AN INTEGRATED SMART RURAL DEVELOPMENT MODEL: EDUCATION, COMMUNITY BUSINESSES, YOUTH INCLUSION, COOPERATION

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ABSTRACT

The article analyses the challenges to traditional villages in transitioning to a smart village strategy, which is becoming increasingly relevant due to the ageing population, shrinking services and infrastructure, job losses, and other reasons. In the scientific literature, barriers such as the lack of local leaders, limited human and financial resources, the digital divide, insufficient cooperation and a lack of youth inclusion are often mentioned. Although there are successful examples of smart villages in Europe and beyond, they are not yet widespread. Applying the PRISMA 2020 methodology, the article conducts a systematic content analysis, and formulates an integrated smart village development model that identifies the main challenges to the viability of villages and smart ways to solve them. This model reveals that in order to implement the smart village strategy and ensure its sustainable development, the comprehensive involvement of the local community and the participation and education of young, creative and motivated people are necessary. Interdisciplinary education, from technological skills and digital literacy to social competences and entrepreneurship, creates conditions for the formation of local leaders who are able to initiate change, and the entire community can focus on a common goal. Community businesses encourage a focus on a common goal, strengthen the local economy, and improve the quality of life. Cross-sectoral cooperation with scientific and government institutions, business organisations and other local communities helps more active participation in EU initiatives. The four driving forces act as a response to local structural problems, and at the same time create the prerequisites for strengthening rural sustainability, resilience and autonomy. Substantial changes are possible only when local development challenges are addressed in a comprehensive manner using a holistic approach, strengthening the unique features of each village, which are based on natural, cultural, social and human resources, and competence and development capacities.

KEY WORDS: *smart village, viability challenges, smart solutions, development management model*.

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Introduction

European villages face long-term structural problems: population ageing, lack of public services, infrastructure deterioration, job losses, etc (European Commission, 2017). In response to these challenges, in 2016 the concept of the Smart Village was launched to be more actively developed, which is essentially based on the previous LEADER method tool (European Commission, 2023). The LEADER method is designed to activate local communities, promote their involvement in regional development, and support community-based solutions. However, as Creineanu, Parnus and Marcuta (2024) point out, LEADER is only one of the tools that can contribute to the development of smart villages, because turning a traditional village into a smart one requires a holistic approach and complex solutions.

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The scientific literature emphasises that the development of a smart village is a complex and multifaceted process, which is complicated by several factors. One of them is the insufficient readiness of communities to adopt technological and social innovations (Mukti et al., 2021). Also indicated are limited financial and human resources, weak support from local authorities (Jezic, Górecka, Kardum, 2021; Sikos, Szendi, 2022), and a lack of leadership (Mańkowska, Szałata, Derlukiewicz, 2023). Huda et al. (2024) refer to the concept of smart village administrators in this context, defining local leaders as educated, institutionally prepared individuals who can coordinate systemic rural transformation processes in an integrated manner. However, according to them, such individuals are missing in many villages. Zhang and Zhang (2020) note that the introduction of digital technologies can improve access to education, but at the same time it highlights a fundamental problem, the digital divide between urban and rural residents. Głębocki (2023) also distinguishes social exclusion, depopulation processes, untapped cooperation opportunities, and a lack of economic activity as important challenges for villages.

These challenges are also reflected in the official online platform for smart village development Smart Rural'21 (2021), which presents implemented smart village development strategies in various countries around the world. Although the above examples reveal the possibilities for positive transformation, they remain rare, and in Lithuania there was not a single fully implemented smart village project until 2024. This reveals the need to create an integrated smart village development model that would help address the challenges of traditional villages and turn them into strengths of smart villages.

Research problem. Although there are successful examples of smart villages in Europe and beyond, they are still few, and in Lithuania we still have not achieved such a systemic change. This is usually due to complex recurring reasons: weak local infrastructure, lack of human resources, gaps in education and cooperation, etc. Given these circumstances, it becomes relevant to search for an integrated rural development management model that would help optimise rural development by responding to the main challenges of rural viability and IT implementation.

Research objectives:

1. To identify and systematise the main challenges faced by villages, drawing on scientific literature and smart village case analyses.
2. To reveal and classify the smart solutions identified in the case studies presented in village strategies.
3. To develop an integrated smart rural development management model that addresses recurring challenges and supports systemic transformation in rural areas.

Research methods. The article conducted a systematic content analysis based on the PRISMA 2020 methodology (Moher et al., 2021). Data were selected using the snowball method, and only the strategies presented on the official Smart Rural'21 (2021) platform, which examines the challenges experienced by villages and the smart solutions applied, were analysed.

The aim of the study is to highlight the main challenges of villages and their solutions through the implementation of smart village strategies and, based on the results obtained, to create an integrated management model for smart village development.

