rural area can be identified (Bielska et al., 2021). So, in order to create a strategy for transforming the traditional village into a smart one, it must be decided which dimensions are the most important from the perspective of the village inhabitants and what are the main driving forces of the development of a particular smart village.

2.2 Smart village dimensions

Different research on the concept of smart villages takes different dimensions into account (Table 1). Some of the dimensions appear more often, some less often, and this usually depends on the interests of the rural environment that is being investigated. All these aspects are intertwined and interdependent.

Table 1: Smart village dimensions

No.	Scholars / Institutions	Dimensions
1.	Viswanadham & Vedula (2010)	Resources, institutions, service delivery technologies and mechanisms, and service chains

(table continues)

(continued)

Table 2: Smart village dimensions

No.	Scholars / Institutions	Dimensions
2.	Somwanshi et al. (2016)	Smart governance, smart mobility, smart economy, smart living, smart people and smart environment
3.	Sai (2016)	Smart infrastructure, smart technology and innovation, smart institutions and smart service delivery
4.	Ella & Andari (2018)	Resources, technology, service chains, institutions and sustainability
5.	National Institute of Public Administration Indonesia (LAN, 2018)	Smart government, smart society, smart economy and smart environment
6.	Syaodih (2018)	Smart institution, smart resources, smart service and smart technology.
7.	The Bled Declaration (European Commission, 2018)	Precision farming, digital platforms, shared economy, circular economy reducing waste and saving resources, biobased economy, renewable energy, rural tourism, and social innovation in rural services and entrepreneurship
8.	ENRD (2018a)	Society, digital services, technical platform and infrastructure
9.	Kamal et al. (2018)	Agriculture, health and telemedicine, market management, education, law, micro financial skill assessment programme, outsourcing programme, disaster management and electrification.
10.	Atkočiuniene & Vaznoniene (2019)	Economic resources, social resources, environmental resources and cultural resources
11.	Herdiana (2019)	Smart government, smart community and smart environment
12.	Adamowicz & Zwolińska-Ligaj (2020)	Management, life quality, economy, society, natural environment, mobility
13.	Aziiza & Susanto (2020)	Governance, technology, living, resources, village services, tourism
14	Mishbah et al. (2018)	Energy, economy, ICT, people, governance, environment, living
15.	Wang et al. (2022)	Smart environments, smart infrastructure, smart economy, smart people, smart governance, smart living, and other future directions
16.	Ranade et al. (2015)	Economic, environmental and social component

Source: Adapted from Jayanthi et al. (2022).

If we were to rely on sustainability as the overarching goal of a smart village, which will be further explained in the following chapter, then we could say that smart village is a village that is economically, socially and environmentally smart. However, like any other strategy or project, it requires a proper governance and people and resources management (Adamowicz & Zwolińska-Ligaj, 2020). According to ENRD (2019), the active participation of all stakeholders is crucial for the success of the project. Therefore, for the purpose of this master's thesis I will further explain the following dimensions: smart government, smart society, smart economy, and smart environment.

2.2.1 Smart Government

Smart government deals with employing the innovative business models and technologies, as well as proper governance policies, in solving social, economic, environmental, and administrative issues of public sector (Glybovets & Mohammad, 2017). It implies facilitating and expediting the social development and changes, while respecting the ideals of the rule of law, justice, responsibility, transparency, participation, etc. (Asriadi et al., 2021). On the other side, the growth of rural areas is reliant on the motivation of local, national, and global governments to supply the necessary infrastructure and encouragement to new businesses through tax reductions and financing (Iberdrola, 2021).

In order for sustainable development, as the goal of the smart village project, to be successful, coordination between ministries and governmental organizational structures, local authorities, as well as the involvement of local residents and other stakeholders, is necessary in order to strive towards it together. This makes it possible to take a comprehensive view of the citizens' needs and direct the development of the project towards meeting their needs. Local authorities have a crucial role because they are in charge of connecting different interest groups and coordinating them. Both national and local authorities must work to promote the project, as well as provide institutional and legal foundations for its realization. Involving stakeholders, and especially locals, in the decision-making is of crucial importance so that their voices are heard (ITU, 2020; ENRD, 2019).

2.2.2 Smart Society

The smart society dimension of a smart village is an important part of creating a sustainable and resilient community. It is about the people who take advantage of the development of digital technologies to improve their well-being (Rochman et al., 2020). Smart society deals with demographic pressures such as low population density and an aging population, by increasing the attractiveness of rural areas in the social context. The attractiveness of a certain environment, mainly means providing access to educational and health services, improving the existing infrastructure and services, and creating new opportunities for economic growth. However, in addition to all that, smart villages also strive to create a sense of belonging and inclusion for everyone. Among other things, this means creating a safe space where people can come together and share their experiences and ideas. The goal is to create opportunities for people to learn from each other and build relationships that can last a lifetime (OECD, 2020).

By creating strong social bonds, people are able to work together to create solutions to their local problems, while creating a sense of community and belonging. In this sense, technology can be used to improve social interactions between people and foster a sense of community. Technology helps people stay informed and get the services they need in a faster and easier way. Also, with the help of technology, people in rural areas get the opportunity to be educated, informed, and also involved in cultural, political and economic events in the

world. Overall, access to technologies alleviates the rural-urban divide and reduces the feeling of being cut off from the world for people living in rural areas (OECD, 2020).

2.2.3 Smart Economy

The smart economy dimension in a smart village is about sustainable economic development and it means improving the financial stability and living standards of people living in these areas. It is based on resource efficiency and the idea that local resources, together with access to technology and capital, can be used to enable a more diverse and resilient economy. This means using a range of technologies and services, including digital platforms, mobile devices and the Internet of Things, to create an interconnected ecosystem that enables the exchange of data, goods and services between rural communities and the rest of the world. This enables the development of new markets and new sources of income for rural communities and is essential for increasing employment opportunities, which in turn improves the living standards (Popova & Popovs, 2022).

One of the main sectors driving economic development in rural areas is agriculture. It provides employment opportunities, improves food security and connects rural areas to the global economy. However, relying only on primary sectors is not sustainable in the long run. Therefore, an important step in promoting smart economic growth in rural areas is economic diversification. It is a key element in rural development strategies that improves the resilience of rural areas by creating new and sustainable sources of income and improving access to services and amenities (OECD, 2020).

Besides economic diversification, developing a smart economy also involves promoting financial inclusion. This is enabled by providing access to financial services and products, such as microcredit, banking and insurance, to create an environment where residents of rural communities can access capital, which can be used to develop local businesses, to create new jobs and to ensure access to education, which can subsequently lead to improved economic outcomes for rural communities. Ultimately, by creating a more diverse and robust economic base, rural communities can be better prepared to deal with economic shocks and disruptions (OECD, 2020).

2.2.4 Smart Environment

Smart environment dimension is about preserving nature. In the rural development context, it means employing the technology and data for managing natural resources in order to create more efficient and sustainable environment. In other words, it is about sustainable use of natural resources and use of renewable energy sources (such as solar and wind power, implementation of smart grid, etc), the preserving of natural environment and preventing the pollution of land, water and air, the preserving of biodiversity and taking care of the green areas. Preservation of the environment is not only the need of today's generations, but also our responsibility towards future generations. Achieving economic and social well-being

must never come at the expense of environmental protection (OECD, 2020; Wahab et al., 2020).

Due to the fact that rural economies mostly rely on natural resources, rural environments are crucial in the transition to more sustainable resource-based industries. On the other hand, the main branches of the rural economy, such as forestry, agriculture, hunting, fishing, energy and mining, are in increasing danger due to climate change, which causes more frequent extreme weather disasters, destroyed biodiversity, as well as polluted environment. Therefore, rural environments have a great role in providing a more sustainable environment, that they can also benefit from, and in doing so, they increasingly rely on technologies and technological innovations (OECD, 2020).

2.3 Drivers for the smart village development

Considering all the definitions of a smart village mentioned above, we can say that a smart village is a development concept, through which the rural residents, in cooperation with the government and local leaders, are trying to find the solutions for the numerous challenges that rural areas face, which further leads to the increase in life quality of rural residents.

Some authors believe that the purpose of developing smart villages is to improve the quality of life and prevent younger people from leaving villages and seek their place in the city (Van Gevelt & Holmes, 2015), while other aspects emphasize more the improving of the network, the eliminating the digital divide between rural and urban areas, and agricultural policy (ENRD, 2018b). Additionally, there is an environmental aspect that sees smart villages as an opportunity to explore the solutions for solving environmental issues and promote environmental sustainability (Crawford, 2018). Therefore, it can be concluded that the smart village concept does not have a precisely defined goal.

However, what most authors agree on is that one of the main goals of this concept is sustainable development of the particular rural area. The term sustainability was firstly mentioned in the context of environmental protection. It was later expanded to include economic growth with the necessity to protect the environment. And finally, the social aspect was added as the third component of the sustainability concept. Today, sustainable development refers to the environmental, economic, and social sustainable development (Adamowicz & Zwolińska-Ligaj, 2020). The most commonly accepted definition of sustainability and sustainable development is the one from the Brundtland Report: “sustainability is about meeting today's needs without compromising the ability of future generations to meet their needs" (Brundtland, 1987).

On the other hand, the two most commonly identified driving forces of the smart village developments are people and technologies. Without people, there wouldn’t be a need for village development, and an active group of local villagers is usually the initiator of a smart village process (ENRD, 2019). All the while, the technology, even not a necessary part of the smart village, is seen as the most mentioned strategy in the literature (Mishbah et al.,

2018). Additionally, most of the smart village definitions focus on digital technologies and people (Renukappa et al., 2022).

Even though people and technologies are most commonly identified, they are certainly not the only driving forces of smart village development. According to ENRD (2018a), there are five driving forces of smart village development: 1) addressing population decline and demographic shifts; 2) seeking solutions to the centralization of public institutions and low public investments; 3) taking advantage of connections with surrounding cities and municipalities; 4) the potential of rural areas to contribute to the transition towards a more sustainable and green economy; 5) encouraging rural areas to undergo digital transformation.

Observing the depopulation and demographic changes of smart villages, it should be pointed out that one of the fundamental forces behind the concept of smart villages is depopulation, even though some studies view it as the primary symptom rather than the root of the village decline. Bearing in mind that Covid-19 pandemic happened, which greatly affects problems in urban areas, it is possible that this trend will not be fully realized, because more and more people, all over the world, prefer rural areas, which are less populated (ENRD, 2018a).

Another reason for the emergence of the concept of smart villages is reflected in seeking solutions for the centralization of public institutions and low public investments. This refers to the fact that areas of low population density face the problem of increasing unit costs of providing certain basic services, such as education, health care, trade, public transport, etc. In order to respond to this issue, states often resort to reducing the provision of services in rural areas and concentrating them in larger cities, which has led to a further increase in inequality between rural and urban areas (ENRD, 2018a).

It is believed that better connection between rural and urban areas is also necessary. Analysing the complex relations between cities and rural areas, the Organization for Economic Cooperation and Development concluded that, by carefully managing these relations, a situation can be dealt with in such a way that both parties, both rural and urban areas, can benefit from. They discovered that those cities that are close to rural areas generally record quite fast growth, and those rural areas that are close to cities function quite efficiently and well. The most successful results of the concept of smart villages are realized in cases where the cooperation between rural areas and larger and smaller urban centres is expressed (ENRD, 2018a).

The concept of smart villages is based on a more efficient use of natural resources and a positive impact on the environment. Analogously, smart villages are suitable for transforming rural areas into areas suitable for establishing circular economy systems. The circular economy represents a new approach to waste management, that adheres to the idea of sustainable development. Namely, in contrast to the linear waste management system, which implies that the exploitation of natural resources produces as many products as possible that will eventually end up as waste in landfills after their use, the circular economy

relies on the concept of recycling and it represents a more efficient approach to waste management. In terms of that, instead of being disposed of as waste, these products should be collected through the recycling process, and used for new production processes. However, in most cases, rural areas, including those in the Republic of Serbia, do not have adequate waste management system. The development of smart villages offers a solution to this problem, as the concept itself is in line with environmental protection and sustainable development (Vujović, 2019; ENRD, 2018a).

The last but not least, digital transformation is the driving force. The benefits that digital technologies provide in many areas of life and business are widely known. However, there is another side of the coin, where digital technologies often create certain challenges, especially if the access to them, the ability to use them and their adoption is not at a satisfactory level. Thus, in the context of smart villages, the goal is not only to provide access to digital technologies, but also to promote digital technologies as a tool for solving existing and potential problems faced by rural areas and thus support the digital transformation of rural areas (ENRD, 2021, ENRD, 2018a). Promoting digitization in rural regions is crucial for addressing the issue of limited access to digital technologies and the absence of digital skills. The primary goals are to enhance digital literacy, to cultivate specific information and communication technologies (ICT) skills, and to assist people with limited abilities to facilitate their full engagement in the digital economy and society. This would facilitate the advancement of innovative business models, apps, and services while promoting economic success and social solidarity (CORA, n.d.).

2.4 Transformation of the traditional into a smart village

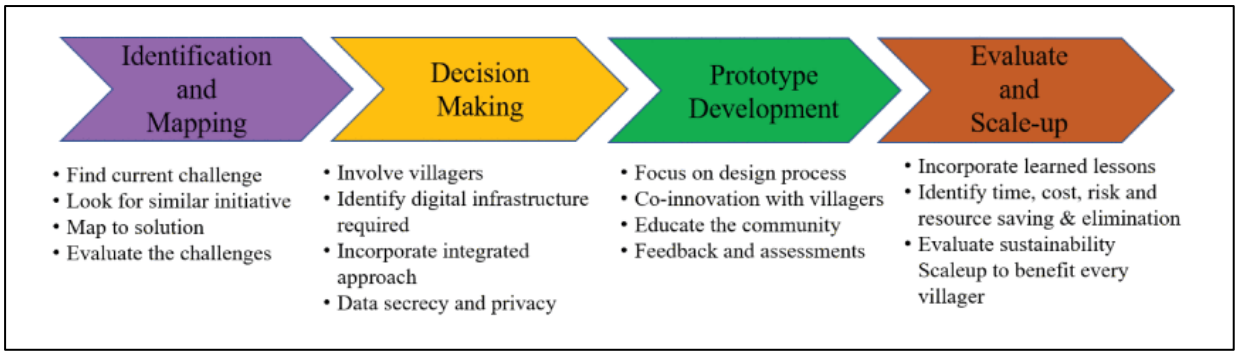
Depopulation and the aging of the population, as well as the digital divide, are just some of the problems that rural areas face due to insufficient development. The concept of a smart village appeared as one of the approaches of solving these problems. The transformation of the traditional village into a smart one is a complex process that involves the connection of various subjects and policies. Smart village development strategies must be made in such a way that they determine short-term, medium-term and long-term goals. Their development must be measurable and regularly evaluated (Edgars et al., 2021).

There are many smart village development strategies and steps for implementations in literature. So, for example, according to Federico (2021), transformation of a traditional village into a smart one requires a whole process of activities, such as:

1. Raise awareness - develop a clear community vision for change.
2. Identify & ensure a good mix of resources to support the process.
3. Develop a roadmap for change.
4. Broaden cooperation and create an enhanced partnership.
5. Implement the change.
6. Enhance knowledge further.

According to (ITU, 2020), the concept of smart village can be seen as a comprehensive approach to rural (digital) transformation, which implies taking certain steps. Designing and implementing a project such as smart village involves four phases: analysis, design, implementation, and evaluation, which take place through the certain sub-phases (Appendix 3). The first phase is analyse and plan and the purpose of it is to build guiding principles for the design process while studying and learning from the experience of other initiatives. The second phase is design and develop, and the goal of this phase is to create appropriate and pertinent digital services, based on needs and requirements of inhabitants. Third phase is deployment and implementation, and as its name says, the objective is to successfully establish an environment that will enable the deployment of created services in a sustainable manner, until the end of the phase. The final phase is monitor and evaluate, and it does not end. This step is about implementing ongoing monitoring and evaluation of the smart village project status for continued improvement.

Figure 1: Smart village design cycle



Source: Degada et al. (2021).

On the other side, Degada et al. (2021) describe four steps in the design of a smart village (Figure 1). The first step is to identify and analyse the existing challenges and design an appropriate smart solution for the identified challenges. The second step is decision making and is about choosing the pertinent, appropriate, and flexible technological solutions to employ and deploy resources and promote sustainable development. The third phase is about prototype development. In this step, through the implementation of the prototype, the applied technologies are evaluated, and possible weaknesses and opportunities are analysed. The fourth step is to evaluate and scale-up and it is about replicating the cloning of prototype for the whole group of villagers.

Since every village is unique, in the process of considering the implementation of a smart project, it is important to take a good look at its specific characteristics and possibilities and to decide on the implementation of the project that will surely meet the needs of the local community, increase the quality of life and management, and will be financially feasible and sustainable (Stojanova et al., 2021).

2.5 Main challenges in smart village planning

It is already mentioned that the process of transition from a traditional village to a smart one is a long-term process that requires the cooperation of several stakeholders in achieving common goals. When planning a project such as a smart village, in addition to the advantages that the project offers and the already existing examples of good practice, difficulties and challenges that arise during the implementation of such a project must also be taken into account. Previous experience has shown that many remote areas have faced more challenges than suburban areas, and the reasons for this outcome are that these areas have more limited communication accessibility, a lower level of education of the population, more limited access to markets and resources, as well as a higher rate of outflow of population (Renukappa et al., 2022).

Mukti et al. (2021) in their literature research of 119 selected articles, group the challenges that may arise when adopting the principles of the smart village concept, based on the technology-organization-environment (TOE) framework. Technological challenges take into account the availability, quality and suitability of technologies, as well as the conditions necessary for their use. Organizational challenges consider the capacities of the organization that is in charge of managing the smart village project. Finally, environmental challenges consider the stakeholders and legislative framework which affect the adoption of smartness. Research results show that the most common technological challenges are unsupported technology infrastructure, technology services suitability, end-user digital devices ownership, reliable electricity, and strategic guidelines. On the other hand, funding issues, capabilities of the organization responsible for the project, government's commitment, and lack of collaboration between involved stakeholders were highlighted as the most common organizational challenges. And finally, digital literacy, involvement of the third parties, involvement of the citizens and resistance to change, finances, lack of supportive regulations and policies, lack of entrepreneurial capabilities are the most common problems from the environmental aspect.