1. Theoretical justification of the study

The challenges facing villages are widely discussed in the scientific literature. Mańkowska, Szałata and Derlukiewicz (2023) argue that many European villages are not only not prepared to improve their governance and become smart, but also generally rely on their own development and are therefore at risk of extinction. According to the authors, this situation is especially characteristic of small villages that are far from cities. Such areas experience youth migration to cities, while the remaining population is rapidly ageing. New residents move here extremely rarely, mainly due to limited access to public services (e.g. healthcare, education) and a lack of jobs. In addition, the authors identify other unfavourable factors: poor infrastructure, technological exclusion (poor transport, a weak internet connection, a low level of digital literacy), limited

economic opportunities (a low level of entrepreneurship, traditional single-family farming), and a lack of strategic planning. Analysing these challenges, the authors present solutions: activating communities, involving them in decision-making, and developing a holistic approach that would include the implementation of technologies, community empowerment, strategy development, and the use of EU financial opportunities; also, focusing on creating jobs by the community itself, using the potential of the village.

Mukti et al. (2021), analysing the challenges faced by villages, distinguish the lack of infrastructure (in transport, energy and other areas), and the limited involvement of local residents in community processes. According to the authors, the passivity of residents is often associated with a settled lifestyle, where the main focus is on individual household activities, farming, gardening or animal husbandry. In addition, the technological divide between urban and rural areas and the insufficient readiness of local communities to accept and apply technological innovations are emphasised.

As solutions, changes based on community are proposed, for example, the sharing economy, community businesses, and digital education, the development of skills in the use of technology. Special attention is paid to the role of youth. The article describes cases where young people have initiated innovative businesses, such as agritourism, by implementing information technologies, creating online platforms and mobile applications. When talking about increasing business efficiency, the authors emphasise the importance of inter-institutional cooperation at various levels: with the European Union, other villages, cities, and business organisations.

Jezic, Górecka and Kardum (2021) focus on the lack of economic investment, the lack of financing, and the closely related limited cooperation between sectors. They also highlight problems such as depopulation, social exclusion and low civic and economic activity by local residents. The main solutions proposed are: strengthening digitalisation processes, developing a business ecosystem, creating intersectoral partnerships, promoting community-based businesses, increasing the availability of educational services, and involving young people in local development processes. The article also provides specific examples of young people successfully initiating and implementing local projects, such as the development of ecotourism. Sikos and Szendi (2022), analysing the case of rural Hungary, distinguish the main challenges as rural depopulation and population ageing, a poor infrastructure (especially weak internet connection), and limited financial instruments. To solve these problems, the authors suggest the more active involvement of local institutions, community initiatives (e.g. organising festivals, nurturing cultural traditions), programmes for youth (training them to encourage them to return to the countryside), and the creation of a smart model and strategic planning, as well as the gradual implementation of strategies.

Many researchers examine the possibilities of strengthening the vitality of villages. Huda et al. (2024) identify digital literacy and information technologies as essential factors in the transformation of villages. They also emphasise the importance of local leadership: the development, empowerment and ability of a smart village administrator to motivate other community members. Zhang (2020), analysing the transformation processes of Chinese villages, emphasises government support for infrastructure, the implementation of ecological technologies, and the involvement of local residents in decision-making. Investment in digital learning and specialised training platforms are also highlighted. Głębocki (2023) emphasises the importance of human capital, and the significance of social organisations and educational initiatives (partnerships, IT training). Creineanu, Parnus and Marcuta (2024) emphasise cooperation and EU funding mechanisms, especially LEADER initiatives, which support youth businesses, community projects, social programmes and local technological solutions.

All the sources analysed emphasise similar challenges for villages: depopulation, community passivity and limited skills, technological exclusion, insufficient economic opportunities, lack of cooperation, lack of financial and human resources, digital exclusion, and an unfavourable demographic context. Solutions are dominated by the implementation of technologies (IT platforms, digital training), financial instruments (e.g. LEADER and other initiatives), cooperation (cities, other villages, business, educational institutions, local government, EU, etc), and a community-educational focus (entrepreneurship, youth involvement, strengthening local leadership). It is often emphasised that the key areas of transformation are youth, education, cooperation and community mobilisation, which are necessary for a successful transition from the traditional to the smart village model.

The literature stresses that villages face recurring challenges, such as depopulation, youth migration, ageing populations, a weak infrastructure, technological exclusion and limited economic opportunities. A lack of cooperation, strategic planning and community engagement further hinders development. Common solutions include empowering communities, fostering youth involvement, improving digital literacy and using technology to support entrepreneurship and cooperation. EU financial mechanisms (e.g. LEADER), intersectoral partnerships and local leadership are emphasised as key enablers. Across studies, youth, education, technology adoption and community mobilisation emerge as central drivers for transforming traditional villages into smart villages.

2. Research methodology

The study was conducted in accordance with the PRISMA 2020 methodological guidelines (Moher et al., 2021), which include a systematic search, selection, analysis and presentation of documents related to the research topic. The official online platform for smart village development Smart Rural'21 (2021) was used to search for smart village development strategies.

Out of the 21 strategies available on the Smart Rural'21 platform, eight were selected for detailed analysis due to their relevance, data quality and diversity. These villages provided comprehensive examples of challenges and solutions related to youth involvement, community businesses, education and cooperation, which are also highlighted in the scientific literature, while representing different geographic, socio-economic and cultural contexts. Focusing on these eight well-documented cases allowed for an in-depth analysis and the development of a robust integrated smart rural development model. The documents had to be in English and published by 2025.