Renukappa et al. (2022) grouped the challenges in the implementation of the smart village initiative into technical and non-technical and conducted a web-based survey to assess the relevance and impact of challenges in smart village development. He included digital transformation challenges, the challenges of multidisciplinary work and the absence of a business model for improving rural residents' well-being among the technical challenges. On the other hand, he classified complex policy frameworks, lack of investment capital and financial issues, poor understanding of user needs and preferences, administrative and institutional issues, rural to urban migration, generating income for long-term sustenance, and competing with other initiatives and plans as non-technical challenges. The results showed that the biggest technical challenges are the lack of infrastructure and the necessary technology, while the key non-technical challenges are the lack of investment capital, the absence of straight strategies, as well as poor cooperation and collaboration among stakeholders.

Other authors consider the following challenges as the most common challenges faced by the initiators and implementers of the smart village project: insufficient knowledge about the smart village concept and its advantages, low level of digital literacy, the unwillingness and resistance of the community to change, low involvement of the community in the project, the attitude of local authorities towards the smart village initiative, obstacles in developing innovative projects and financial issues related to them, weak communication and transportation connection due to poorly developed digital and road infrastructure, absence of the knowledge and innovations sharing between scientific institutes and business practice, and the difficulties in creating a development strategy that is fully integrated across a variety of policy sectors at the regional and local levels (Satoła & Milewska, 2022; Juan & McEldowney, 2021).

Anyway, it is clear that smart village initiatives are not easy to implement, and these challenges need to be taken into account on the path of transition toward smart village.

3 THE ROLE OF TECHNOLOGY IN THE SMART VILLAGE CONCEPT

3.1 The importance of technologies and their implementation in rural areas

Negative demographic changes, poor transportation options, inefficient use of resources and therefore a bad impact on the environment and community, insufficient access to capital and labour, poorer public services (educational, health, cultural, utilities…), weaker economic growth which often causes poverty and the lack of job opportunities, poorer access to the Internet, etc., are just some of the challenges that rural areas face. All these challenges cause a low life quality in rural areas and therefore a high rate of population outflow to urban areas (Gollakota & Doshi, 2011).

It would be completely wrong to think that rural development is only important for the people who live there. Considering the fact that the world practically depends on rural areas and that most of the natural resources are located in rural areas, it is safe to say that the development of rural areas is crucial for the lives of all people, as well as the survival of the planet. Because of these, as well as many other reasons, it is necessary to react as urgently as possible and to focus on the development of rural areas (Ellis, W. N., 1981).

The main premise of the smart village initiatives, according to Juan and McEldowney (2021), is that technological innovation can offer better quality of life through providing different possibilities for increasing income, provision of new services, improving environmental conditions and thus building up and strengthening the society. The 21st century will probably be known for global and technological changes which, among other things, have an impact on rural development. Technologies are already helping in overcoming numerous challenges that rural areas face. At the same time, technological

changes and achievements make the environment significantly more complex and dynamic, and it is almost impossible to ignore them in modern conditions. Covid 19 pandemic was a showcase of how utilizing technology can help in various aspects of life.

However, utilizing the technology is not only oriented toward problems solution but can also be beneficial in creating new opportunities and providing conditions for exploiting the already existing potentials of rural areas (OECD, 2020). If used properly, technology can significantly improve quality of life. But when used improperly, it can create damage to society and environment (Ferrari et al., 2022).

According to Miller (2019), some of the main advantages technology has brought to civilisation are:

1. Unlimited access to information even from the comfort of our homes. This saves our time and energy and increases productivity.
2. It has brought huge advances in science, and it inspires new innovations. The creation of new machines, intended for researchers, has brought great progress and discoveries in fields like medicine, food production, etc.
3. Advances in technology have enabled the creation of tools that have increased productivity in production of goods and providing services.
4. With technology, we have additional alternatives for mobility. Thanks to various means of transport created with the help of technology, people and goods can travel much faster and stay in good quality.
5. The way of communication between individuals has greatly improved providing greater ease in communication.
6. Emergence of new business models. Technology has undoubtedly revolutionized business. The advancement of this has created a number of alternatives in the entrepreneurial world.
7. By increasing the productivity, technology led to decreasing of unit costs and decreasing of final products prices, which makes more products affordable to more people.

People need all kinds of information since it is essential for development, hence one of technology's main roles in rural development is to give people access to it. For instance, information and communication technology (ICT) can provide farmers with information regarding new resources or farming techniques which increase productivity and, consequently, produce higher profit; it also makes it easier for people in rural areas to get medical advice; it creates new educational and career development opportunities; increases jobs diversification and thus opens up a lot of new opportunities to earn money. It contributes to creating a good image and increases the visibility of a certain rural area, which increases the attractiveness of the rural environment, reduces population outflow and contributes to the development of tourism. Also, it creates the opportunity for farmers and other local businesses to promote themselves and their products and services through various types of online markets, social networks, websites, etc. (Musingafi & Zebron, S., 2014).

Although technology is often considered as an indispensable component of smart villages, it is only a means by which the goals of the smart village project are achieved. Technology brings numerous opportunities with it and contributes to the overall development of society, but negative effects of its use are also present. Therefore, when planning the implementation of new technologies, it is important to take into account the potential challenges of using them, and to take all the necessary actions to eliminate the difficulties and reduce the negative effects. It is very important to maximally adapt the technology to the users and to maximize the use of all the benefits that the technologies provide (Ferrari et al., 2022).

3.2 Challenges of introducing technologies in rural areas

Regardless of the numerous advantages and regardless of all the potential that the use of technology has in solving numerous problems faced by rural areas, they still remain significantly behind urban areas and least benefit from the development of technologies. More precisely, there is a large urban-rural digital divide. There are many definitions of digital divide, but they are all similar and they mostly see the digital divide as the difference between those who have access to digital technologies and those who do not have it or have limited access to it. And, while variety of technical solutions for urban areas problems is created, in the context of rural areas, there is still discussion on digital infrastructure (Blešić & Pivac, 2020).

Cowie et al. (2020) claim that technologies, by creating a digital divide between rural and urban areas, further marginalize rural areas, which violates the principle of "Responsible Research and Innovation" (or RRI). RRI is a policy framework that aims to ensure that advances in science and technology are always aligned with social and moral norms. RRI means that when developing a certain technology, the effects it can have on society must be taken into account. The question about the purpose of the technologies must be answered in a manner that explains what they are supposed to do and who will benefit from them (Stilgoe et al., 2013). Seen through the RRI prism, the more common orientation of new technologies towards solving urban problems more than rural ones (most technologies are made for urban environment and technology is significantly more accessible to people in urban areas), creates a digital gap between these two areas, creating social, economic, and cultural inequalities between these two areas (Cowie et al., 2020).

The reasons for this situation, i.e., for digital divides between rural and urban areas, are numerous, beginning with geographical distance and underdeveloped digital infrastructure, all the way to digital literacy and awareness of the people who live there. However, even the basic assumption of digital divide is network exclusion, it is very important to emphasize that the factors that determine digital inequality are not exclusively of a material nature and are not only manifested in the possession or non-possession of technologies, but also in the knowledge and skills of using them (Breulj, 2016).

Ferrari et al. (2022) grouped all barriers of introducing technologies in rural areas into socio-cultural, technological, economic, and regulatory-institutional. Among the socio-cultural challenges, the most common are demographic problems, in terms of age and low population density, and educational issues, in terms of information illiteracy and lack of information about the benefits of using the technologies. The main technological problem is connectivity, because without connectivity there is no discussion about using more advanced technologies. The costs of adopting technologies and the lack of confidence in their cost-effectiveness are the key economic problems. And finally, when it comes to regulatory-institutional barriers, the biggest problem is mistrust in regulatory authorities and manufacturers of smart technologies in the context of data management and privacy protection. Out of all the mentioned barriers, the most common barriers to technology adoption are socio-cultural.

According to ENRD (2018a), the three key pillars of the rural digital divide are broadband infrastructure, digital literacy of inhabitants and adoption of digital services, and all of them need to be addressed simultaneously, so all the effort will be worthy. All three are equally important and the development of one is not sufficient without the development of the other.

A prerequisite for the development of advanced smart services from the smart village domain is the existence of an appropriate information and communication infrastructure on which such services are usually based. Digital infrastructure is not only the pillar, but also a primary factor of the urban-rural digital divide. Availability of the digital infrastructure is a condition for eliminating urban-rural digital divide. It can also encourage digital literacy and increase and improve a lot of local services. The development of broadband infrastructure in rural areas will reduce the digital gap between rural and urban areas and enable further development of rural areas. The goal is to provide equal opportunities for assets and usage of advanced digital ICT between urban and rural areas (Blešić & Pivac, 2020; ENRD, 2018b).

Although broadband infrastructure is a condition for reducing the digital divide, it is by no means sufficient. In order to use technologies in a proper way, it is necessary for the users to be digitally literate. People in rural areas are usually less digitally literate than people in urban areas. Therefore, to take advantage of the benefits that technologies provide, in addition to providing the necessary infrastructure, it is necessary to invest in the knowledge and skills of the users themselves. Locals must have at least basic knowledge in order to be able to take advantage of technologies in a useful, safe and secure way (Blešić & Pivac, 2020; ENRD, 2018b).

Finaly, the adoption of digital services refers to the acceptance of technologies by the users. In order for users to accept the technologies and use all of their advantages, first they must be aware of all the benefits they provide. It often happens that rural residents are not aware of the potential benefits of adopting and using technologies and are less tolerant about the change than people in urban areas. Therefore, it is very important that the locals are aware of the importance and changes that technologies bring and that they want this kind of change

so that the implementation of technologies in the rural environment is meaningful and successful (Blešić & Pivac, 2020; ENRD, 2018b). So, it is extremely important to work on the promotion of digital services, in order to raise the awareness of people in rural areas about the potential that technologies have in solving social, economic, cultural as well as environmental problems.

3.3 Presentation of smart technologies used in a smart village concept

The concept of smart villages was created based on the smart city concept, which was created earlier as a response to the problems of growing urbanisation. However, as the conditions and problems of rural areas differ from those in urban areas, the concept of a smart city had to be adapted before it was used for the development of a smart village. This also applies to technologies. Smart village technologies were mostly created as an adaptation of smart city technologies to rural conditions and needs (Bielska et al., 2021). Here, I will present some of the technologies, which can be mutually combined and used in solving problems and facilitating life in rural areas.

3.3.1 Information Communication Technologies

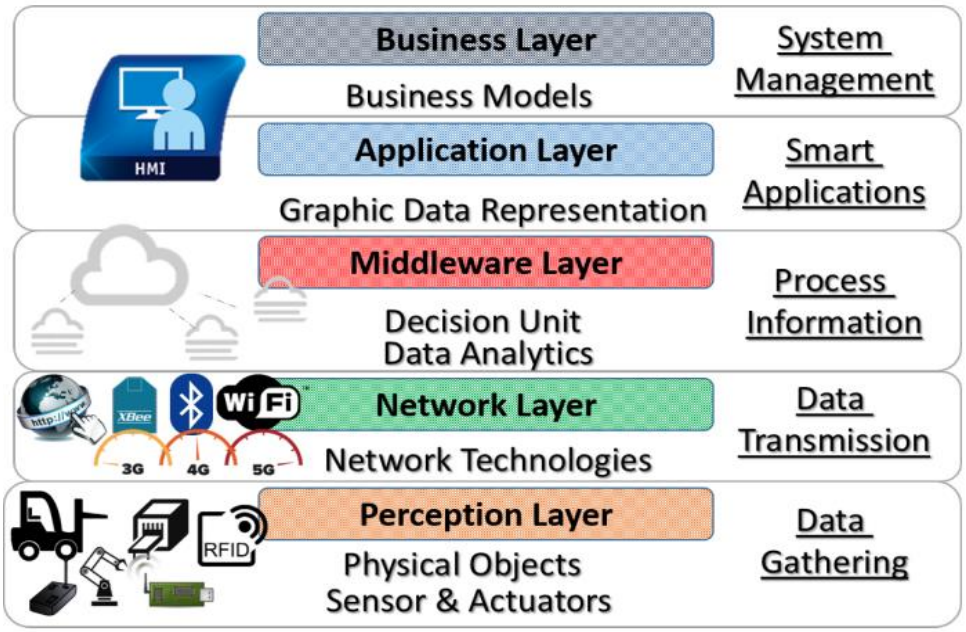
ICT represents communication technologies, which include the Internet, Wi-Fi, computers, mobile phones, social media, and other applications and services, that enable the reception, processing, storage, and transmission of information in digital form, thereby adding value to it (Ella & Andari, 2019). The development of ICT has always been interesting in various aspects of human life, and it is believed to have a positive significance for sustainable development. This means the positive impact on economic, social and environmental productivity and sustainability, as well as the impact it has on improving government transparency (Wijaya, 2023). There is no doubt that ICTs contribute to a better quality of life in the countryside. In addition to enabling better communication between users, they also create new services and activities in the countryside, as well as the improvement of existing ones. Also, ICTs contribute to raising the awareness of the rural population, which results in their more active participation in social and political life. We can say that ICT is used in various spheres of life of the rural population, such as health, education, agriculture, governance, economy and employment opportunities, environmental protection, etc (Nimodiya & Ajankar, 2021).

3.3.2 Internet of Things

Some authors perceive IoT as a key technological player in the concept of a smart village. The IoT is a network of interrelated things that can sense, communicate, and act with one another and with the environment. It is actually a network of physical objects, i.e., things connected via Internet and its synchronisation. IoT enables the sharing of information between physical objects over the Internet, which further enables automated real-time reactions to events in the real environment, with or without human mediation. IoT functions

by establishing a connection between devices with servers and other administrative locations, to get instructions that need to be performed, transfer data, and perform remote control (Singh et al., 2022). The IoT is already making our lives a lot easier, so it is not surprising that it is becoming an important aspect of our lives.

Figure 2: Five-layer IoT architecture.



Source: Antão et al. (2018)

The Internet of Things architecture consists of five layers, which can be seen in the Figure 2. The first layer is the perception layer, and it actually represents all the physical devices used to collect information, such as barcodes, sensors, chips, and the like. The second layer is called the network layer and actually serves to transmit the collected information, by wire or wireless, to the system for its processing. This system represents the third layer which is known as the middleware layer. In this layer, information is processed and analysed, and based on the obtained results, decisions are made and sent back to the physical devices. Furthermore, this data can be used in the application layer, through which the user can control the devices and the whole system. The last layer, located at the top of the architecture, is called the business layer and it serves to manage all other layers. In this layer, all collected information is statistically processed and visualized, and the acquired knowledge is used in creating future strategies (Antão et al., 2018).

IoT technology is used in many aspects of rural life and plays a crucial role in smart village development. IoT-based applications are used in agriculture and livestock to monitor resources such as water and agricultural resources, generate reports on these resources, and remotely manage them. Also, as it optimizes distance learning, IoT technology is also used in education. Various applications for waste management, monitoring, and management of

smart energy systems, monitoring the health of people, animals, and plants, and monitoring the state of infrastructure (e.g. public lighting) are based on IoT technology (Degada et al., 2021).

3.3.3 Blockchain

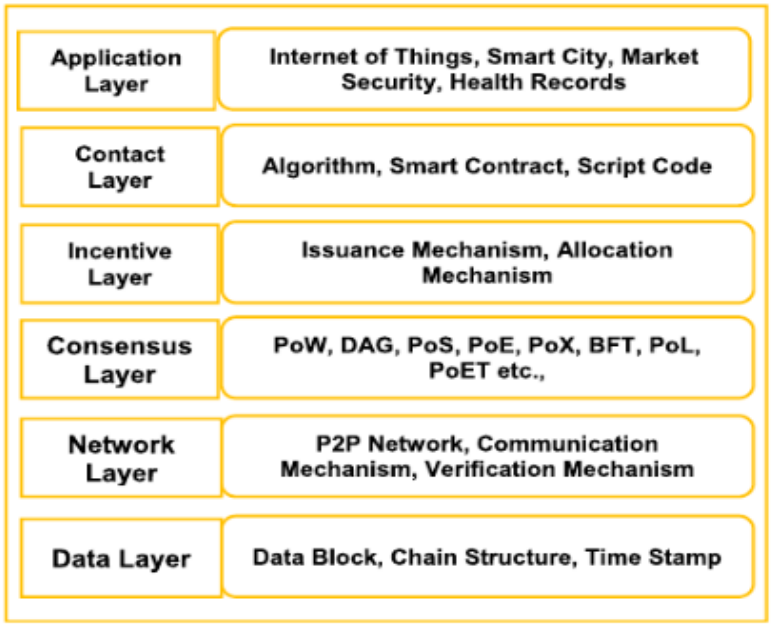
Blockchain is essentially a decentralized database made up of smaller databases (blocks) that are connected. These databases can contain any information about any completed digital transaction. The first time blockchain implemented in practice was in 2009, when a person or a group of people known under the pseudonym Santoshi Nakamoto, created bitcoin. Bitcoin is a platform that enables the exchange of digital currency directly between two parties, without the need for intermediaries. This solved the problem of double spending without compromising safety. Another blockchain platform worth mentioning is Ethereum. Ethereum has modified and improved the storage and operation of computer code, enabling the creation of smart contracts. A smart contract is a contract whose terms are entered digitally, where the parties to the contract can be completely anonymous persons, and security is provided by a code that controls the execution of the transaction, without the need for an intermediary. This is made possible by the fact that it is realizable to define that the transaction takes place only when both parties meet predefined conditions (Pavlović, 2022; Bhutta et al., 2021).

As blockchain technology enables security in data exchange, ensures transparency, guarantees security in transactions and reliable records of ownership, and enables automation and decentralization of processes, it can be used in smart villages in different ways. For example, with the help of smart contracts, trade in agricultural products, energy, assets, and services can be automated. In agriculture, it can also be used to monitor the distribution of food, which allows the end consumer to see the origin and quality of the product. A variety of energy and water production and consumption data can also be stored on the blockchain, thus enabling data transparency and integrity (Kaur & Parashar, 2021).

Depending on the application and application requirements, the architecture of blockchain technology can have a smaller or larger number of layers. In the literature, the following six layers are most often encountered: application layer, contract layer, incentive layer, consensus layer, network layer and data layer, as displayed in the Figure 3. The first layer is the data layer, and it is the only one that communicates directly with external services. It consists of all transactions, i.e., the information contained in them, grouped into blocks. The next layer is the network layer or P2P layer and it serves to connect the nodes. This layer is responsible for addressing and naming, as well as checking the validity of the transaction, and makes sure that the once written data is never changed again. The next layer is the consensus layer, and it consists of rules and algorithms according to which participation in the blockchain is ensured and decision-making is done. The incentive layer is an optional layer and serves to distribute rewards to network nodes as compensation for establishing consensus. In the contract layer, terms of the contract are defined and is located right below

the application layer. The application layer is a device that enables the end user to use blockchain technologies (Pavlović, 2022; Bhutta et al., 2021).

Figure 3: Six layers of blockchain architecture.



Source: Bhutta et al. (2021)

3.4 Application of technologies to different spheres of life in rural areas

Access to advanced technologies and smart services in rural areas has a direct impact on reducing the urban-rural digital divide and increasing the quality of life in villages, and indirectly on reducing migration to more urban areas. People have easier access to the necessary information and services, new business opportunities have been developed that can be carried out from people's homes, and the potential for further development of the community has also increased, thus enabling sustainable rural development, which is a goal of a smart village project (Grgić & Job, 2021). As already mentioned, sustainability is reflected in three components: environment, society, and economy. This means that when introducing new technologies, it should be ensured that they contribute to environmental, social, and economic sustainability.

The development of technologies in rural areas takes place in accordance with the needs of the village as a community and the individuals who live there, with the aim of improving the life and work conditions in the village. A village is an ecosystem that consists of several components, and each village is a story itself. Ideally, rural development would include the improvement of all components at once. However, this is not possible. That is why, when planning a project for rural development, e.g., smart village initiative, priorities must be determined. When setting priorities, the characteristics, challenges, and opportunities that exist in a certain village, the needs of the village community, as well as the conditions that exist in the environment must be considered (Stojanova et al., 2021).

Thus, some areas present challenges, while others present opportunities, and at the end of the day, it is important to overcome as many challenges as possible and take advantage of the opportunities. Certainly, technology cannot be a universal solution to all problems. However, it creates new opportunities for development and can significantly help in overcoming various challenges in more interrelated areas of the village (OECD, 2020; Bielska et al., 2021).

The concept of smart villages is related to finding and adjusting the solutions for territorially specific conditions - potentials, needs and problems. Although the investment and use of technologies is most often mentioned as a solution, the range of solutions is much more diverse. Some of the areas in which it is possible to introduce smart solutions are: improving public services for the inhabitants of rural areas, forestry, agriculture and industry, protection of the environment and ecosystems, the fight against climate change, waste management, natural resource management, sustainability of energy systems, infrastructure and mobility, tourism and village promotion, promotion and sale of local products, social life enrichment, education and culture, diversification and improvement of employment opportunities (Bielska et al., 2021).

Energy/Natural resources: As already mentioned, smart villages imply achieving social, economic, and environmental sustainability. This means, among other things, smart, i.e., sustainable energy production and consumption. Since the current consumption of energy is far from sustainable and given the fact that we must think about future generations and their needs for energy and a healthy environment, it is necessary to review and rationalize the production and use of energy. The use of renewable resources as energy sources, as well as energy production on a micro level, more precisely by bringing energy production closer to consumers, enables greater independence and control, and therefore safety and efficiency in both production and energy consumption (Stanišić, 2017). Although the transition to renewable energy sources is increasingly emphasized, it can be noticed that they are not widely used. This happens because the dependence on natural conditions is great and cannot be controlled so easily. Although the potential for using renewable energy sources is greater in rural areas than in urban areas, due to economic, technological and other challenges, this potential is not used enough (Deshmukh, 2017). However, there are smart technologies which can help in overcoming these obstacles. As in the other domains, technology can also contribute to the solutions in the field of energy, from start to finish, i.e. in the production, storage, distribution and consumption of energy. So, for example, blockchain can help distribute energy by allowing residents to sell excess energy to each other or to the main energy grid (Aloqaily et al., 2020).

Agriculture: One of the areas where it is beneficial to utilize the technology solutions is agriculture. Agriculture is the main source of income for many villages and is the basis of the economic stability of rural communities. On the other hand, agriculture requires consumption of an extensive amount of natural resources and energy, but at the same time, agriculture is one of the sectors that will be the most affected by climate change. Therefore,

technological improvements in the field of agriculture have a great potential in achieving environmental, but also social and economic sustainability. It has been proven that the use of technology in agriculture and forestry is very important for improving the competitiveness of these two economic branches. Also, it turns out that technology provides an opportunity for diversification of the rural economy and increases the potential for the sustainability of rural areas, thus making them more desirable to live in. By increasing the efficiency and effectiveness of operations, technology significantly boosts existing businesses operating in rural areas, and makes these areas more attractive to potential investors (Musingafi & Zebron, 2014).

With the help of smart technological solutions such as IoT, big data, machine learning, sensors, drones, and others, it is possible to monitor the situation on the ground in real time and make decisions about the use of resources. One such solution is a smart irrigation system that, with the help of sensors and big data, collects data on soil moisture, then processes it and sends it to a remote device (usually a mobile phone), from where the farmer sends commands to the irrigation and fertilization system with the help of IoT (Renukappa et al., 2022). In addition to measuring and regulating soil moisture, these mechanisms can also be used to measure soil chemical composition, soil and air temperature, solar radiation, atmospheric pressure, etc. All these data are collected and processed, and then based on them, recommendations on optimal procedures and agrotechnical measures are given to the end user, i.e., farmer. In addition to saving resources and optimising agricultural activities, the benefits are also reflected in saving time spent on the farm. This gives farmers the opportunity to engage in other activities while simultaneously handling agricultural activities. Drones that enable remote monitoring of the conditions in the fields also help saving the farmer's time (Cherlinka, 2022).

Some of the other innovations are smart tractors and harvesters, which transform traditional agricultural production into a smart one, by saving time for farmers and creating conditions for increasing yields. In addition to plant growing, there are also innovations in animal husbandry. For example, there is an invention called "smart shepherd" that solves the problems of traditional sheep farming, such as the loss of farm animals and attacks by wild animals, which allows farmers to perform other agricultural activities, without worrying about the farm animals. It can be concluded that innovations and digitization in agriculture improve living conditions in the countryside by saving time for farmers and increasing yields, which indirectly encourages people to stay in the countryside (Vladisavljević et al., 2019).

Access to the Internet allows farmers to constantly improve their knowledge and to be informed about innovations in the field of agriculture, as well as to attend organized webinars, but also to organize it themselves. Organizing a webinar in the village may have a positive impact on the branding of the village, which would consequently attract investors and tourists, which may further positively affect economic stability and sustainability (Tsimakuridze, 2021). On the other hand, from the consumers aspect, blockchain

technologies can be used for traceability of supply chain and food security. For example, with the help of blockchain technology, consumers could see the entire history of a product, from information on how and where it was made, as well as how and where it was transported and stored. In this way, they would be sure of the product's origin, as well as its safety (Kaur & Parashar, 2021).

Local commerce: Although in rural areas the local commerce is most often associated with agricultural products, this does not mean that the advantages of e-markets cannot be used for other opportunities as well. The possibility of buying and selling at a distance, comparing the prices of products and getting reviews about them, made the life of people in the countryside much easier. They can now find the products they need more easily, and for those who have their own business, this provides access to a wider market where they can offer their products and services. Online markets also offer the possibility of monitoring the market, i.e. consumer habits, which gives producers and sellers better insight into demand. This saves both money and time (Lele, 2017; OECD, 2020).

Employment opportunities: The primary activity of the population in rural areas is agriculture. In other words, income from agriculture represents a significant source of income for residents of rural areas. However, these incomes are often insufficient and result in a low standard of living of the rural population, so that, very often, the majority of the young population decides to leave rural areas for urban areas. Also, not all residents of the village are able to engage in agriculture, given that it is a demanding job that requires some skills. The conclusion is that the inhabitants of the village need an additional form of income, and technologies enable exactly that. The remote work model creates new jobs and thereby removes the distance barrier. For many jobs, it is no longer necessary to go to the office every day. Although the remote work model has existed for a long time, the Covid 19 epidemic has considerably accelerated the process of acceptance of this model both by employers and by workers. Along with the low cost of living and a healthier environment, the possibility of working and earning remotely makes rural areas much more desirable for living. Also, through distance learning, locals can gain new knowledge and develop new skills, which can help them create a new job, as well as facilitate work in the countryside. In addition, there are various platforms that connect employers with potential workers, thus expanding the job offers and making it easier to find a job. Workers are no longer limited to local firms. On the other hand, access to the Internet and new technologies makes it much easier for new entrepreneurs to do their entire business, thus making rural areas more attractive for investment. They therefore decide more easily to localize their business or at least part of their business in rural areas, which opens new positions for the local population (OECD, 2020).

Governance/Administration: Thanks to ICT, today people can receive most services from public administration without going to the building of the administrative unit. Providing public administrative services to residents through ICT is known as e-government. In addition to the interaction of administrative bodies with residents, e-government also implies

the mutual interaction of state bodies with the application of modern ICT. E-government services allow citizens to electronically submit, deliver and download various documents, submit requests and petitions, pay administrative fees, schedule appointments in public institutions, as well as communicate with them. Through e-government, citizens can also be informed about various topics related to public administration, which increases the transparency and credibility of state bodies (Stratigea, 2011).

Health: Perhaps the most important condition for a life quality, not only in rural, but also in urban areas, is health. However, while cities often have several health centres, many villages do not have one. If we also take into account limited transportation options, either due to the poor road infrastructure or lack of public transport, it can be said that there is a huge gap between rural and urban areas when it comes to the providing of health services. Technology cannot completely solve this problem, especially not when it comes to emergencies. However, there are some technological solutions that can at least facilitate certain processes and they are: telemedicine, telehealth, telecare and e-health. Telemedicine involves the examination of patients at a distance with the help of using digital technologies including phones, computers, and video conferencing. Telehealth is the transfer of knowledge from health workers to patients, who, with the help of instructions received through digital technologies, perform the examination, diagnosis and treatment of themselves. Telecare is a technological device that serves patients with the aim of reducing the need for more intense support by effectively alerting others when you need assistance at home. Digital health records, electronic prescriptions for drugs, electronic ordering of examinations, as well as e-instructions represent e-health (Peck et al., 2019).

Education: Education plays a significant factor in human development. Digital technologies open up new opportunities for education and make it much more accessible. Internet access and basic digital skills allow people to access scientific literature and various courses in the fastest possible way and find out almost anything that interest them. The principle of distance learning has long been in use, however, the Covid 19 epidemic has significantly accelerated the process of adopting this method of education. Due to government measures in most countries of the world, schools were closed, and classes were conducted through various platforms for online interaction. In addition to formal education, technology provides opportunities for informal education through various courses, books, articles and other educational digital materials. Introduction of technologies in rural areas solves the problem of access to education and opens up new opportunities for the people who live there. If they use this opportunity to learn new things and develop new skills, the locals can become more productive, and therefore more competitive on the labour market. This also gives the adults an opportunity to retrain and eventually improve the economic status. Given the fact that the availability of information is significantly greater, villagers can also acquire new knowledge that can help them work on improving their living conditions (OECD, 2020). Rural schools are usually not equipped with modern laboratories, which prevents rural students from taking

advantage of the practical way of learning. However, with the help of digital technologies, schools and students can access so-called simulated laboratories (Bhute et al., 2021).

Culture: Access to the Internet allows the village inhabitants to access various cultural events online. For example, many museums and galleries offer the possibility to access some contents online. This allows the population of rural areas to keep up with cultural events in the world and to not be completely isolated. In addition to consuming cultural content, technologies allow people to create cultural activities and content themselves, learn about them, and share them with the general public. Also, thanks to ICT, all cultural events and manifestations organized in the village can be advertised and thus reach a significant number of potential visitors (Stratigea, 2011).

Environment protection: Technological innovations encourage innovations in various fields, including the field of environmental protection. Today, there are technological solutions that reduce the negative impact of humans on the environment through the optimization of the use of resources and thus contribute to a more sustainable future (ECLAC, 2021). Environment protection in rural areas is important for preserving rural ecosystems, communities, and the health of our planet. Smart technology solutions are playing an important role in supporting rural environments through improved monitoring, data collection, and conservation efforts. Such solutions are mainly focused on increasing the efficiency of resource usage, waste reduction, and energy efficiency. For example, solar energy can be used for producing the electricity in rural areas, so the need for burning fossil fuels is lower, water filtration systems can be used for reducing the need for chemical treatments, recycled materials and renewable energy sources reduce the carbon footprint of the village, etc. Smart solutions directed toward environment protection are an important step in creating more sustainable future. Utilizing renewable energy sources, reducing energy consumption, improving waste management systems, and planting trees and other vegetation can help with the protection of the environment and the promotion of sustainability *(*Bee Smart City, 2022; ECLAC, 2021).

Waste management: As the population and the consumption of goods grow, and with it the amount of waste, waste management becomes more and more important. According to the World Bank, of the total global waste only 19% is recycled and 11% is used for energy recovery, the rest 70% ends up in landfills and dumpsites (Kaza et al., 2018). Traditional methods of waste collection in rural areas is often not that efficient and, even more important, it is not safe for health of living beings (Degada et al., 2021). To reduce the abovementioned issues and to improve waste collection and create a healthy community, investment in advanced waste management technologies must be considered. As in many other areas, the use of smart technologies provides significant benefits in waste management. Technologies such as waste segregation, methane capture, aerobic digestion, composting, and anaerobic digestion can be used to reduce waste and increase resource recovery. Tracking the waste collection is possible via Smart bins equipped with sensors which enable efficient routes and schedules for waste pick-up. This reduces the number of times public service is obliged to

pick-up the waste. Smart technologies can help create cleaner and healthier rural areas, while also improving the overall quality of life for the residents *(*BigRentz, *2021*).

Mobility/Transportation: Transport connectivity is a very important factor that affects the quality of life in the rural areas, and indirectly the decision of young people to live there. However, this also represents one of the biggest problems faced by the inhabitants of rural areas, especially those areas with high dispersion (Ristić & Bošković, 2020). Technology solutions for rural mobility have the potential to improve transportation options for rural residents, bridge the gap between urban and rural areas and promote sustainable transportation. These solutions can include ride-sharing platforms, electric vehicles, autonomous vehicles, telematics and improved public transportation technology. The solution that is used more and more is ride-sharing platform. This platform serves to connect people in rural areas who need a ride with those who can provide it. This allows people to move from one place to another even when they do not own a vehicle. There are various platforms which provide such services, e.g., blabla.com, prevoz.org and similar (Żukowska et al., 2023).

When it comes to public transportation, this service in rural areas is often scarce and infrequent. Technology can improve this service by using real-time information systems, for example. This can provide live bus and train timetable data as well as route optimization technology to improve the efficiency of public transport services. Other solutions are shared bicycles, electric bicycles, and scooters. Bicycles are the most cost-effective and sustainable form of transport in rural communities. Another solution for rural mobility is the use of autonomous vehicles. Autonomous vehicles have the potential to reform transportation not only in rural areas, but wider. These vehicles can be used for a variety of purposes, such as providing transportation for people who are unable to drive, or for delivering goods to remote areas. Technology solutions such as smartphone applications, can provide information about transportation options and routes, as well as real-time updates on traffic, weather, and other local conditions. They can also be used to book rides and find the best routes for a specific trip. Implementing these solutions can help reduce the burden of transportation on rural populations and help them access the resources they need (Żukowska et al., 2023).

Tourism: Rural tourism is growing as an industry and the use of new technologies is playing an important role in its development, and technologies are being used to help promote, market, and manage rural tourism businesses. Technologies that are widely used in rural tourism are the internet and social media. These tools can be used for the promotion and marketing of locations and can also be used for online booking and reservations. So, for example, services like Uber and Lyft allow travellers to easily book transportation, while Booking and other sites are used for accommodation booking. Additionally, strong online presence can attract more visitors to a rural area by providing information about local attractions, events, and accommodation options. Also, through the Internet and social networks, tourists get a large amount of necessary information that can help them make travel decisions more easily. Also, thanks to the virtual reality and 360-degree videos,

tourists can have a showcase of the attractions and experiences offered in a rural area (Kumar & Shekhar, 2020). Another technology that is used in rural tourism is Geographic Information Systems (GIS) which enables the mapping and analysis of geographic data, which helps tourism operators and planners understand the potential of a specific area for tourism development and to make informed decisions about tourism investments (Wei, 2012).

Social networking: Technology can play an important role in improving the quality of life for those living in rural areas. By adopting innovative technology solutions, rural communities can access resources that can help them connect better with each other and with the outside world. As already mentioned, the condition for usage of technology is to provide rural areas with access to reliable and fast internet and proper equipment. This can enable rural communities to stay connected with their family and friends, access educational and career opportunities, and access services such as health care (OECD, 2020). Additionally, it can also provide access to social media platforms and other online outlets, which can facilitate communication and socialization. For example, online platforms can be used to organize local events and activities, such as potluck dinners and outdoor activities. This can help foster a sense of community and bring people together.

Another increasingly popular solution is also digital hub. Digital hubs are physical spaces where people have access to computers, internet access, and digital literacy trainings. Rural digital hubs can be an important tool for improving social life in rural areas. By providing access to technology and digital learning opportunities, rural digital hubs can help bridge the digital divide between rural and urban areas and allow rural communities to become more connected. This can facilitate greater access to services, resources, and opportunities, which can help improve quality of life. Additionally, digital hubs can provide a space for community members to come together and engage in meaningful activities, such as workshops and seminars, which can help build relationships, foster collaboration, and create a sense of community. Finally, digital hubs can increase access to educational resources and job training programs, which can help reduce unemployment, poverty, and other social problems (Ashmore et al., 2019). By improving access to technologies and internet, more people will consider the particular rural area for touristic visit or even for living. This has the potential to increase the population in the area and therefore improve social life.