The database was selected based on its reliability, accessibility and thematic relevance. The following keywords in English were used to search for strategies: smart village development, rural challenges, smart solutions. A total of 21 smart village cases were identified, of which eight were selected for the final systematic analysis (see Figure 1).

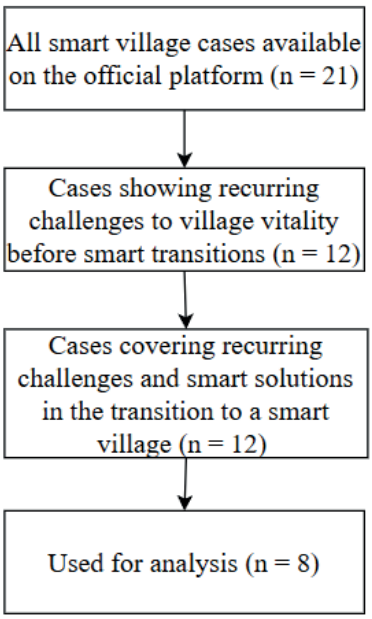

Figure 1. The PRISMA flowchart: systematic analysis of components of the conceptual model of smart village

Cases of smart villages were included in the study according to the following criteria:

- the documents were published on the official smart village online platform;
- smart village development stakeholders identified challenges for viability and becoming a smart village;
- smart solutions defined to address local challenges and rural transformation.

Based on the analysis of cases of good practice, an integrated conceptual model of a smart village was created, which includes four main components: cooperation, educational initiatives and methods of their implementation, youth involvement, and goals of existing or potential community businesses.

3. A systematic analysis of smart village strategies using the PRISMA method

Using the method of systematic content analysis, applying the PRISMA 2020 methodology, an analysis table was compiled according to the characteristics of the study, covering rural viability challenges and smart solutions, based on data from smart village development strategies published on the official platform Smart Rural'21 (2021). The challenges and smart solutions of rural viability will be presented in the next subsections of this article. The entire analysis structure with the characteristics of the study is presented in Appendix 1.

3.1. Challenges faced by villages before becoming smart

The research analysis data (see Appendix 1) show that the problems of traditional villages that emerged in the cases analysed are recurring and reflect similar trends. For example, the problems of depopulation and an ageing population are mentioned in all cases. The Alsunga (Latvia) rural strategy emphasises that this trend is determined by the natural migration of young people to cities due to the lack of job opportunities and services (leisure, education, cultural life, etc). It is also noted that the outflow of young people causes a decrease in the number of students and the closure of schools, as well as contributing to the lack of innovative ideas and innovations. The Babina Greda (Croatia) smart village strategy emphasises that young educated people leave in search of better living and working conditions. The Virtsu (Estonia) strategy draws attention not only to the migration of young, creative people from the countryside, but also to the fact that their places are not being filled: there is no return migration or migration from other areas. This is associated with a lack of local businesses, which makes it difficult for new residents to find work. It is also noted that the closure of schools further reduces the attractiveness of the village to young families. In the case of Sollstedt (Germany), as many as a third of the population are over 65 years old, and the total population is constantly decreasing due to ageing and migration. The Tomaszyn (Poland) strategy provides a historical comparison: in 1895 there were 228 people living in the village, and in 2020 there were only 18. The Dingle (Ireland) strategy notes that, compared to 1911, the number of young people (aged 0–18) has decreased from 31% to 23%.

It is important to note that the problem of youth migration is closely related to other problems that are often repeated in strategies: these are the established habits of the population, the unwillingness to change and accept innovation, technological backwardness, the lack of local leaders, and the lack of skills and educational opportunities in the community. These factors not only complicate the transition to the smart village concept, but also reveal a clear need for education. For example, the Alsunga (Latvia) strategy states that before the transition to the smart village model, the skills of the local population were extremely low, and there were no conditions for their education. It is also noted that the community had a passive attitude: it expected the municipality to solve all problems, and did not want to change its habits. The Penela (Portugal) strategy emphasises that as the number of young people decreased, the community became increasingly passive and was slow to engage in activities necessary to become a smart village. It is also noted that there was a lack of knowledge about the preparation of strategic plans and the use of local resources. The Virtsu (Estonia) strategy indicates that there is weak cooperation in the community, people find it difficult to cooperate, and

their knowledge is outdated: the level of education is low. In the case of Sollstedt (Germany), the lack of both digital and social skills is highlighted. The Tomaszyn (Poland) strategy notes that when the idea of a smart village began to develop, the village lacked knowledge and innovations for the development of organic agriculture. The Kythera (Greece) strategy mentions that the rural community lacked various training and educational programmes.