4 EXAMPLES OF SMART VILLAGE CONCEPT IMPLEMENTATIONS

4.1 Examples of smart villages outside EU

The development of rural areas in relation to urban areas is gaining more and more attention. This is not surprising, considering that the development of rural areas is one of the key elements of the 2030 Agenda for Sustainable Development. Urban development is still more popular, but this trend is changing and is yet to be changed. As already mentioned, the

concept of smart villages appeared as one of the strategies for rural development (United Nations, 2021). Today, there are already many examples of rural areas in the world that have implemented some of the smart solutions in different areas. Some of the smart solutions are described below.

The examples are selected based on two criteria: first, that the projects described through the examples are feasible in the selected village, and second, that the described projects have already been completed and that their effectiveness has been proven through a real example. In addition, the goal was to cover as many areas as possible in the village using the presented examples. Therefore, solutions from the fields of agriculture, tourism, public services, education, environmental protection, local commerce, waste disposal, energy supply, and the social sphere were presented. Considering the importance of motivation for the use of smart solutions by the local people, this topic is covered through a couple of examples, where local people were encouraged to participate in the implementation and use of the solutions.

Xibaidian Village, China

China is a country that pays special attention to the development of rural areas. One of the projects created in that direction is the "Smart Countryside" model. The main focus of this model is on the use of modern technologies for the transformation of agriculture and the promotion of villages and farmers. The model is applied throughout China, and one of the cases worth mentioning in this thesis is Xibaidian Village in the Pinggu District. With the application of smart (mainly IoT) technologies, Xibaidian Village has managed to integrate e-agriculture, e-commerce and e-government into rural life, production, business, and ecology (Chen, 2018). This was achieved by implementing a system for smart monitoring and management of agricultural production and agricultural products. Sensors for collecting information about humidity, temperature and composition of soil and air are installed in as many as 42 greenhouses throughout the village. This has enabled real-time data monitoring and therefore more precise crop control, which can lead to increased yields, improved quality, and reduced risk of crop failure. Some of the greenhouses have also introduced video surveillance and remote control. Video surveillance allows monitoring crop development over time and planned further measures, while remote control saves time and resources. This data is useful not only to the farmers who implemented this solution, but also to other farmers in that region (Zhang & Zhang, 2020).

Taishun County, China

One interesting technological solution in the field of tourism was implemented in Taishun County. Taishun County is Chinese rural area positioned in a mountainous area, which allowed it to preserve most of the cultural-historical objects and relics during the wars. However, today the danger is a little different and lies in the fact that young people are less and less interested in preserving cultural heritage. This is a problem that surely requires a solution, and Taishun County saw the solution precisely in modern technologies, integrating

two very important areas into one, which are the preservation of rural culture and cultural resources, on the one hand, and the development of tourism, on the other hand. The concept relies on the help of 3D technology and holographic images which place the tourists in re-enactments of the real scenes from ancient history. This not only increases the interest of tourists to visit the place, but also helps them understand and preserve the cultural heritage. This solution attracted as many as 200,000 tourists in 2020 alone (Zhao et al., 2022).

4.2 Examples of smart villages in EU

According to Eurostat (2023) for 2021, rural areas represent almost 45% of EU territory and around 21% of its population lives in rural areas. However, in the period from 2015 to 2020, the rural population decreased by about 0.1% annually, while the population in urban areas grew at a rate of 0.4% annually. Therefore, it is not surprising that rural areas are of particular importance for EU member countries. When we look deeper into the structure of the population that leaves or stays in the village, the situation becomes even more serious. The share of the elderly population increased in rural areas and decreased in urban areas, while the situation with working age (20-64 years old) and young people (less than 20 years old) was reversed. In rural areas, the working-age and youth population declined by 0.6% and 0.7% respectively, on average each year, from 2015 to 2020.

In order to mitigate the trend of depopulation of rural areas, some efforts must be made to improve their living conditions. However, modern conditions require that rural development should be planned and carried out in accordance with the global trends and that it must not lag behind urban areas. To achieve this, rural areas must efficiently use the resources they have, which means applying innovative methods to solve current and emerging economic, sociodemographic, and environmental problems (Ristić & Bošković, 2020).

When it comes to the EU, the concept of a smart village has almost simultaneously become important in the political and academic scene. On the political side, the Cork Declaration of 1996, and Cork 2.0 Declaration of 2016, by which the European Commission laid the foundations for the development of the concept of smart villages in the EU, should be highlighted. Since 2018, the European Parliament has continued with this trend, which further develops the very idea of smart villages, points out their importance and even presents development political strategies, in the Bled Declaration. On the other hand, the academic contribution to the topic of smart villages started as an upgrade to the story of smart cities, while respecting the differences between rural and urban conditions, especially referring to the problems rural areas face in relation to urban areas (Visvizi, 2019). Nowadays, there are several smart village projects in EU. The following is a brief description of some of the examples of a good practice.

Ciugud, Romania

Romania is also among the EU countries that are in the process of vitalizing rural areas. The concept of smart villages emerged as one of the strategies for achieving that. Therefore, this concept has gained attention in Romania and there are already several projects, e.g.: Boghis, Saschiz, Balasesti, Corunca, Manastiur, Selimbar and Snagov. In 2022 a survey was conducted, according to which Ciugud was declared the best example of smart village practice in Romania. The village already has eight implemented projects, mostly in the field of public services, environmental protection, education and innovation, as well as encouragement of the local economy. The solution implemented in the field of public services, which has a positive impact on the environment as well, is based on the almost complete abolition of paper in the provision and use of administrative services. Software solutions are used for services such as paying taxes, uploading and downloading documents, reporting problems, and the like. So, for example, to pay taxes, residents can use the national platform, the digital services platform of the municipality, payment machines placed in certain places in the municipality, as well as the mobile application. In order to reduce the need for administrative personnel, as well as for paper, certain financial incentives were introduced for all residents who use smart solutions to obtain administrative services. With this, the municipality managed to attract as many users of public digital services as possible. According to data from 2021, smart solutions were used for as many as 85% of total payments (Barbut, 2022).

Another important project is the opening of a smart school. The school is considered smart in two aspects. Smart solutions are used for energy consumption, air conditioning and maintenance, but also for teaching. The school is equipped with a smart laboratory where various innovative solutions are tested, and the classrooms have interactive whiteboards. It is the first rural school in Romania where students use VR glasses and headsets to follow the lessons that take place in smart laboratories where the teaching is fully interactive. This project aimed to reform teaching in rural areas (Barbut, 2022).

The third implemented solution is in the field of environmental protection, but also collective awareness of the locals. Namely, the locals were rewarded local digital currency for each recycled garbage. They could later spend the currency in local stores, which also participated in the project. Currencies are also used to collect data on recycled garbage, which is later used in additional analyses relevant to the municipality. In addition to this, the village also promotes green transportation. A couple of electric cars charging stations are installed in the village. Another solution, developed during the Covid19 pandemic, is an online platform for selling local products. This platform serves to help local small producers, who, during the pandemic were faced with the impossibility of selling their products in the traditional way, due to the risk of the spread of the virus (Barbut, 2022).

A very important step in the process of transforming the village into a smart one was introducing the locals to smart solutions, as well as encouraging their use. A mentoring

program was implemented, which aimed to teach the villagers how to use the applications. In addition, the village issued a so-called "citizen's card" to make it easier to register and use public services. This later became an example of good practice for villages in Germany, Poland, Moldova, and others (Barbut, 2022).

Betzdorf-Gebhardshain, Eisenberg and Göllheim, Germany

One well-known pilot project of good practice exists in Germany. Germany is one of the many countries in the world where rural areas face the problem of depopulation. In response to these problems, the Fraunhofer Institute for Experimental Software Engineering (IESE) launched the "Digital Villages" project in 2015. The goal of this project was to find digital solutions that would help overcome the problems that rural areas face on a daily basis, with a special focus on alleviating the problem of physical distance between people. Three municipalities in Rhineland-Palatinate were selected as pilot municipalities: Betzdorf-Gebhardshain, Eisenberg and Göllheim, but the solutions that were developed during this project are also available to other municipalities (Trapp & Hess, 2020).

The applications focused on local commerce, communication, and voluntarism. BestellBar application was created in the area of local commerce. Together with the LieferBar app, it enables sustainable local supply through a combination of promoting and selling local products and volunteering. BestellBar is actually an online marketplace, while LieferBar is a delivery app. The system is based on selling local products through the BestellBar application. It is possible to sell food, but also other non-food products, as well as services. At the moment when the customer registers the purchase, it is automatically transferred to the LieferBar, where people traveling along the given route can pick up the products and deliver them to their owners, or bring them to one of the parcel terminals, where the owners can pick them up. As a reward, they receive certain points, i.e. DigiTaler, which is a virtual currency that they can spend within their community. However, it is important to note that this is not the only motivation. In addition to points, volunteers also get the opportunity to meet other people, as well as the feeling that they are doing a good deed (Trapp & Hess, 2020).

Another application, which brings a solution in the field of communication, is Dorf News, i.e., local news portals. The application serves to inform citizens in a timely manner about important events, current projects, working hours of institutions, the latest news and various other topics that may interest them. DorfNews is complemented by DorfFunk and together they form a platform which connects citizens with the municipality, but also with other local organizations. In addition to informing citizens by the municipality, the application also provides the opportunity for residents to forward their feedback, remarks, and suggestions directly to municipal officials, thus enabling them to actively participate in making important decisions in their environment. Interactivity makes applications even more interesting and increases the motivation of locals to use them (Trapp & Hess, 2020).

Košeca, Slovakia

Rural areas around the world face the problem of solid waste disposal. The amount of waste in the world is increasing, and if it is not disposed of properly, it poses a danger to the environment (Vinti & Vaccari, 2022). One Slovak village, Košeca, has struggled for years with the problem of inadequate waste disposal and the motivation of residents to recycle waste. Back in 2008, the village opened a recycling centre, but the amount of waste being recycled was still at an unsatisfactory level. In 2019, the village hired a private company to create a waste tracking system - ELWIS. ELWIS is a sustainable waste management system consisting of sensors, RFID chips and QR codes. The system works in such a way that every household gets a sticker with a QR code when properly disposing of waste. On the other hand, the containers have built-in chips that utility company workers can scan using smart watches they receive from the municipality. This allows the municipality to have insight into the amount and structure of produced waste, as well as the percentage of recycled waste per household. This data is later considered when calculating the costs for waste removal. Thus, the more the household recycled and was responsible, the lower its waste disposal cost. Even the most reluctant residents were encouraged to use this system. Of course, in order to make the use of the system successful, the training for workers who work on waste collection was organized, as well as a campaign aimed at informing residents about the system and its advantages. The result of all these activities is that the village of Košice now has less unrecycled waste, which makes the village more suitable for living, while responsible citizens pay lower bills. In such a way, progress is achieved in both ecological and economic aspects (Smart Rural 21, *n.d.*).

Luče, Slovenia

Luče is a rural tourist municipality in the Savinja region, which for years faced the problem of unstable electricity supply. Today it is the first energy community in Slovenia. In response to the energy issues the community was facing, the COMPILE project was launched in 2019 with the aim of making Luče an energy self-sustaining community. The system includes a renewable energy source, microgrid, and smart meters to optimize energy production, distribution and consumption. The main objectives of the project were: benefits for as many stakeholders as possible, more stable and safer energy production and distribution, decarbonization of the energy network, as well as independence from centralized energy systems. The project gathers several stakeholders, local government, active consumers, as well as DSO (Distribution System Operators), and is supported by 12 European and 2 global partners. As in any other smart village project, a very important step was to familiarize the residents and local authorities with the project and raise their interest in participation. This was done through workshops aimed at raising awareness of energy savings, as well as the environmental and economic benefits of the project. The goal of this phase was to turn passive users into active users who participate in the implementation of the project and who represent a link in the entire system (Jereb & Artač, 2019; Šalamun 2020).

Figure 4: Transformer station (left) and system battery (right).

Source: Cvjetović & Kovač (2021).

From a technical point of view, the solution consists of several components that together form one system. 102 kw of solar production units, 5 house and 1 community battery, as well as a vehicle charging station were installed as part of the project. The existing transformer station has been renovated and adapted so that it enables energy management via a microgrid controller. In addition to management, the microgrid also has the role of collecting data on energy consumption and production. This data is then sent to the IoT platform, Tango, and used in machine learning models, for making predictions of energy production and consumption and thus enabling preventive action and efficient management of energy use. Excess energy produced during the solar period is stored in batteries and can be used when needed (see Figure 4). With the help of smart management, greater reliability was achieved, as well as five times more efficient production of electricity (Jereb & Artač, 2019; Šalamun 2020).

The greatest importance of the project is that Luče is now an energy self-sustainable village that can cover its own energy needs. In addition, progress has been made in the area of the environment by enabling energy saving, obtaining energy from renewable sources as well as carbon-free electromobility. However, we should not ignore the fact that this project is a testing project and an example of good practice, which will spread the good influence beyond the borders of the village of Luče (Jereb & Artač, 2019; Šalamun 2020).

5 CURRENT STATE OF RURAL DEVELOPMENT IN THE REPUBLIC OF SERBIA

5.1 Current state of villages in the Republic of Serbia

The abandonment of the countryside began at the end of the 19th century and reached its peak at the end of the 20th century, and the main reason for this situation is industrialization, which led to greater employment of people in cities. Agriculture was also mechanized, so a smaller number of workers were needed in the countryside. The rural areas of the Republic of Serbia are in the process of disintegration and disappearance. Although there are still villages from which the population has not yet migrated to the cities, local communities have remained without integrity. The reason for this is the lack of applications and programs for revitalising rural areas, especially in the field of culture and socialisation, as well as a series of historical events, such as de-agrarization and industrialisation. Also, it is important to note that there is a big difference in the development of villages in the south and north parts of the country (Stanišić, 2017).

Veličković and Jovanović (2021) highlighted key challenges the rural areas of the Republic of Serbia face, including population decline, youth migration due to harsh living conditions, inadequate infrastructure, and limited social services. Usually, unfavourable educational structures in rural areas hinder the adoption of technological solutions that could potentially facilitate living in rural areas. The rural economy of Serbia is closely tied to natural resources, including agriculture, mining, and energy, which contributes to the degradation of natural resources in villages, such as inadequate use and pollution of water, unregulated soil treatment, deforestation, waste contamination, reduced biodiversity, etc. In most Serbian villages, agriculture is the primary income source, yet small farms struggle with income reliability, resulting in widespread poverty and high unemployment. In addition, poor institutional support in terms of inadequate strategic planning for rural development and insufficient funding of projects significant for rural development only deepen the problem of poverty and insufficient economic development of rural communities. Finally, Serbian rural areas are characterised by insufficiently developed road infrastructure and limited transportation options, which limits the village's connection with the surrounding areas, isolates its inhabitants, and negatively affects its standard of living.

Villages in the Republic of Serbia are different in the aspects of natural, economic, infrastructural, and other spheres of life and work, which further, through influence on the quality of life and work, also affects demographic trends, and therefore requires a different approach in terms of economic, social, environmental, and cultural development (Ristić & Bošković, 2020).

5.2 Pioneers in self-sufficiency and digital advancement

Although the concept of smart villages is still not sufficiently developed in the Republic of Serbia, an example of a self-sustaining village in the country can be found in the municipality of Kosjerić. It is the village of Seča Reka. Due to the climatic and terrain characteristics of this village, the predominant activity of the inhabitants of this place is agriculture. Due to all the efforts invested in the arrangement of the road network, the arrangement of the water supply network, the arrangement of the electricity network and telecommunications, this village can be considered self-sustaining. Namely, the construction of the infrastructure in this place was financed by the investments of the inhabitants of the village and the municipality of Kosjerić. Economic self-sustainability is based on the improvement of agriculture, primarily through the intensification of raspberry and blackberry fruit production. In addition, there are several cold stores in the village, a healthy food production system has been developed, and a number of tourist and cultural events is held in the village (Jovanović & Gavrić, 2018). All the above, along with the fact that local residents are actively involved in the development of the village, indicates that this village has the potential to develop into one of the smart, self-sustaining rural areas on the territory of the Republic of Serbia.

Another positive example of a village on the territory of the Republic of Serbia is the village of Krivaja, next to Bačka Topola. The first digital farm in Serbia, and in the region, was opened in this village. The farm was designed by the BioSens Institute in cooperation with the agricultural producer Krivaja d.o.o. and was financed by the European Commission and the Government of the Republic of Serbia. The most modern digital technologies are used in daily work on the farm: sensors, drones, robots, satellites, modern agricultural machinery. In order to enable farmers to learn more about the potential that digitization, i.e., new technologies, provide to the agricultural sector, open days are organized. Here, locals can learn how to save on resources (seeds, fertilizers, water, human and machine labour), how to contribute to the reduction of risks related to production and weather conditions, and how to increase yields. Visitors have the opportunity to see and test various devices, systems and machinery for precision agriculture and to learn more through direct contact with farmers who already use the latest technologies, as well as through contact with the scientists of the BioSens Institute, present their problems and work together to find solutions that will improve their production. Although only a digital farm has been formed by now, the plan is to evolve it into a digital village in the future (BioSense Institute, *2022*).

One more positive example of the village is Vrmdža. Vrmdža is a town in the Zajecar Administrative Region of the Republic of Serbia and is a part of the Sokobanja Municipality. With more than 1,500 residents living in the post-World War II era, this area had a depopulation trend during the second half of the past century. The latest official population count (2011) indicates that 497 people live in this area. Nevertheless, during the past decade, this trend reversed and there is a high possibility it will keep the positive course in the years to come, considering the fact that the new inhabitants are mostly young couples. It is

estimated that by 2020 the village counted 580 inhabitants. The village itself offers a lot of possibilities for tourists. Vrmdža is home to several historical sites because it is one of the older villages in this area. The proximity of one of the most popular mountains in Serbia, Rtanj, makes this place even more attractive for tourists. In addition to the tourist potential, the village also has agricultural potential, and the Rural Hub, which was created in 2010, makes it especially attractive. The Rural Hub in the village of Vrmdža is a multifunctional complex that serves as a centre for various kinds of activities and resources for the locals. The hub seeks to enhance the quality of life and encourage rural development. One of the Hub's most notable efforts is the development of an interactive map called "Through Vrmdža and Centuries," which serves as a virtual tour guide for this village's landmarks and history. Residents, students, and professionals all worked together to implement the project. The mobile app for the interactive map can be downloaded from the Google Play Store, but it can be used online as well. Accommodations for the entire Sokobanja municipality are available on the website, which is available in 7 languages. Every year, Vrmdža offers many cultural and tourism-related events that draw a lot of visitors, and all the details are posted on the website. The strategy they advocate in Vrmdža is called the "Rurban" strategy, and it combines cutting-edge technology with traditional approaches in order to find a balance in people's lifestyles and economic endeavours. This blending of urban and rural culture, conventional and modern knowledge, and cooperation between various generations and backgrounds produces beneficial results, such as an enhancement of rural tourism while offering local population job opportunities (Manasijević et al., 2019).

6 ANALYSING THE POTENTIAL FOR IMPLEMENTING SMART VILLAGE CONCEPT IN THE MRSAĆ VILLAGE

6.1 Village description

The village of Mrsać is located in the valley of Zapadno Pomoravlje. Administratively, it belongs to the Raška district and is part of the Municipality of Kraljevo. According to the population census conducted by the SORS (2011), the village had a total of 1307 inhabitants and 404 households in 2011. Mrsać covers an area of 1,712 hectares, with agricultural land occupying the most significant share- 44.5% - while meadows occupy 18.72%. Only 25 households and the local school are connected to the water network, which was built with private funds, while the rest of the households are supplied with water through pumps and wells. The village has an elementary school and an ambulance, a cultural centre, a sports centre, and a local community building (Poreklo, 2017).

The village occupies the area of the river terrace on the right side of the Zapadna Morava around the confluence of the Mrsać River and the Čađavac Stream. The surrounding villages are Adrani, Jarčujak, Musina Reka, Samaila, Bapsko Polje and the Morava River. An asphalt road passes through the village, which connects it with the main highway Kraljevo – Belgrade (Poreklo, 2017). The village is located in the immediate vicinity of Lađevac, only 9.6 kilometres away. This settlement represents a geographical position of strategic

importance, where the Morava military and civilian airports are located. Mrsać is connected to the urban centres of Kraljevo and Čačak by a railway that transits through this settlement. Additionally, the planned passage of a section of the highway known as the Moravian Corridor through this village indicates its important role as a direct link between Corridors 10 and 11. This infrastructure segment will promote the improvement of internal traffic connections, facilitating fast and efficient connections between the western, southwestern, southern, and southeastern regions of Serbia. In a broader context, the upcoming Moravian Corridor will be an integral link in improving regional connectivity with Bulgaria, Greece, and Turkey (Goran, 2022). All the mentioned characteristics point to the exceptional potential of the village of Mrsać for improvement of infrastructural, economic and trade activities in the regional and international framework.

6.2 Research methodology and data analysis

I used survey questionnaire and interview as research methods for the empirical part. The questionnaire consists of 26 questions, and the first four are demographic. The second part aims to determine the residents' satisfaction with the current situation in the village. In this part, I asked them to evaluate the services they receive in the village, identify the main challenges they face, and assess the main resources of Mrsać they can rely on. In the second part, I examined their attitude towards technologies and their willingness and ability to use them. The third part of the questionnaire aims to investigate awareness and adoption intentions of smart village solutions. Finally, the last question aims to identify priority areas in the village for implementing smart solutions. This part is important because the success of the smart village project and the successful use of technologies require stakeholders' motivation and active participation, so their opinions and needs must be prioritised.

A significant part of the questions arose from a detailed review of the relevant literature, which allowed me to identify key aspects of the topic and identify pre-existing patterns, theoretical concepts, and research approaches. I designed some questions based on my specific research interests to obtain answers that would help me understand the situation in the village in more detail. The integration of these different sources allowed me to develop a comprehensive set of questions that will be the basis for guiding the research process. Most of the questions are of the closed type, some are multiple choice, some are dichotomous, and some are in the form of a Likert scale. However, there are also some open-ended questions, in case I missed some important aspects. These types of questions also allowed participants to enter some answers I could not anticipate during the making of the questionnaire.

I selected the participants by random sampling. The survey was created in both digital and paper format. For the digital format, I used Google Forms. I posted the link to the digital survey on the village's Facebook page and forwarded it to acquaintances, who forwarded it to their acquaintances. I got 32 responses using this method. In order to get input from people who do not use technology for some reason, I opted to have the survey also in paper format. However, I was only able to get three responses via the paper survey.

As the second part of the empirical part of the thesis, I conducted interviews with village representatives to get additional information about the characteristics of the village, current projects and plans for the village, as well as the challenges and potentials of the village. Also, they were asked for their opinion regarding possible challenges in implementing smart village projects.

Like the survey questionnaire, I generated the interview questions based on the literature review and my specific interests. Some questions were repeated from the survey questionnaire to compare the opinions of residents and local leaders. The goal was to identify potential gaps between the real needs of locals and the leaders' opinions and plans. All but the last question are open-ended. The last question is a closed type in the form of a Likert scale, where the respondents ranked the challenges in the implementation of the smart village project on a scale of 1 to 5.

An interview was held with two representatives of the village, with the President of the local community board and an activist in the local community. First, I came across the President of the local community board and went to the other interviewee on his recommendation. Both were asked the same questions from the previously defined questionnaire, and I had made separate calls with both of the respondents. Additionally, available documentation about the village is reviewed to gain necessary information about the village's characteristics.

Table 3: Demographic profile of respondents

Parameters	**Share (in %)**
Age	
▪ Under 20	28.6
▪ 21-40	45.7
▪ 41-60	14.3
▪ 61 and above	11.4
Gender	
▪ Male	37.1
▪ Female	60
▪ Undeclared	2.9
Education	
▪ No formal education	2.9
▪ Primary school	22.9
▪ High school	37.1
▪ College education	34.3
▪ Other: (Master studies)	5.8
Occupation	
▪ Employed	54.3
▪ Unemployed	14.3
▪ Retiree	8.6
▪ Student	22.9

Source: Own work.

A total of 35 respondents responded to the invitation to participate in the survey and contributed to this research. Their demographic profile is presented in the Table 2. I could not find official up-to-date data for village population. However, according to one of the interviewers, who participated in the latest census conducted at the end of 2022, the number of residents has decreased from 1307 (as it was in 2011) to 1100. These data is not yet publicly and officially available, so should be taken with caution. The latest available data on the population structure of the village of Mrsać are from the 2011 census (SORS, 2011). According to these data, most residents (30.45%) fall within the 41-60 age range and are followed by the group aged 61 and above, which constitutes 27.08%. Individuals aged 21-40 were 23.79% of population, and those aged 20 and less represent 18.67%. In terms of gender, 50.11% identified as female, while 49.89% identified as male.

6.3 Research results

6.3.1 Inhabitants' satisfaction with the current state of conditions in Mrsać

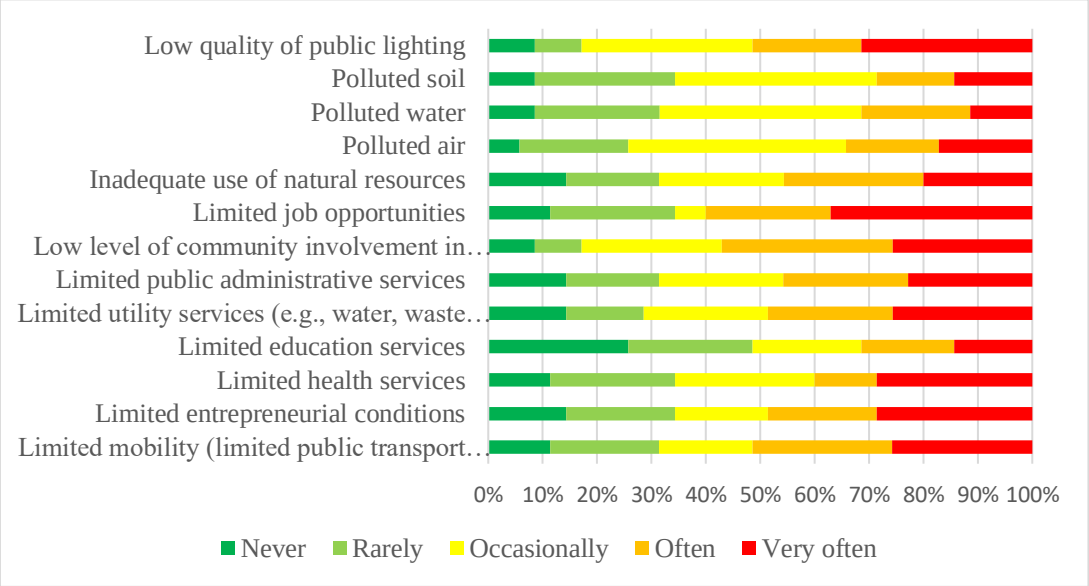
As the purpose of this master's thesis is to analyse how the quality of life in the village can be improved with the help of technology and hence prevent people from leaving the village, first I wanted to analyse people's attitudes towards the village and life in it. The results showed that more than half of the respondents, 51.4%, are dissatisfied with life in Mrsać, while only 25.7% are satisfied, and 20% are neutral. On the positive note, 60% of respondents stated that they would continue living in the village. I isolated all the respondents who were not sure, and the respondents who said that they would not continue their lives in the village, and the result showed that 57.2% of them would continue their lives in the village if living conditions improved, 21,4% were still not sure and 21.4% would leave the village in any case. Using these questions, I wanted to examine the enthusiasm of the locals towards life in the village. This is important because people and their participation are crucial to rural development, so it is good to see how interested they are in rural life. These results indicate that residents love their village and life in it, regardless of the potential challenges they may be facing. Regardless of possible difficulties, this positive connection with rural life indicates a strong sense of community and loyalty to the place where they live. These feelings represent a valuable resource for initiatives and solutions aimed at improving the quality of life in rural areas.

With the next set of questions, I wanted to examine the residents' satisfaction with different services, which can indicate specific problems and deficiencies in infrastructure and management, which is crucial for identifying priorities in rural development projects. Understanding the needs and expectations of the local population enables more effective planning and implementation of measures that will improve living conditions and strengthen the sustainability of rural communities. Most residents in the village express dissatisfaction with the quality of all services. However, they are particularly dissatisfied with waste management (74.3%), public transport (60%), and cultural and entertainment programs (62.9%), while the smallest percentage of people (32%) is dissatisfied with energy supply.

Nevertheless, the quality of life is most affected by public transport, with 35.3% of respondents, followed by waste management with 23.5% and energy supply as an essential factor with 20.6%, suggesting that the effective resolution of these issues can significantly contribute to the improvement of the environment and the quality of life of the locals. Cultural and entertainment programs and air pollution control comprise a smaller percentage of priority. These results provide valuable guidelines for directing resources and efforts towards solving critical challenges affecting daily life in the rural environment.

In order to identify the main problems the locals face, I asked three questions. In the first one, respondents had to indicate how often they encounter certain challenges in their village. With the second question, I wanted to see if there are any challenges that they often face, which I did not mention in the previous question. And finally, in the third question they should identify the challenges that impact the quality of life the most.

Figure 5: Assessment of village challenges.



Source: Own work.

The results showed that limited employment opportunities are most often manifested, which suggests the present need for economic revival. Also, many respondents identified the low level of community involvement in public decision-making and limited mobility as challenges that require attention and potential solutions. Limited utility services and a poor entrepreneurial climate also emerged as frequent challenges (see Figure 5). This more extensive analysis provides a deeper insight into the specific aspects that the community faces, laying the foundation for the development of targeted programs and initiatives that could adequately respond to the identified needs.

The results of the second question indicate that I left out an important aspect of socio-cultural life in the previous question, based on the fact that even six out of ten respondents gave answers related to this aspect. All answers are presented in Table 3.

Table 4: Frequently experienced issues

Answers:
Environmental protection
Poor infrastructure
Kindergartens
Extensive political involvement in everything, including this domain.
Bad roads
Poorly addressed sewage issues in some areas
Poor road quality
Poor social life
Loneliness, inadequate cultural and entertainment programs
Better organization of rural cooperatives is needed. Road infrastructure
Youth leaving the village.
Decreasing number of young people in the village.

Source: Own work.

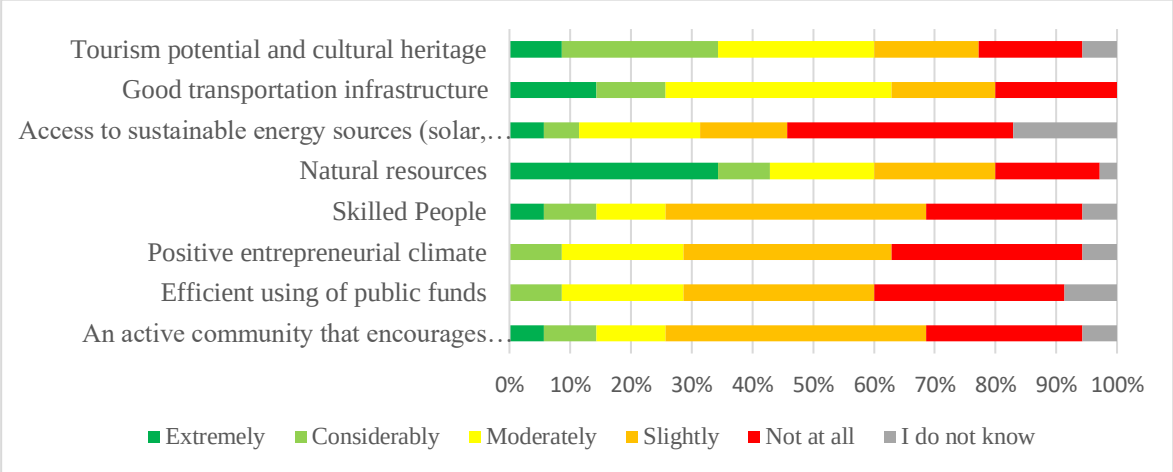
Of all the challenges they often face, limited employment opportunities, limited mobility, and low water quality have the highest impact on quality of life. Following that, limited communal services, low community involvement in public decision-making and low quality of public lighting were also highlighted.

Funding is a critical factor for the success of any project. Insufficient financial resources can prevent even the most innovative plans from being effectively implemented. In the rural context, where financial resources are often limited, the source of funding becomes a vital issue when implementing infrastructure projects, technological improvements, and sustainable initiatives. Having in mind that the villages are financed by the city and municipal budgets, and because these funds are usually insufficient to meet all the villagers' needs, it is important to know whether the villagers are ready to contribute financially to village development or not. Therefore, I found it beneficial to ask inhabitants for their willingness to pay higher taxes for better services. A significant majority, precisely 85.7% of the respondents, claimed they would be willing to pay a higher price for the services they are not satisfied with if they were of better quality. These facts just confirm that people are attached to their villages and municipalities and are ready to contribute to the community they live in.

Another goal of this research is to determine the capacity and potential of the village; that is, to gain insight into the availability of resources that are important for the planning and implementation of smart villages. According to the locals, the primary resources that the village can rely on are natural resources, transportation infrastructure, tourism potential and

cultural heritage. On the other hand, the locals least rely on skilled people and an active community that encourages innovation and development (see Figure 6).

Figure 6: Assessment of village potentials.



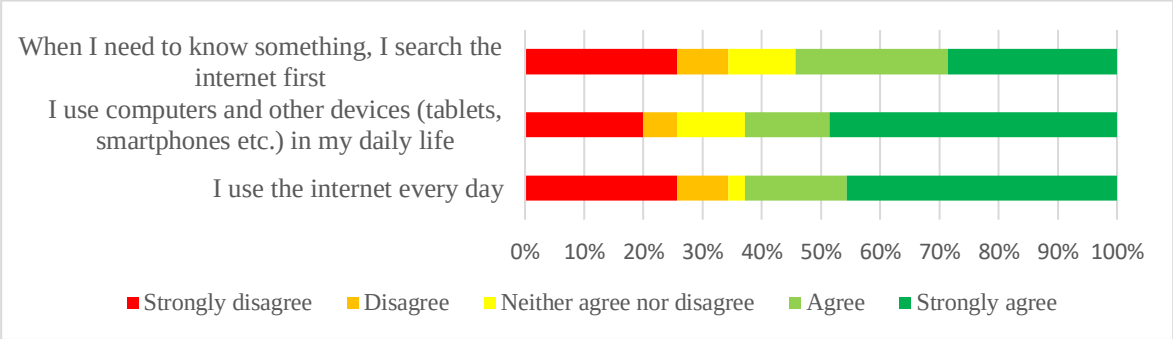
Source: Own work.

Understanding these results is key to tailoring smart village strategies to capitalize on existing strengths. The identified primary resources underline the existing strengths that can be harnessed to advance smart initiatives. On the other hand, it is important to mention again that, in addition to technology, people are the main driver of smart village initiatives. Therefore, engaging the community and nurturing qualified talents are essential for fully unlocking the village's potential.

6.3.2 Attitude towards technologies

As already mentioned, technologies are one of the fundamental driving forces in the concept of smart villages, and therefore, their acceptance and adoption by the locals is of crucial importance. In terms of this, I wanted to see to what extent the locals use technologies, the main barriers and concerns to using technologies, and their attitude towards technologies.