Another challenge that often recurs in the smart villages analysed is poor living conditions: insufficient infrastructure, limited leisure and cultural opportunities, a lack of public gathering spaces, as well as limited accessibility of public services. This problem not only contributes to population migration, but also reduces the potential for tourism development, which for many smart villages is a key factor for survival and development. Tourists often lack public catering establishments, various forms of leisure (active and passive activities), and also a sense of security due to limited access to healthcare services. As the analysis shows, this problem was highlighted by all the villages analysed. For example, the strategy of Babina Greda (Croatia) notes that the village lacks educational and cultural opportunities: both young people and senior citizens lack space and funding for self-expression, creativity, and cultural and physical activities. It is noted that the school did not even have a gym, and physical education classes were held in the corridors during the winter. Also, older residents did not have the opportunity to engage in physical activity, and they especially lacked public transport. The village of Alsunga (Latvia) faced the problem of a lack of housing, which is especially relevant for young people or newcomers. Existing housing did not meet modern requirements (heating, water supply and sanitary facilities were not provided). A lack of infrastructure funding limited the development of roads, services and businesses. Sollstedt (Germany) highlighted poor infrastructure, including the digital divide: there is no broadband internet, which limits the possibilities for working remotely and attracting businesses. There is also a lack of attractive public spaces, activities for young people, services for senior citizens, and modern housing. Tomaszyn (Poland) is facing lost services: closed shops, medical centre, school. There is also a lack of production infrastructure for storing and processing products. Dingle (Ireland) is experiencing a housing affordability crisis, with the rise of AirBnB and second homes making it difficult for locals to buy or rent a home. There is also a lack of public transport, especially in rural areas west of Dingle, where residents are becoming dependent on their own cars. Limited access to public services (post offices closing, shops only in neighbouring villages) is increasing social isolation.

Analysing the data, it was found that in addition to the common problems that are typical for many smart villages, there are also specific challenges that are relevant only to individual regions. These challenges require individualised solutions that correspond to the local context. For example, Alsunga (Latvia) is not considered a tourist destination: it is mostly a pass-by village that does not attract visitors, which reduces the possibilities for economic activity. Babina Greda (Croatia) does not use its agricultural potential: there is a lack of innovation, technology and marketing solutions that allow for strengthening the value chain of agricultural products. Penela (Portugal) faces a high risk of fires, which limits the possibilities for developing sustainable rural tourism and agricultural activities. Virtsu (Estonia) lost its status as a municipal centre after administrative reform, which reduced political attention and investment opportunities. In addition, the identity of Virtsu has not been clearly formed so far. The village is mainly known as a transit port to the island of Saaremaa (Estonia), and not as a tourist destination or an attractive place to live. Sollstedt (Germany) experienced an economic downturn after the closure of a potash mine: there is a lack of businesses in the area, which limits job creation and social vitality. Tomaszyn (Poland) faces the negative environmental impact of conventional agriculture: the inefficient use of water and energy resources poses sustainability challenges. Dingle (Ireland) experiences the strong seasonality effect of tourism: during the summer, the influx of tourists overloads the infrastructure and reduces the quality of life for the local population, while at other times of the year, tourism activity drastically decreases. Kythera (Greece) is an island and is naturally isolated from the mainland, therefore facing difficulties in logistical access, the accessibility of services and social integration.

The challenges faced by all the villages analysed in this study are closely interconnected. They are: lack of funding, underdeveloped partnerships and cooperation, lack of knowledge and education, and limited market and export opportunities for local products. These factors not only exist in parallel but also reinforce

each other: without funding, it is difficult to develop educational initiatives or promote joint business projects, and without education and innovation, the competitiveness of local products in the market is limited.

For example, the strategy of Alsunga (Latvia) identifies both financing and cooperation gaps as the main obstacles to rural development. Babina Greda (Croatia) faces insufficient entrepreneurship support: there is a lack of assistance for start-up entrepreneurs, information about EU support opportunities, consultations, business premises and connections between local businesses. There is also a weak awareness of local products and cultural identity. Penela (Portugal) highlights the limited market for local production: products such as cheese and honey do not reach wider markets, and market development requires innovative solutions. Virtsu (Estonia), located far from the municipal centre, suffers from a lack of financing and isolation from important decision-making centres. Tomaszyn (Poland) points to a lack of knowledge and innovation in organic agriculture, which is directly related to limited cooperation with scientific institutions. A similar situation is seen in Kythera (Greece), where not only are financial challenges highlighted, but also poor cooperation with scientists.

Case analyses show recurring village problems: depopulation, youth migration, ageing, poor infrastructure, limited services, weak cooperation, and low levels of education and innovation. These issues reinforce each other: population loss reduces schools and services, while a lack of skills and passivity hinder smart transitions. Poor living conditions (housing, healthcare, leisure, internet, transport) further reduce attractiveness and tourism potential. Specific regions face additional issues, such as environmental risks, tourism seasonality, agricultural inefficiency, industrial decline and isolation. Overall, the main barriers are a lack of funding, weak partnerships, insufficient knowledge and limited markets, highlighting the need for integrated, locally adapted solutions.

3.2. Smart solutions to address challenges to rural vitality

After analysing the data (see Appendix 1), it can be assumed that smart solutions that help villages become smart are also repetitive. These include youth involvement and empowerment, community activism, gatherings and the creation of community businesses, interdisciplinary education (from technological skills and digital literacy to social skills, entrepreneurship and practical skills for a specific business, etc), and multifaceted cooperation (NGOs, EU, businesses, villages, other cities, educational institutions, etc). Also, all strategic documents emphasise that the uniqueness of the village and the use of its potential are of particular importance for the development of a smart village.