Figure 7: Utilization of Internet and technologies in daily life



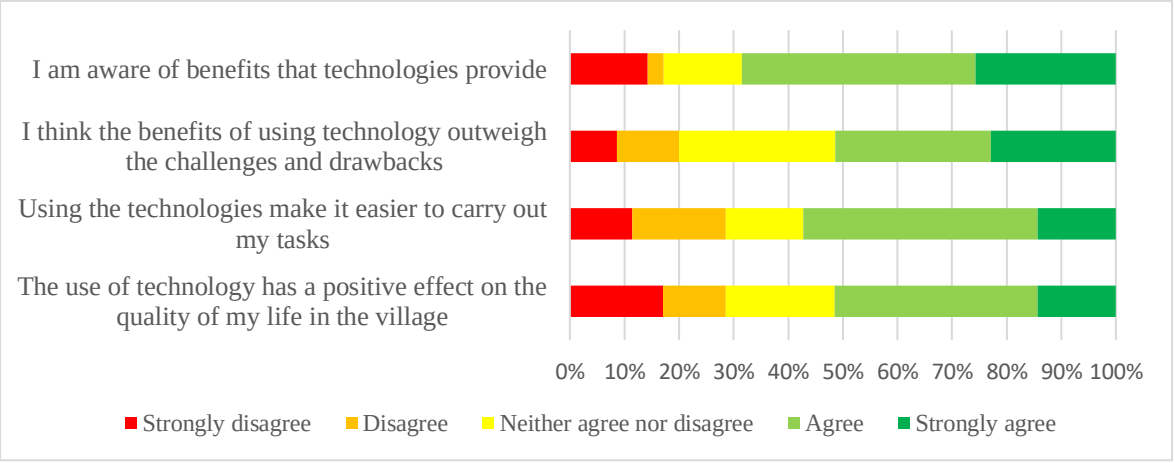
Source: Own work.

In that matters, I wanted to see if they already use the Internet and technologies in everyday life. As it can be seen on the Figure 7, 25,7% of people do not use computers and other devices (tablets, smartphones etc.) in their daily life, while only half of them firstly search internet when they need to find some information.

Further, I wanted to see if there are technical, economic, social, or regulatory barriers in using technologies. Out of the total respondents, 74.3% answered the question by noting that they have access to stable internet connection in their houses. This data is interesting because it closely matches the SORS (2023) data, which shows that 79.8% of rural households in Serbia have internet in their homes. This similarity confirms that the results obtained in the village reflect the general situation at the republic level when it comes to the access to stable internet connection. Furthermore, I asked them if infrastructure limitations prevent them from using technologies, and 20% of respondents answered with "Agree" and "Strongly Agree", while 17.2% were unsatisfied with technical support in the village. Considering that the access to technology and Internet is an important factor in establishing a smart village, these results are a warning that technical barrier can be a first issue this project may encounter.

Access to the Internet and technologies is only a condition for their use. However, it does not imply that people accept and use the technologies and that there are no more barriers to their use. On the contrary, socio-cultural barriers, such as digital illiteracy and lack of knowledge about the advantages of technology, often represent significant challenges in using modern technologies. These social and cultural factors can result in resistance or uncertainty regarding the adoption of new technologies. Therefore, regarding digital literacy, 20% of respondents answered that a knowledge barrier prevents them from using technologies. In comparison, 34,1% of respondents said there are not enough educational resources to help them learn how to use technologies (Figure 8). Those results recognise digital illiteracy as a significant barrier to adoption that requires actions for improvement.

Figure 8: Perceptions of technological benefits



Source: Own work.

Besides digital literacy, I also wanted to evaluate their awareness of the benefits the technologies provide. Based on the results, I can conclude that people have mostly positive attitudes toward technology. However, many are still unaware of all the benefits of technology (Figure 8). This result implies that promotion and communication about technologies is necessary in the village to encourage the use of technologies.

Economic barriers often play a key role in adopting technologies, especially in rural or less privileged communities. Acquiring the necessary equipment, such as computers, smart devices, or other technological tools, can be a significant cost, making technological innovation unreachable to individuals and households of lower economic status. The survey's results indicate that a significant proportion of respondents, precisely 68.5%, perceive the pricing of technical devices as excessively high. Also, 51.4% of the respondents declared that the device maintenance costs are too high. This implies a real concern about long-term financial obligations arising from owning and maintaining technological devices. At the same time, 40% of respondents declared that they do not have enough financial resources for education on the use of technologies. This fact highlights that economic constraints affect not only the physical possession of devices but also access to educational resources that would improve digital literacy. However, less than half of respondents - 28.5%, said that financial limitations are a barrier to using technologies, which implies that they are mostly aware of benefits of technology.

Finally, an important group of barriers are regulatory-institutional barriers. These barriers are related to trust in authorities and technology producers in the context of data and privacy protection. This significantly impacts the acceptance of technologies, as data protection and privacy issues are often key factors in embracing technology. If users perceive a lack of transparency, this can create reservations about using new technological solutions. More than half of the respondents, precisely 51.4%, express worries regarding their privacy while using technologies, with merely 22.8% having confidence in the government's ability to safeguard their data privacy. This places privacy concerns high on the list of barriers of using technology.

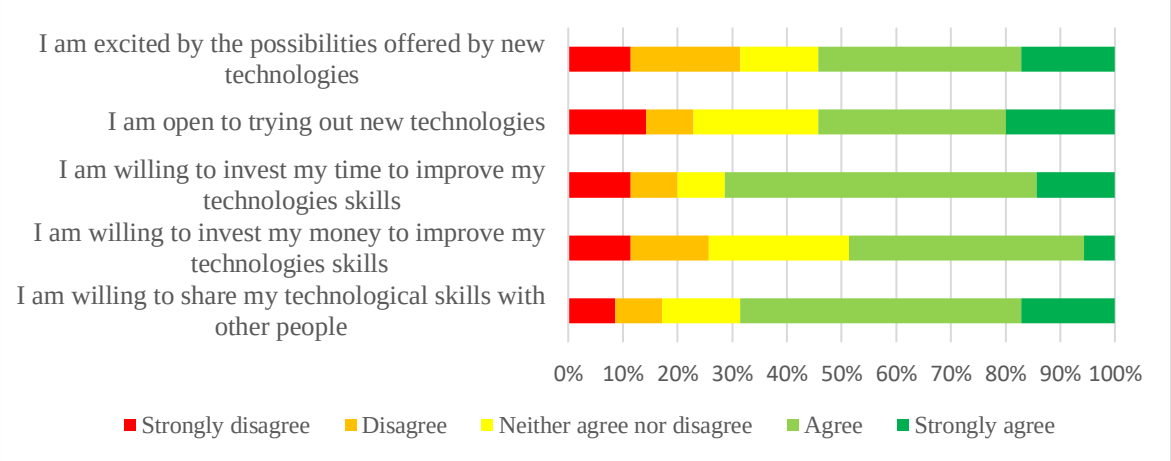
I took the classification of these four groups of barriers from Ferrari et al. (2022). However, unlike Ferrari et al. (2022), where it was concluded that the main barriers to technology adoption in rural areas are socio-cultural, based on the previously described results obtained for the village of Mrsać, I can conclude that the most significant barriers in this village are economic and regulatory-institutional. This is not surprising as each village represents a unique narrative characterised by distinct challenges, potentials, and barriers, emphasising the need for a location-specific approach to understanding the dynamics of technology acceptance in rural areas.

In addition to concrete measures, which will be discussed in the next section, and which are necessary to overcome each of the mentioned barriers and challenges to the use of technologies, it is also important to notice that an enthusiasm for technologies exists. It is

important that people do not have an aversion to technology and learning because in that case, they will be less ready to adopt the concept that relies on technology, such as a smart village. Enthusiasm also plays an important role in inclusiveness, as it motivates people to share their knowledge and experiences with others, thus contributing to the creation of a digitally connected and empowered community.

The following diagram (Figure 9) shows that as many as 31.4% of respondents do not feel excited about technology's possibilities, while 20% of them have no desire to try new technologies. Interestingly, more than a quarter of respondents are not ready to invest money in digital literacy, while 68.5% of respondents declared that they would help others adopt new technologies. Based on these results, I can conclude that people are not enthusiastic enough about the technologies for one reason or another.

Figure 9: Enthusiasm regarding technology



Source: Own work

In the contrast to enthusiasm, there are concerns regarding technology. Among the most frequently cited responses were apprehensions about technology replacing their jobs, compromising their privacy and safety, as well as fostering addiction and undermining social connections. Also, it is important to mention that most common answer was “nothing”, which is a positive result in this case, as I gave them some possible answers in parenthesis, so the possibility that they couldn’t remember any of the concerns is lower (Figure 10).

Figure 10: Main concerns regarding technologies

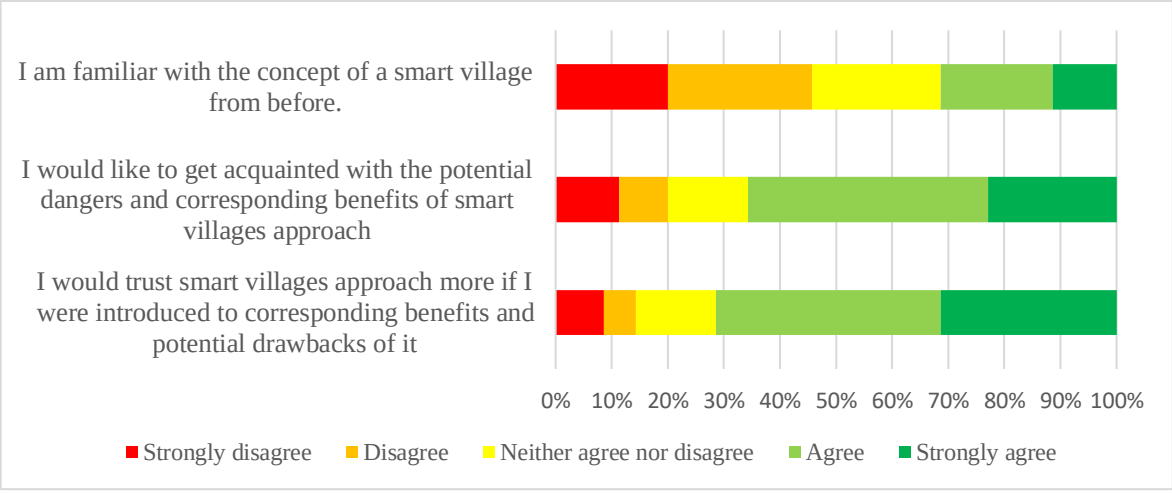
Source: Own work.

6.3.3 Smart village perceptions: awareness and adoption intentions

The fourth part of the questionnaire aims to understand respondents' perceptions regarding smart villages, focusing primarily on the level of awareness and intentions to adopt this concept. I wanted to identify how familiar the respondents were with this approach and whether they are open to adopting smart solutions in their local community. At the beginning of the questionnaire, I briefly explained the concept so that respondents who had not heard of the concept before would get an idea of what smart villages are.

As it presented in the following diagram (Figure 11), I can conclude there is a general lack of familiarity among respondents regarding the concept of smart villages, considering that only 31.4% of respondents had already heard about it. This lack of awareness can be attributed to the limited coverage of the concept of smart villages in the media and everyday conversations. As a result, respondents have limited knowledge about the significance of smart villages and the steps involved in implementing this concept. However, it is encouraging to note that, despite this limited awareness, respondents want to get acquainted with the concept and to understand better the potential dangers and benefits of smart villages. This paradox that involves insufficient awareness and an expressed desire to acquire knowledge indicates the importance of education and information about smart villages. Given the interest (65.8%) in learning about the potential risks and benefits of this approach, the critical question is how to focus efforts on proactively informing the community.

Figure 11: Awareness and interest in smart villages.



Source: Own work.

Additionally, the fact that as many as 71.4% of respondents would show greater confidence in the smart village concept if they were familiar with its advantages and potential disadvantages opens opportunities for developing a targeted educational strategy. Focusing on the transparent presentation of the benefits and challenges of this innovative concept can

significantly contribute to the broader acceptance and integration of smart villages in rural communities.

In the end, I asked two questions to encourage respondents to think about problems that the concept of a smart village could potentially solve. Given the fact that residents are informed the most about local challenges and needs, asking this question allows direct participation in identifying issues that are of greatest importance to them. Also, one of the definitions of smart villages is that it is a participative approach. Therefore, including the locals in every planning phase is crucial, especially in identifying problems. Asking this question encourages thinking about technology's possibilities for solving local problems. It can raise community awareness about the capabilities of smart technologies and create opportunities for creativity.

With the first one, I asked them to write down the specific problems of the village that could be improved with the use of smart technologies. For this question, I was inspired by the research of Xydis et al. (2021), where they asked about the awareness of problems in the municipality that a smart city approach could solve. Their question was of a closed type, where they had to answer the question if they are aware of a municipality problem that could be solved via a smart city approach with “yes” or “no”. As even 55% of their respondents answered yes, I got the idea to leave some additional space for answers to get specific responses and ideas.

However, the most frequent answer I got is "no", which may indicate that respondents may have ideas but do not want to share them or cannot remember them at the moment. Perhaps additional information or incentives would help them think better about potential problems and solutions that could improve the quality of life in their village. However, I also received several interesting answers, which are presented in the Table 4.

Table 5: Perceived challenges addressable by smart village concept

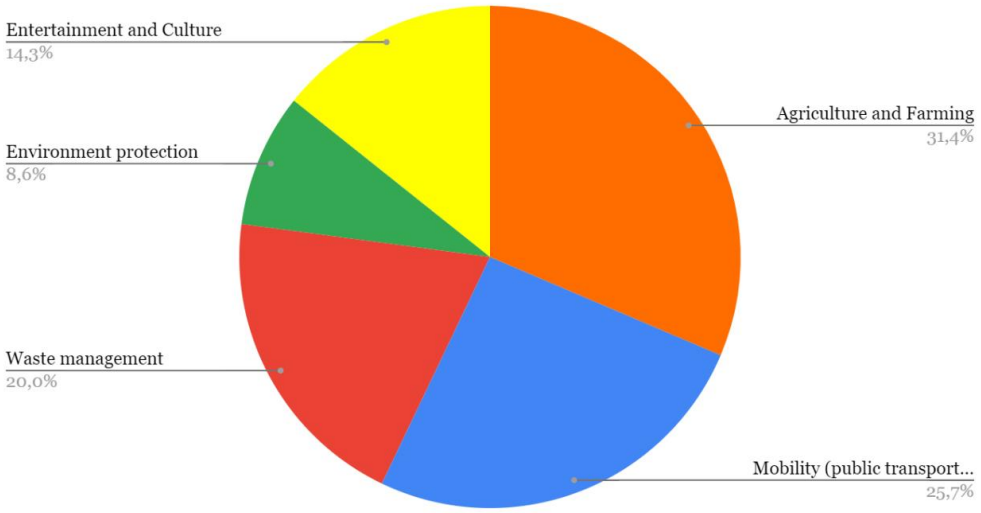
Answers:
Waste disposal
Mutual collaboration of entrepreneurs, farmers, and agriculturalists in marketing their products online.
Agriculture, public services
Limited job opportunities for the youth
Online reporting of violence, selective waste disposal...
Playground renovations, organizing excursions
Waste disposal, mobility
Poor social life and energy supply.

Source: Own work.

With the second question, I wanted to see which area the locals consider the most prioritizing for implementing the smart village solution. The variety of responses is shown in Figure 12. People revealed agriculture and farming as the highest priority areas, which is not surprising

considering that most of the inhabitants is engaged in farming and agriculture. Mobility and waste management follow. These results align with the identified challenges and reflect the need for their priority resolution.

Figure 12: Priorities for implementing the smart village solution



Source: Own work.

6.3.4 Local leaders' perspective: projects, plans, and anticipated challenges

To strengthen understanding of ongoing projects, near-future development plans, and the primary funding sources for the village, I conducted the interview with two village representatives.

As, according to Renukappa et al., (2022), the biggest challenge in implementing the smart village project is the lack of finance, I wanted to check what the sources of finance are and how public funds are managed. I got different answers to this question from both interviewees. The complete responses are presented in Table 5:

Table 6: Sources of finance and public fund management

President of the local community board	"I would assess the financial situation as satisfactory. The village is funded by the budget of the Republic of Serbia and its residents' contributions. The funds are primarily allocated towards maintaining road infrastructure and financing sports and cultural events."
Activist in local community	"The state of public funding for our village is quite dire. Currently, we receive only around 500,000 RSD per year from the local government, which falls far short of meeting all the needs of our village. This inadequate funding presents significant challenges in addressing various essential requirements and projects within our community."

Source: Own work.

While the Activist in local community, the second respondent in further text, believes that the funds available to the village and received from the local self-government are insufficient to reach all the needs of the village, the President of the local community board, the first respondent in further text, is optimistic about this issue and points to the contributions of the locals. This aligns with the result obtained by the survey where majority of respondents answered that they would be willing to pay more for services they are not satisfied with, if they were of higher quality. Different answers to the question about public funds emphasize the diversity of perceptions of the financial situation in the village. This diverse approach provides a basis for further research and a deeper understanding of different perspectives regarding the village's public funds, which goes beyond the needs of this master's thesis.

The second topic are challenges and potentials of the village. According to the interviewers' responses, the key problems in the village are population decline, poor road infrastructure, inadequate waste disposal, and limited administrative services. Both interviewees highlight the severe problem of emigration of young and educated residents. According to the first respondent, over 100 people from the village have gone abroad for work. Compared to the answers obtained from the survey, I can conclude that interviewees are aware what the main challenges in the village are, as they both highlight population decline, limited employment opportunities and infrastructure problems. Analysing both perspectives can serve as a foundation for developing targeted programs and initiatives that would adequately respond to the identified needs and create a sustainable solution for the village's challenges. On the question of what the village is doing to solve those issues, both interviewees answered that they depend on the city administration, and eventually I did not get a specific answer.

On the other hand, the interviewees also highlighted certain advantages of the village. The first one emphasises the good financial situation of the locals and the favourable conditions for producing organic food, especially oysters and blueberries. The other emphasises the fertile land as a key material advantage, as well as the clean air and peaceful environment, free of pollution and traffic problems, making the village attractive for those who want to escape from the city bustle and enjoy the natural beauty, as well as a potential for hunting and sports tourism. He also emphasises that people from all around the world used to come to Mrsać for hunting and participating in New Year's Athletics Race. Both the interview and survey results reveal consistency in the perception of the advantages and resources of the village of Mrsać. Both responses emphasise fertile land as a key material asset of the village, emphasising the importance of agriculture for the community's economic well-being and a potential for tourism. However, there is also a difference in perspectives regarding the role of village representatives and the active community. While the interviewees rely on the wealth of the locals, the locals do not put much hope in an active community and management of public funds. This consistency and contrast provide a holistic view of the village's resources and strengths, highlighting the need for further research to reconcile different perspectives and foster sustainable development.

The next topic is plans for future development. According to the answers from both interviewees, short-term goals in the village development are paving roads and installing public lighting, maintaining existing facilities, establishing drainage systems for immediate infrastructure improvements and revitalization of the cooperative-cultural centre. In parallel, long-term plans include the construction of a digital power plant, establishing a preschool, connecting to the gas pipeline, and constructing a sewage network. This comprehensive strategy balances the village's needs with long-term sustainable development goals.

The respondents agreed that they would start a smart village project from agriculture, animal husbandry and waste disposal. The first interviewee emphasised the construction of a dairy, the second emphasised the importance of expanded processing of agricultural products, and both interviewees mentioned the importance of a waste disposal project. These three proposals indicate a comprehensive approach to improving life in the village through support for agriculture, livestock, and sustainable waste management.

Regarding the digitalisation projects in the village, both respondents answered that no project is currently underway, but that high-speed internet had been brought in the past. As for future digitisation plans, they mentioned introducing the 5G network and establishing e-government. However, neither of them thought about investing in smart solutions that have the potential to bring some benefits to the whole village, except for the two plans mentioned.

Finally, when it comes to optimism and belief in the potential of the Mrsać to become a smart village in the future, the first interviewee answered optimistically. He believes that an opportunity will arise to start a project such as a smart village in Mrsać. He believes in the locals' will to engage and contribute to such project. The other interviewee was not that optimistic and stated that a lot of things need to be improved and that it will take some time. On the other hand, they both agreed about possible challenges in implementing a smart village project. According to them, the main challenges can be a lack of knowledge among local/government authorities, user adoption, distrust in local/government authorities, and lack of financial resources.

7 PROPOSALS FOR THE FUTURE DEVELOPMENT OF THE MRSAĆ VILLAGE

7.1 Proposing solutions to potential barriers

Based on the survey and interview results, I can say that Mrsać represents a promising area which can evolve into a smart village. Its favourable geographical position makes it a suitable candidate for developing innovative solutions. Its proximity to critical infrastructure hubs, such as airports, highways, and railways, further increases its attractiveness for implementing smart technologies. The wealth of natural resources adds dimension to the potential of Mrsać. These natural resources can serve as a basis for sustainable initiatives,

including smart approaches to agriculture, water management and energy projects, and the tourism potential further emphasizes the area's attractiveness. However, the essential factor contributing to Mrsać's potential to become a smart village is the locals and their commitment to the community. Their enthusiasm and willingness to engage in the implementation of smart technologies, support innovation, and actively participate in initiatives to improve life in the community are vital dynamic forces. Although only a small number of respondents recognized this as a strength, based on other questions and answers I can conclude that there is a positive environment in Mrsać that can encourage innovation and sustainable development in the long term.

Also, it was shown that in the digitalisation process, they may encounter certain problems and challenges that would have to be solved. The first barrier they might encounter is a lack of financial resources. However, there are some solutions to overcome these barriers. For example, I realised from both sources, surveys and interviews, that inhabitants often contribute financially to the village. It indicates a strong attachment of the inhabitants to the village and suggests that most respondents prioritise quality over price, recognising the value of improved services in their village. Some potential solutions involving the villagers are investments by the villagers. These investments could be returned to them in form of money or in the form of certain benefits in the village, such as public recognition or improved services. Other ways inhabitants could be included are donations, increasing prices for improved services, or, as Šrot (2022) suggested, through introducing fees.

An alternative approach could involve funding from the municipal budget. Since the primary objective of the smart village concept is achieving self-sustainability, the city would experience advantages as Mrsać would become less reliant on the municipal budget. Also, investing in tourism, for example, would increase the attractiveness of the village and the popularity of Kraljevo, which would attract more tourists and, therefore, more money. The third source is the investments and sponsorships of local companies. Thus, for example, a public utility company could benefit from efficient waste management in villages through reduced maintenance and cleaning costs, organising recycling centres or partnerships with recycling industries, generating additional income, raising its image, and similar. Another alternative is to seek funding through the projects organised by the EU or other international organisations that are accessible to Serbia. There are also national-level initiatives, such as the "Digital Village" project. This project arranges workshops focused on smart villages and trains farmers to develop proficiency in utilising digital tools. It also facilitates collaboration between agricultural producers and third parties and the establishment of virtual cooperatives. According to Spicer et al. (2019), a practical option could be to form a regional partnership. It means collaborating and pooling resources with neighbouring villages to create and execute solutions that benefit everyone involved collectively. The good thing here is that they can participate in tenders together and thus increase the chances of obtaining funds for larger projects, as well as for the development of sustainable initiatives.

Other barriers they could encounter are data privacy concerns and mistrust to local/government authorities. One of the proposed solutions to overcome these barriers is adopting an open data policy. This policy would focus on respecting the rights of individuals to access information, creating transparent data policies and informing citizens about the use of their data. It is important to implement transparent data policies that detail the purpose of data use and set clear boundaries (Ferrari et al., 2022). Another solution is the education of inhabitants regarding the project. As concluded by Manfreda et al. (2020) and based on the results of a survey conducted as part of my research, people's perception of the problem of threatened privacy and concerns about data security is greatly influenced by familiarization with the potential benefits and dangers of the smart village approach. This only confirms the importance of educating locals about the concept itself and its impact on their perception and participation in the project. My suggestion is to organize security awareness trainings, where the locals could learn more about internet security, personal data protection, fraud recognition and prevention, and the like. It would show the locals that the authorities care about their privacy and security.

7.2 Proposing solutions for identified challenges

As was emphasized at the beginning of the thesis, this work aims to identify the main problems that the inhabitants of the Mrsać village of Mrsać face and to offer solutions for these problems. Through analysis of the survey and interview findings, I have identified the most important and urgent problems that require resolution and the key areas requiring prioritized investment. In this part, I will propose smart solutions for priority areas and problems. I separated the solutions into two groups: highly critical and less critical, according to the answers I received from the locals and local representatives (see Table 6).

Table 7: Proposed solutions for identified needs

Highly critical	**Less critical**
Establishment of a digital hub	Smart governance
Smart agriculture and farming	Sustainable energy sources
Smart mobility and transportation issues	Improvement of socio-cultural life
Smart waste management	Village promotion and tourism
Increasing employment opportunities	

Source: Own work.

Highly critical

Although establishing a rural digital hub or rural development centre has not been identified as the highest priority for the village, my first proposal will revolve around it. The first reason is that involving citizens from the very beginning is crucial for the success of the smart village development project. Another reason is that one of the village representatives mentioned the revitalisation of the cooperative-cultural centre as one of the planned projects

for the development of the village. My proposal, which builds on this fact, is that when planning to revitalise the cooperative-cultural centre, they should consider repurposing a certain segment of this building into a digital hub. It will transform the cultural centre into a dynamic space that will not only preserve tradition and cultural heritage but also actively contribute to the modernisation and technological progress of the rural community. The digital hub would represent a central place of innovation, education and interaction, placing the cultural centre at the centre of digital transformation. Thus, the purpose of this area would be to promote the idea of a smart village, encourage the digital literacy of the local population, and coordinate diverse activities focused on collaborative learning and cooperation. This initiative is also a socio-cultural strategy that aims to preserve local identity by integrating modern technologies (Manasijević et al., 2019). Establishing a digital hub may also help other projects, such as creating employment opportunities, improving socio-cultural life, and promoting village and tourism. This project would also contribute to creating an active community that encourages innovation and development, which the inhabitants recognised as a resource that the village is lacking the most.

Inhabitants and local representatives consider agriculture and animal husbandry to be the most significant areas. The importance of this sector for the local community is also reflected in the fact that both locals and community representatives recognised natural resources as the most important strength of the village. In the context of improving agriculture and animal husbandry, it is crucial to consider smart solutions that could effectively contribute to increasing the productivity, sustainability and competitiveness of these rural activities. Possible solutions for the agricultural sector include using sensors to monitor crucial characteristics, including moisture, temperature, and soil conditions. This data can give information about the optimal moments for sowing, irrigation, fertiliser application, and optimising yield and quality. Sensors can be placed at critical points in the village, and the obtained information can be available to all farmers. For instance, the Xibaidian Village in China (Zhang & Zhang, 2020) implemented this solution. Another proposal is the joint purchase of smart tractors and harvesters that would be at the service to the residents of Mrsać and the surrounding villages for a certain price. As a solution in the field of animal husbandry, I would emphasise investment in egg and milk vending machines, which would be firstly placed in the surrounding towns, Kraljevo and Čačak, and later in other towns. Another solution I suggest is a collaborative investment in sensors to control the well-being and productivity of livestock and to track their location. These sensors are better known as "smart shepherd". The sensors would be accessible to all residents in the Mrsać and the residents of neighbouring villages at a specified cost. Once they collect enough money from the rental, they can invest it in more sensors or some new potential solutions. My proposal for promoting and selling agricultural and livestock products is for users to register on one of the already existing platforms, such as seljak.co, agroponuda.rs, agroclub.rs and the like.

Despite the fact that the village is geographically well-positioned, mobility and poor infrastructure is recognized as critical problem that requires a priority solution. On the other

hand, this is not a surprising fact, as mobility is most often mentioned as a problem in rural areas, which is most often the cause of the isolation of their residents. Although mobility is more often considered in the context of smart cities, there are certain possible solutions applicable to rural environments. My suggestions for alleviating mobility problems are familiarizing and training the locals to use already existing car-sharing applications and introducing an application to provide real-time data on bus and train timetable, as well as buying bicycles, electric bicycles and scooters that would be available to citizens.

Waste disposal is a problematic topic in Mrsać, which I can confirm from my own experience. There are numerous illegal dumps in the village, and due to inadequate waste disposal, the village is often fined by the public utility company. One potential solution I suggest is to prioritise the promotion of reuse and reparation, as they are crucial in mitigating the issue of waste disposal. This strategy promotes awareness regarding the preservation of resources, the decrease of consumption, and the general minimisation of waste. I would emphasise the establishment of a platform for exchanging and sharing things, organising craft workshops, and promoting repairs instead of purchasing the new things, which would promote the work of local handypersons, which would increase employment opportunities and potentially increase the connection of community members and develop a sense of belonging.

Another proposed solution to this problem would be to implement a system like the one in the village of Košeca, Slovakia. The village of Košice has adopted ELWIS, a sustainable waste management system. Citizens receive stickers for correct disposal, and chips in the containers allow monitoring and analysis of waste. It allows the municipality to reward responsible citizens with lower garbage collection costs. Thanks to worker training and campaigns, Košeca has less unrecycled waste, making environmental and economic progress (Smart Rural 21, n.d.). As garbage disposal is regulated and depends on the city of Kraljevo, Mrsać could join forces with the surrounding villages, thereby increasing the chances of approval of such a project.

Lack of employment opportunities and poor entrepreneurial climate are also listed as critical problems that the locals face. As a solution to this problem, I suggest introducing high-speed Internet in the entire village, making it easier for potential entrepreneurs to accomplish their work. The second approach involves creating a digital hub and conducting workshops to educate and train local individuals, enabling them to fulfil the requirements of the local job market or motivating them to initiate their own business endeavours.

Less critical

Low community involvement in public decision-making and low quality of administrative services were identified as less critical problems. As the village does not have a direct impact on administrative services, not much can be done in this matter. However, given that the e-governance platform is operational in Serbia, enabling various administrative services, I

recommend organising training sessions to educate inhabitants on how to effectively utilise this platform and increase their understanding of its potential uses. Alternatively, enhancing the current Municipal Office Mrsać website can facilitate the involvement of inhabitants in village-wide public decision-making. On the website, they can provide updates on village events, projects, development plans, and other relevant information that directly impacts inhabitants' lives. Additionally, the website can offer a platform where inhabitants can provide feedback and actively participate in crucial decision-making processes. A similar resolution was implemented in the German municipalities of Betzdorf-Gebhardshain, Eisenberg and Göllheim (Trapp & Hess, 2020).

Improving socio-cultural life also builds on establishing a digital hub where different generations would socialise, get to know each other, and exchange knowledge and experiences. Mrsać can also take inspiration for the second solution from the German municipalities of Betzdorf-Gebhardshain, Eisenberg and Göllheim. The solution is centred around utilising the BestellBar application for purchasing things and the LieferBar application for local product delivery. It relies on the voluntary efforts and the goodwill of villagers who transport the purchased items to the buyers. In return, these villagers are rewarded with points they can spend in the community. It turned out that this solution increased the sense of belonging in the community, and it helped to solve the problem of depopulation and abandonment of the village (Trapp & Hess, 2020).

Tourism, particularly sports tourism, is also recognized as an important village potential. Interviewees highlighted hunting tourism, mentioning how tourists from all over the world used to come to Mrsać for hunting and attending the New Year race. In order to enhance tourism, it is necessary to promote these events. Also, improving the village website and posting information about the village can attract potential tourists.

Developing sustainable energy sources is also recognised as a less critical project. Potential solutions for this problem are installing solar panels on buildings of public importance and saving energy in these buildings. Later on, as a longer-term project, the construction of a solar power plant can be planned. Since I do not have enough data to know which solutions are feasible in Mrsać, I cannot make any more suggestions.

8 DISCUSSION

8.1 Implications

The main implication of this master’s thesis is to raise awareness of the importance of smart village approaches in rural development. While writing the theoretical part, I struggled to find scientific research on the topic of smart villages. This is why I have to rely on the smart city approach in some parts. Therefore, my main theoretical implication is to raise the awareness and importance of rural regions in the technological context. In addition, it

encourages further research and development in the field of smart solutions for rural communities by providing additional sources for further research.

As the thesis takes a participatory approach, it also emphasizes the necessity of involving the community in the process of rural development. By analysing the motivation of residents to adopt smart solutions, this thesis helps to create strategies that not only meet technical requirements but also reflect the real needs and values of the inhabitants.

Other research I have found usually focuses on the stories of already existing smart villages and the success they accomplished or not. Therefore, the originality of my thesis is that it focuses on a village that did not take any steps toward developing smart village solutions and elaborates on the steps before implementing the solutions.

In addition, I developed my methods and survey and questionnaire questions based on the existing literature, so I could compare my results with those of previous researches. For example, the results of my research indicate that people are willing to pay a higher price for services they are not satisfied with if they were of better quality.

This confirms the results reached by Šrot (2022), who investigated the application of the smart city concept on the example of the municipality of Hrastnik. This confirms people's attachment to the place they live in and their willingness to participate in its improvement. This is important because the willingness to participate is the basis for thinking about the implementation of a concept such as a smart village.

On the other hand, practical implications of the thesis are probably higher than theoretical, considering that I developed my research on the example of one village, and when it comes to other villages the results must be used with caution. During my research the main focus was finding smart solutions and providing specific guidelines for solving problems and fulfilling the needs of the residents of Mrsać. I consider this my main contribution.

An additional contribution of this thesis is that during the empirical research, I had the opportunity to talk with locals and local representatives and to awaken their curiosity. From answers such as "Our village is not mature for such a project" that I received at the beginning of the research, I got to the questions such as "Does such a village already exist in Serbia?", "Are there funds designated for such projects in Serbia?", "Which smart solutions exist?" and the like.

8.2 Limitations and future research recommendation

Of course, the thesis has certain limitations that are worth mentioning. One of the biggest limitations is that I could not make a valid assessment of the representativeness of the sample because I could not find up-to-date statistical data on the population of the village. However, when compare the sample structure with 2011 census data, it can be concluded that village

population is older than the one included in the sample. Also, the percentage of male is higher in the population compared to the sample.

Another limitation is that all conclusions can only be applied to the population included in the study. In other words, the results are relevant only for the sample that was included in the research.

As the sample was taken from one specific village in Serbia, and questions refer to that specific village, the findings cannot refer to other villages in a country. However, as I underlined in several parts in literature review, the concept of smart village is not universal, but region specific. This means, each village needs its own approach while implementing smart solutions, depending on its own needs and challenges, as every village is different and provides different life conditions. Therefore, the results obtained in my research cannot be widely used and must be taken with caution when it comes to other villages.

Finaly, because of the length of the survey questionnaire there is a small number of completed surveys and, therefore, a small sample, which potentially additionally reduces the representativeness of the sample. Also, a questionnaire that is too long can lead to the respondents getting tired and it can reduce the accuracy of responses. In order to get a comprehensive insight into the research topic, the survey should include a bigger number of respondents.

My future research recommendation is to improve the representativeness of the sample by expanding the data search to find up-to-date statistical data on the population of the village. My suggestion is to use a variety of sources of information, including government agencies, research institutes, and academic institutions, and to consult local authorities or organizations involved in the collection of statistical data who may have access to relevant information and who are willing to share data or provide guidance on accessing resources.

Additionally, I would recommend the adaptation of the questionnaire and explaining smart village technologies more specifically at the beginning and maybe providing examples of some existing smart solutions. The reason for this is that a few answers from the survey made me realize that people did not understand the questions and the concept. So, this was one of those answers - “I do not know what the smart village technologies are”. A more detailed explanation increases the respondents’ understanding of the concept and increases the validity of the answers and the motivation to participate.

Another suggestion is to analyse the financial viability of implementing smart solutions in rural areas in order to better understand investments, costs and potential economic benefits. One more tip would be to conduct similar research in other villages in Serbia, and to compare the results, in order to gain better insight into the state of the villages in Serbia and reasons that prevent them to become a smart village.

Despite these limitations, the work provides a practical foundation for further research, identifying areas that require additional attention and improvements in the following phases of research into smart solutions in villages like Mrsać.

9 CONCLUSION

In my master's thesis, I conducted research to investigate "How can technology and the concept of smart village help harness the potential and overcome the challenges of rural areas?". To answer this question and fulfil the goal set at the beginning of this thesis, I first described the concept of a smart village through a presentation of definitions and dimensions of a smart village, motivation for implementing such a concept and the implementation steps and challenges. As people and technology are at the centre of the concept, it was important to present smart village technologies and their application in different areas of rural life and possible challenges that implementers could face. All this information helped me investigate the possibility of adopting the smart village concept in Mrsać.