The case of the village of Alsunga (Latvia) illustrates the implementation of the smart village concept through sustainable cooperation with scientific institutions and social partners. Based on research conducted on local needs, solutions were implemented focused on youth inclusion, improving the quality of life and developing tourism. The quality of services provided by local educational institutions was improved, and information was disseminated about technological innovations and the creation of creative spaces. Special attention was paid to training: community members participated in entrepreneurship development activities in cooperation with the Latvian Rural Advisory Centre, and young people were given the opportunity to acquire the basics of programming in order to promote remote work without leaving the village. Community spirit and social capital were strengthened: a collaboration space was established and the voluntary group 'Smart Village Action Group' was formed, uniting various groups of society (residents, entrepreneurs, youth, senior citizens, municipal representatives), whose activities include generating ideas, organising discussions and initiating projects. The result of promoting entrepreneurship is the establishment of an authentic local market 'Suitų turgus', accompanied by cultural events, craft demonstrations and a musical programme, which contributed to the growth of local entrepreneurship, tourism and community cooperation. Cooperation between local tourism businesses was also initiated: a mobile application has been created to coordinate services, increasing the attractiveness of the village to visitors.

The case of the village of Babina Greda (Croatia) stands out with its targeted development of green technologies and the application of innovative solutions to strengthen the local economy and social cohesion. In response to the decline in the vitality of the village, active cooperation with local and regional authorities

and non-governmental organisations was used. As a result, the use of geothermal potential was developed: a 20 MW power plant is being built, the synergy of which is used for the development of aquaculture, greenhouse farming and recreational tourism. The village also invested in a biomass power plant, which attracted foreign investment and created new jobs. Social projects played an important role: 18 women were employed as part of the Zaželi initiative, providing assistance to seniors, while also solving the problems of unemployment and social exclusion. Innovations are also being implemented in the public sector: an energy-efficient municipal building was installed, and transparent municipal activities were ensured, for example, by broadcasting council meetings. In the agricultural sector, progress has been made towards advanced farming: a digital agricultural map has been created, soil analysis has been performed, and farmers have been included in training on sustainable agriculture and agrotechnologies. Rural social capital is strengthened by an active network of non-governmental organisations, which helps preserve local traditions and promotes inter-institutional cooperation. Significant attention is paid to youth and education: activity spaces are planned, clubs, training and community events are organised. Cooperation with scientific institutions has been strengthened: a partnership is being established with the University of Zagreb, and participation in the EU project 'Smart Village Lab' is being carried out, with the aim of implementing advanced solutions for rural modernisation.

The village of Penela (Portugal) is characterised by a synergy of traditional practices and innovation, strengthening the local economy and social cohesion. A community goat centre was established (in collaboration with local and international partners), integrating traditional livestock farming with the digital platform 'FarmReal', which allows for the virtual adopting of animals and observing their lives, an innovative way to involve young people, local residents and tourists. Educational programmes on water and honey cycles, herding traditions and bread baking were also implemented, aimed at students, guides and tourists. Young people participate in strategic planning processes, and partnerships with scientific institutions (IPN, HIESE), tourism networks (Schist Villages) and Living Labs allow the village to implement innovations in real conditions. In the context of climate change, a protection zone was established, flammable trees were replaced, and the first community fire shelter in the country was built. The village actively participates in national and EU programmes, such as Portugal 2020, which strengthen sustainable development.

Responding to the challenges of rural vitality and aiming to become a smart village, the village of Virtsu (Estonia) has combined community, sustainable business and innovation. The village has started to develop fishing tourism as a community business, offering visitors an authentic fishing experience, while strengthening the local economic potential. Training in maritime tourism is provided to young people, creating conditions for acquiring practical competences and promoting their involvement in the regional economy. Strategic cooperation with Tallinn Technology Park and participation in the EU project Smart Coastal Village allows for the implementation of innovations for the development of coastal regions. The active local development association Virtsu Arenguselts involves residents in various initiatives, from cultural events to workshops and local projects, thus strengthening social capital. Local residents successfully mobilised for the preservation of the school: the signatures and arguments collected proved its importance to the community and youth education. Cooperation with Tartu and Estonian Agricultural Universities has led to joint science and tourism initiatives that contribute to strengthening the local identity and implementing innovative solutions. An entrepreneurial environment is being developed: a business centre is being created, focused on creating new companies, especially in the field of renewable energy. The village is actively developing the tourism infrastructure: the historic castle complex is being renovated, beach and yacht marinas are being created, and tourist routes are being prepared. In the area of sustainability, Virtsu (Estonia) is using the potential of wind farms, and a planned solar energy park further strengthens energy independence. A community cooperative is being created that will invest in local projects: from composting systems to sharing economy solutions.