To provide ideas for smart solutions for Mrsać, I conducted research and presented several cases of smart villages from all around the world. Finally, through empirical analysis, with the help of surveys and interviews, I was able to identify the problems, the resources of the village, and possible implementation challenges that could occur in Mrsać. Based on all the above, I was able to propose possible solutions for exploiting the potential and overcoming the problems that the village is facing, thus answering the research question posed at the beginning of this master's thesis.

Lack of finance and regulatory barriers, as well as distrust in local and national authorities and privacy concerns, were identified as the most critical potential challenges in implementing the smart village project. The inclusion of local people in the process of developing smart solutions turned out to be an indispensable step in solving both challenges. The cooperation of inhabitants and local authorities is the core solution to these problems. That is why I emphasized establishing a rural digital hub as the project of the highest priority, which would serve precisely for the cooperation of inhabitants and project implementers.

Nevertheless, from the perspective of inhabitants and local authorities, the primary areas where smart solutions should be applied are agriculture and livestock, mobility, waste management, and development of additional job opportunities. Less critical initiatives include governance and administration, sustainable energy sources, socio-cultural life improvement, village promotion, and tourism.

The concept of a smart village and technological progress are important factors for revitalising rural areas, and Mrsać stands out as a potential candidate for adopting this innovative strategy. During this path, it is very important to understand that only a comprehensive approach, which includes an active partnership between the local community

and the authorities, can lead to the successful integration of smart solutions. By presenting the ways and specific proposals in which the quality of life in rural areas can be improved and thus the depopulation of the village can be reduced, as well as exploring the potential of Mrsać to become a smart village in the future, I can conclude that I have fulfilled the purpose set at the beginning.

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APPENDICES

Appendix 1: Povzetek (Summary in Slovene language).

Eden glavnih problemov podeželja je odseljevanje. Zaradi težkih življenjskih razmer v zadnjih desetletjih opažamo postopno praznjenje vasi. Ljudje se selijo v mesta, podeželsko prebivalstvo se ne obnavlja, na vaseh skorajda ni prebivalcev. Sodobne tehnologije imajo velik potencial za reševanje omenjenih problemov in izboljšanje življenja na podeželju. Vendar podeželsko prebivalstvo ima na splošno najmanj koristi od sodobnih tehnoloških inovacij, in digitalni razkorak med podeželjem in urbanimi območji je prisoten povsod po svetu (Ristić & Bošković, 2020).

Koncept pametne vasi nastaja kot rešitev za težave podeželja. Koncept pametne vasi je opredeljen kot projekt, katerega cilj je ustvariti takšno okolje na podeželju, kjer bi ljudje radi živeli, saj inovativne tehnološke rešitve omogočajo, da so njihova življenja manj težavna in prijetnejša (Vaishar & Šťastná, 2019). Uporaba tehnologij lahko izboljša življenje na podeželju, zmanjša razkorak med podeželjem in mestom ter s tem poveča motivacijo ljudi za organizacijo življenja na podeželju. Zato je namen tega magistrskega dela raziskati, kako lahko koncept pametne vasi in uporaba tehnologij izboljšata kakovost življenja na podeželju, skupaj z možnostmi za njuno uvedbo v izbrani vas. S tem želim dodatno motivirati prebivalce te vasi, kot tudi prebivalce okoliških vasi, da organizirajo svoje življenje na podeželju in tako zmanjšajo odhod iz ruralnih območij.

Tehnološki napredek v podeželskih regijah je prilagojen posebnim potrebam vaških skupnosti in njihovih prebivalcev s končnim ciljem izboljšanja njihovih življenjskih in delovnih pogojev. Zato je pri določanju prioritet nujno upoštevati potrebe skupnosti in izzive, s katerimi se soočajo njeni prebivalci (Stojanova et al., 2021).

Raziskovalno vprašanje, na katerega sem skušala odgovoriti v magistrskem delu, je »Kako lahko tehnologija in koncept pametne vasi pomagata izkoristiti potencial in premagati izzive podeželja?«. Preko predstavitve definicij, dimenzij in motivov za uvedbo pametne vasi ter predstavitve korakov in izzivov uvedbe sem podala vpogled v koncept. Skozi empirično analizo, z uporabo anket in intervjujev, sem identificirala specifične izzive in probleme Mrsaća. Na podlagi vsega navedenega sem lahko predlagala možne rešitve za izkoriščanje potencialov in premagovanje težav, s katerimi se sooča vas, in tako odgovorila na raziskovalno vprašanje, zastavljeno na začetku magistrskega dela.

Skozi raziskavo sem ugotovila, da pomanjkanje finančnih in regulativnih ovir, kot so nezaupanje v lokalne in nacionalne oblasti ter skrb glede zasebnosti, predstavlja najpomembnejše potencialne izzive pri uvedbi projekta pametne vasi. Ugotovila sem tudi, da so z vidika prebivalcev in lokalnih oblasti kmetijstvo in živinoreja, mobilnost, ravnanje z odpadki ter razvoj novih delovnih mest ključna področja, kjer je potrebno uporabiti pametne rešitve. Nasprotno, manj kritične pobude vključujejo upravljanje in administracijo, trajnostne vire energije, izboljšanje družbeno-kulturnega življenja, promocijo podeželja in turizem. Vključitev lokalnega prebivalstva v proces razvoja pametnih rešitev, ter

sodelovanje prebivalcev in lokalnih oblasti, se je izkazala kot ključen korak pri izvajanju pametnih rešitev. Zato sem, kot najbolj prioriteten projekt postavila vzpostavitev digitalnega središča podeželja, ki bi služil za sodelovanje prebivalcev in izvajalcev projekta.

Na podlagi vsega navedenega sem na koncu predlagala možne rešitve za izkoriščanje potencialov in premagovanje težav, s katerimi se sooča vas, in tako odgovorila na raziskovalno vprašanje, zastavljeno na začetku magistrskega dela.

Appendix 2: Interview Questions

1. Can you please tell me what are your responsibilities in the village?
2. What is the current state of the village regarding public funding?
3. What are the near future development plans for the village?
4. In your opinion, what are the main issues in the village?
5. What is the village doing to solve those issues?
6. In your opinion, what are the main tangible and intangible strengths of the village?
7. Does the village exploit it in efficient manner? Is there a space for improvement (in a sense of more efficient usage of the asset/strength/potential)?
8. Are there any existing digitalisation projects for the village?
9. Have you ever thought about investing in smart solutions which have the potential to bring some benefits to the whole village? If yes, which one?
10. If you decided to start a smart village project in Mrsać, where would you start?
11. Do you think Mrsać has the potential to become a good example of a smart village in Serbia?
12. In the following table, some possible challenges in implementation of a smart village projects are listed. Please state how much you think each of them can be a barrier to implementation of such a project in your village.

	Not at all challenging	Slightly challenging	Moderately challenging	Very challenging	Extremely challenging
Lack of broadband infrastructure	o	o	o	o	o
Digital literacy	o	o	o	o	o
User adoption	o	o	o	o	o
Lack of knowledge among inhabitants	o	o	o	o	o
Lack of knowledge among local/government authorities	o	o	o	o	o
Distrust in local/government authorities	o	o	o	o	o
Unwillingness of the community to participate.	o	o	o	o	o
Lack of financial resources	o	o	o	o	o
Poorly developed transportation connections	o	o	o	o	o
Regulative issues	o	o	o	o	o

Appendix 3: Survey Questionnaire

1. **Gender**
   - o Female
   - o Male
   - o Other
   - o Prefer not to say

2. **Age**
   - o Under 20
   - o 20-40
   - o 40-60
   - o Over 60

3. **Education**
   - o No formal education
   - o Primary school
   - o Secondary school
   - o High education
   - o Other: _____

4. **Occupation**
   - o Employed
   - o Unemployed
   - o Retiree
   - o Student
   - o Other: _____

5. **Please state to what extent do you agree with the following statements?**

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	I do not know
I am satisfied with the living conditions in my village	O	o	o	o	o	o
I want to continue my life in my village	O	o	o	o	o	o
I would continue my life in the village if living conditions improved	O	o	o	o	o	o
I am worried because my village is subject of depopulation	O	o	o	o	o	o

6. **How satisfied are you with the quality of the following services in your village?**

	Very Dissatisfied	Dissatisfied	Neutral	Satisfied	Very satisfied	Not competent
Public transportation	O	o	o	o	o	o

Public administration	O	o	o	o	o	o
Waste management	O	o	o	o	o	o
Energy providing	O	o	o	o	o	o
Cultural life/ Entertainment	O	o	o	o	o	o
Air pollution controlling	O	o	o	o	o	o

7. **Which of the abovementioned services has the highest influence on your life quality?**

_____

8. **Would you be willing to pay more for services that you are not satisfied with but that significantly impact the quality of your life if they were of higher quality?**
   - **Yes**
   - **No**

9. **Please rate how often you face the following challenges in your village.**

	Never	Rarely	Occasionally	Often	Very often
Limited mobility (limited public transport services, poor connections with surrounding places, etc.)	o	o	o	o	o
Limited entrepreneurial conditions	o	o	o	o	o
Limited health services	o	o	o	o	o
Limited education services	o	o	o	o	o
Limited utility services (e.g., water, waste management, etc.)	o	o	o	o	o
Limited public administrative services	o	o	o	o	o
Low level of community involvement in public decisions.	o	o	o	o	o
Limited job opportunities	o	o	o	o	o
Inadequate use of natural resources	o	o	o	o	o
Polluted air	o	o	o	o	o
Polluted water	o	o	o	o	o
Polluted soil	o	o	o	o	o
Low quality of public lighting	o	o	o	o	o

10. **Are there any challenges, not mentioned in the previous question, that you face often or very often? If there are, please list them:**

_____

11. Which of the abovementioned challenges has the highest influence on your life quality?

_____

12. Please rate the extent to which your village has each of the resources listed below, which could potentially contribute to the development of a smart village.

	Not at all	Slightly	Moderately	Considerably	Extremely	I do not know
An active community that encourages innovation and development	o	o	o	o	o	o
Efficient use of public funds	o	o	o	o	o	o
Positive entrepreneurial climate	o	o	o	o	o	o
Skilled People	o	o	o	o	o	o
Natural resources	o	o	o	o	o	o
Access to sustainable energy sources (solar, wind farms, etc.)	o	o	o	o	o	o
Good transportation infrastructure	o	o	o	o	o	o
Tourism potential and cultural heritage	o	o	o	o	o	o

13. Do you have access to stable internet connection in your home?

Yes

No

14. Please state to what extent do you agree with the following statements?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I use the internet every day.	o	o	o	o	o
I use computers and other devices (tablets, smartphones etc.) in my daily life.	o	o	o	o	o
When I need some information, I search the internet first.	o	o	o	o	o

15. What are the main concerns you have regarding technologies (addiction, fear that technology will take over your job, compromised privacy, etc.)?

_____

16. Please state to what extent do you agree with the following statements?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Limited financial resources prevent me from using technologies	o	o	o	o	o
Infrastructure limitations prevent me from using technologies					
Knowledge barrier prevents me from using technologies	o	o	o	o	o
I am willing to invest my time to gain technological skills	o	o	o	o	o
I am willing to invest my money to gain technological skills	o	o	o	o	o

17. Please state to what extent do you agree with the following statements?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
I am aware of benefits that technologies provide	o	o	o	o	o
I think the benefits of using technology outweigh the challenges and drawbacks					
I am open to trying out new technologies					
I am excited by the possibilities offered by new technologies.					

18. Please state to what extent do you agree with the following statements?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
There are enough educational resources that help me learn how to use technologies	o	o	o	o	o
The cost of technical devices is too high	o	o	o	o	o
The cost of maintaining the technical devices is too high	o	o	o	o	o
I do not have the financial means for education on the use of technologies	o	o	o	o	o

19. Please state to what extent do you agree with the following statements?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree

I am concerned that my privacy is compromised by technologies	o	o	o	o	o
I believe that the government ensures the security of my data	o	o	o	o	o
The government and local authorities should play a role in promoting the adoption of technologies in my village	o	o	o	o	o
The government and local authorities should facilitate the adoption of technologies in our village through subsidies	o	o	o	o	o

20. Please state to what extent do you agree with the following statements?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Technical support available in the village is at a satisfactory level	o	o	o	o	o
Using the technologies makes it easier to carry out my tasks	o	o	o	o	o
The use of technology has a positive effect on the quality of my life in the village	o	o	o	o	o
I am willing to invest my time to improve my technologies skills	o	o	o	o	o
I am willing to invest my money to improve my technologies skills	o	o	o	o	o
I am willing to share my technological skills with other people	o	o	o	o	o

21. Do you use any of the smart village technologies? If yes, which ones?

_____

22. Please state to what extent do you agree with the following statements?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Strongly disagree
I am already familiar with the concept of a smart village.	o	o	o	o	o	o
I would like to get acquainted with the potential dangers and corresponding benefits of smart villages approach	o	o	o	o	o	o

Adopting a smart village solution would require additional trainings for users						
I would trust smart villages approach more if I were introduced to corresponding benefits and potential drawbacks of it	o	o	o	o	o	o

23. Please state to what extent do you agree with the following statements?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Strongly disagree
I believe the smart village approach (as defined above) would positively contribute to the development of my village	o	o	o	o	o	o
I would be proud if my village became a smart village	o	o	o	o	o	o
I think the smart village concept is feasible in my village	o	o	o	o	o	o

24. Please state to what extent do you agree with the following statements?

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree	Strongly disagree
I would use smart village solutions if I had an opportunity	o	o	o	o	o	o
I would consider using the smart village solutions if trainings for users were organized	o	o	o	o	o	o
I would be willing to be actively involved in the smart transformation of my village	o	o	o	o	o	o
I would be willing to financially contribute to the smart transformation of my village	o	o	o	o	o	o

25. Do you know of any problems in the village, which you believe could be solved by using smart technologies?

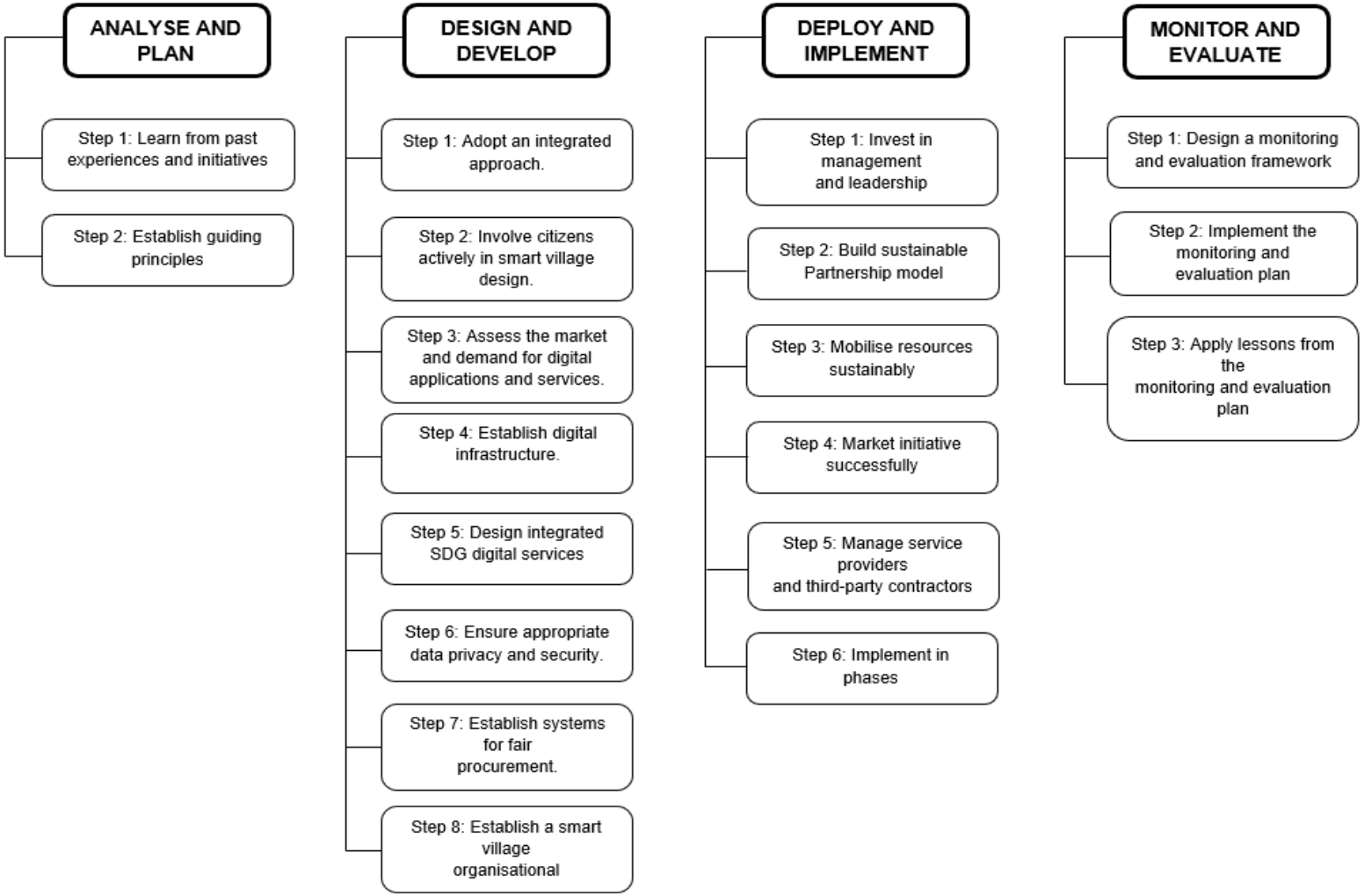
_____

26. In which of the following areas do you think smart village solutions should be implemented first?

- Mobility (public transport, road quality, etc.)
- Waste management
- Environment protection

- Entertainment and Culture
- Agriculture and Farming

Appendix 4: Process for designing and implementing a smart village project



Source: Adapted from ITU, 2020