The development of the village of Sollstedt (Germany) is based on strengthening the digital infrastructure and community involvement. The operational strategy was formed collectively, with the participation of residents, businesses and the municipality. One of the main solutions is the installation of broadband fibre-optic internet, designed to promote remote work and entrepreneurship. Electric vehicle charging stations have been installed to promote sustainable mobility. Digital services have also been introduced: shopping

and medical platforms, which increase the accessibility of services. Tourism and cultural events are promoted through digital channels. Digital literacy training is provided to residents, to enable everyone to use new technologies and contribute to local growth.

In the village of Tomaszyn (Poland), in order to become smart and maintain vitality, the development of community businesses and eco-innovations was strengthened. The established local products cooperative Tomašyno produkty and the cooperative Ostoja Natury united farmers, provided direct access to the market, and encouraged the transition to ecological practices: permaculture and renewable agriculture. Also, innovative solutions were implemented: the BioHub platform connecting the market, an online store and the automated machines Vegemat, allowing for the distribution of local products. Green energy (biomass, solar and wind power plants) is being developed, and advanced water management solutions, such as the passive Ost-Oya irrigation system, contribute to sustainability. Training on brand creation, ecological construction (e.g. hemp concrete) and strengthening farmers' competencies through the BioTech platform is being implemented, involving the local community, youth, and scientific institutions.

The village of Dingle (Ireland) has become smart by leveraging the local community and its community businesses. One of them is an annual music festival. Various youth employment programmes have been launched in the village, encouraging young people to stay in the village. It is important to note that Dingle in Ireland has a participatory democracy that allows residents to address local issues directly. In addition, the Dingle 2030 initiative has been successfully implemented, promoting climate neutrality and green energy in cooperation with universities and research centres. The Dingle Creativity and Innovation Hub has been established in the village. Various local initiatives are also supported through the LEADER and SICAP (Social Inclusion and Community Activation Programme) programmes, and new living spaces are planned. There is a network of energy ambassadors that spread knowledge about sustainable energy and agriculture.

Like Dinge in Ireland, the village of Kythera (Greece) runs a community business: the annual Kythera Cultural Festival is organised by community members. Digital skills seminars are also organised for young people, thus strengthening remote work opportunities. Cooperation is being carried out with the University of Athens and the EU project Smart Islands. The Energy Community is being created, a community energy production platform that involves local businesses and residents. Advanced digital management tools (FarmGeoBalance application) and smart farming technologies, such as sensors on olive farms, are being implemented in agriculture. Solutions for charging electric cars, public transport and e-bike rental are being integrated into the infrastructure. A public Terra Kythera brand is being created to promote entrepreneurship, strengthening the recognition of local products (olive oil, honey). It is planned to establish a community energy system that integrates low-load synergy solutions for businesses, small and medium-size enterprises, and residents.

Smart village strategies emphasise recurring solutions: youth empowerment, community businesses, education, cooperation, and the use of local potential. Examples include: Alsunga (Latvia), which developed youth training, creative spaces and local markets; Babina Greda (Croatia), which invested in green energy and social projects; and Virtsu (Estonia), which combined coastal tourism, renewable energy and education partnerships. Similar initiatives in other villages show that the adoption of technology, education in sustainable energy, and active communities are central to successful smart village transformation.

4. An integrated smart village management model

A systematic content analysis conducted using the PRISMA methodology (Moher et al., 2021) revealed that smart village development is a complex interdisciplinary process. Addressing the structural challenges of rural development requires an integrated approach that not only responds to existing problems but also strengthens the resilience, autonomy and sustainability of local communities. A smart village development model was developed based on these data (see Figure 2).

The model bases the development of a smart village on four main, closely interrelated elements: education, community businesses, youth inclusion and cooperation. These elements act as a response to the structural weaknesses existing in rural areas, and at the same time open up greater opportunities to develop local strengths.

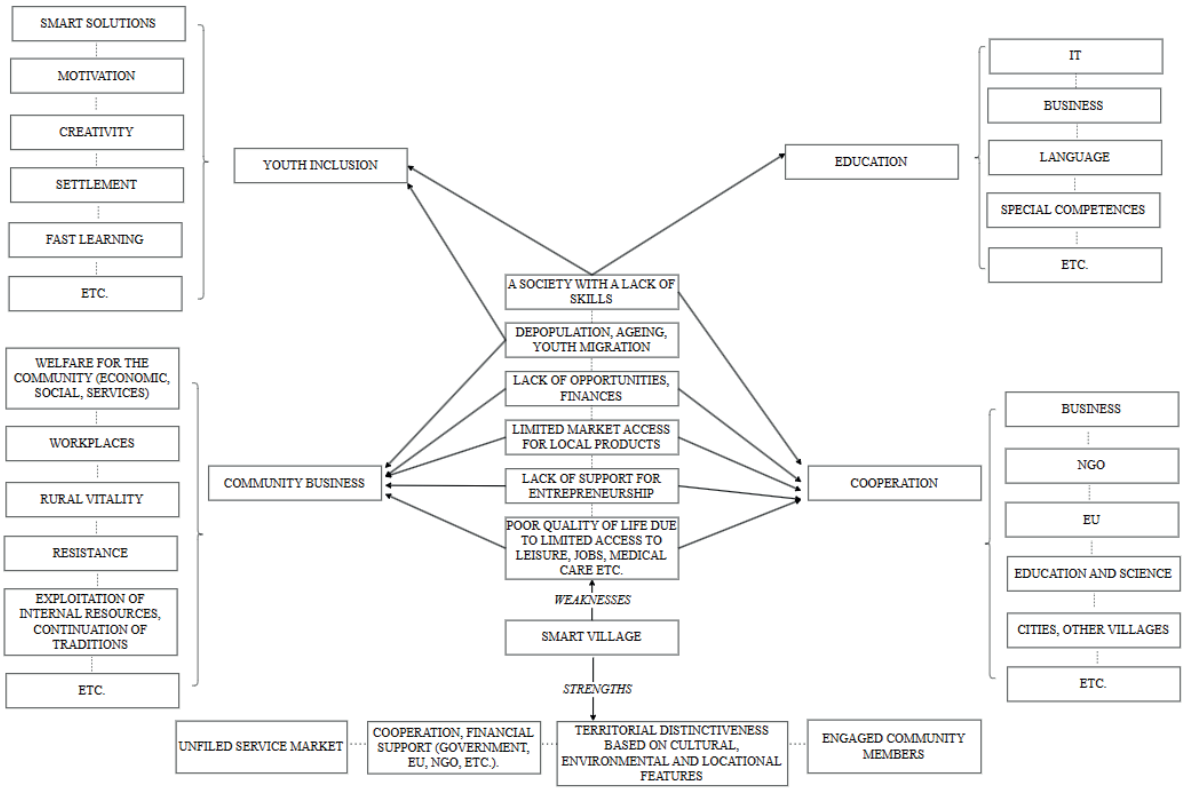

Figure 2. An integrated smart village development model

The model focuses on the main problems of rural areas: population decline and youth emigration, limited opportunities and financial resources, insufficient market penetration of local products, lack of promotion of entrepreneurship, and poor quality of life related to limited access to services, employment and healthcare. These problems are further exacerbated by the low level of skills of the population, which limits their opportunities to integrate into the labour market or initiate local changes.

The model reveals that the most important response to these challenges is integrated solutions and actions. Education helps to strengthen the competences of local communities, both general (IT, language, entrepreneurship, social, etc) and specific, related to specific activities or business niches. The inclusion of young people is based on their creativity, motivation, and their ability to learn quickly and apply smart solutions. Young people become not only renewers of the demographic structure, but also carriers of local innovations, leaders who encourage other members of the community.

At the same time, community businesses play an important role in the model: they not only create jobs, and strengthen social activism and unity, but also allow the use of internal resources, continue traditions, and contribute to the resilience and vitality of the village. Community businesses are directly related to local well-being: economic, social and cultural.

Cooperation plays a special role in the model. It is understood broadly as interaction between communities, businesses, non-governmental organisations, educational institutions, cities, or other villages. Cooperation also includes financial support from the state, the EU or other sources, helping to implement local initiatives. Such interaction becomes an essential condition for successful integrated development.

When applying the model, the strengths and uniqueness of each individual village should be highlighted, which can be purposefully exploited in order to become a smart village: territorial uniqueness (natural or

cultural features), active and involved community members, untapped potential of the service market, etc. All these assumptions create a favourable environment for the implementation of the smart village concept.

Thus, the model proposes a systemic approach in which education, youth engagement, community entrepreneurship and collaboration are interrelated driving forces to overcome the weaknesses of rural areas and exploit their potential, based on local resources, culture and community initiatives. This allows for a transition from a problematic state to a vision of a sustainable, vibrant and smart rural community.

Conclusions

The study revealed that most European villages face complex challenges to their viability: population decline, youth migration, an ageing population, limited access to services, underdeveloped infrastructure, lack of financial resources, and digital and social exclusion. These challenges are exacerbated by low levels of local competence, weak leadership and weak community involvement in decision-making.

The analysis of smart village strategies has shown that four closely interrelated driving forces are necessary for a successful transition to a smart village: education, youth inclusion, community businesses and cooperation. Interdisciplinary education helps to empower communities, develop new skills, and create and implement innovations. Youth inclusion is necessary both as a response to demographic changes and as a driver of innovation: young people usually initiate technological, entrepreneurial and social solutions. Community businesses allow the use of local resources to provide services that meet local needs, create jobs, and strengthen social cohesion. Meanwhile, intersectoral cooperation with educational and municipal institutions, businesses, various community groups and international partners allows for the mobilisation of resources, the exchange of experience, and a long-term positive impact on the development of the area.

Based on the results of the systematic analysis, an integrated model of smart village development has been formed, in which four driving forces act as a response to structural local problems, and at the same time create the prerequisites for strengthening rural sustainability, resilience and autonomy. The model also reveals that fundamental changes are possible only when local development tasks are solved in a comprehensive manner, using a holistic approach, strengthening the unique features of each village, which are based on natural, cultural, social and human resources, competence, and development capacities.

Education, youth involvement and participation in managing local development, community entrepreneurship and cross-sectoral cooperation are key factors, the good management of which can contribute to the successful transformation into a smart, vibrant, sustainable village, capable of adapting to modern challenges, preserving its identity and creating added value, both for the local community and, more broadly, on a regional and European level.

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INTEGRUOTAS SUMANIOJO KAIMO VYSTYMO MODELIS: ŠVIETIMAS, BENDRUOMENĖS VERSLAS, JAUNIMO ĮTRAUKTIS, BENDRADARBIAVIMAS

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Santrauka

Straipsnyje analizuojami tradicinių kaimų iššūkiai pereinant prie sumaniojo kaimo strategijos, kuri tampa vis aktualesnė dėl senėjančios visuomenės, besitraukiančių paslaugų ir infrastruktūros, darbo vietų praradimo ir kitų priežasčių. Mokslinėje literatūroje dažnai minimos tokios kliūtys, kaip vietos lyderių trūkumas, riboti žmogiškieji ir finansiniai ištekliai, skaitmeninė atskirtis, nepakankamas bendradarbiavimas ir jaunimo įtraukties stoka. Nors Europoje ir už jos ribų yra sėkmingų sumanių kaimų pavyzdžių, jie dar plačiai nepaplitę. Taikant PRISMA 2020 metodiką, straipsnyje atliekama sisteminė turinio analizė ir sudaromas integruotas sumaniojo kaimo vystymo modelis, kuriame nustatomi pagrindiniai kaimų gyvybingumo iššūkiai ir sumanieji jų sprendimo būdai. Modelis atskleidžia, kad norint įgyvendinti sumaniojo kaimo strategiją ir užtikrinti tvarų jo vystymąsi, būtinas visapusiškas vietos bendruomenės įsitraukimas, jaunų, kūrybingų, motyvuotų žmonių dalyvavimas ir ugdymas. Tarpdisciplininis ugdymas – nuo technologinių įgūdžių ir skaitmeninio raštingumo iki socialinių kompetencijų ir verslumo – sudaro sąlygas formuotis vietos lyderiams, gebantiems inicijuoti pokyčius, visai bendruomenei susitelkiant į bendrą tikslą. Bendruomenės verslas skatina orientuotis į bendrą tikslą, stiprina vietos ekonomiką ir gerina gyvenimo kokybę. Tarpsektorinis bendradarbiavimas

su mokslo ir valdžios institucijomis, verslo organizacijomis ir vietos bendruomenėmis sudaro galimybes aktyviau dalyvauti ES iniciatyvose. Keturios varomosios jėgos veikia kaip atsakas į struktūrines vietos problemas, kartu sukuria kaimo tvarumo, atsparumo ir autonomijos stiprinimo prielaidas. Esminiai pokyčiai įmanomi tik kompleksiškai sprendžiant vietos plėtros iššūkius, laikantis visa apimančio požiūrio, puoselėjant unikalius kiekvieno kaimo bruožus, kurie grindžiami gamtos, kultūros, socialiniais ir žmogiškaisiais ištekliais, kompetencija ir vystymosi pajėgumais. Įgyvendinant modelį, kai veikiama sistemiškai, sudaroma galimybė kaimo bendruomenei pereiti nuo problemiškos būsenos prie tvarios, gyvybingos ir sumanios kaimo bendruomenės vizijos. Svarbu puoselėti kiekvieno kaimo stipriąsias puses ir unikalumą: teritorinį unikalumą (gamtos, kultūros ypatybės), bendruomenės narių aktyvumą ir įsitraukimą, neišnaudoto paslaugų rinkos potencialo pritraukimą ir kt. Visos šios prielaidos sukuria palankią sumaniojo kaimo koncepcijos įgyvendinimo aplinką.

RAKTINIAI ŽODŽIAI: *sumanusis kaimas, gyvybingumo iššūkiai, sumanūs sprendimai, vystymosi valdymo modelis.*

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ANNEX 1. Smart village case studies

	Challenges facing the village	Smart solutions
Alsunga (Latvia)	• Depopulation • Ageing society and youth migration • Lack of housing (especially for young people or newcomers) • Existing housing does not meet modern requirements (heating, plumbing, toilets) • Poor quality of education: Alsunga secondary school is losing students, parents are sending their children to other schools • Alsunga is not a tourist destination: a passable village • Lack of infrastructure funding: limited resources for the development of roads, services and businesses • Beliefs, established habits (that all problems must be solved by the municipality, the passive attitude of the community) • Community passivity • Unpreparedness for change, poor skills: some residents do not want to change their habits	• Formation of an action group (Smart Village Action Group), an open, voluntary group uniting residents, entrepreneurs, municipal representatives, young people and elders. They generate ideas, carry out activities, and organise discussions • Focus on entrepreneurship (Suitu market): promoted cooperation, tourist stops, entrepreneurship of craftsmen and farmers • Cooperation between tourism businesses (a mobile application was created for coordinating services) • Installation of a collaboration space in the local library (created for small businesses, especially those working remotely) • Training on business creation is being carried out (in cooperation with the Latvian Rural Advisory Centre). • Research on service needs in the village has been carried out (missing solutions identified) • Popularisation of the school (creative environment, technologies, children's inclusion) • Programming training (as an opportunity for young people to obtain knowledge and work without leaving the village)
Babina Greda (Croatia)	• Population ageing and youth emigration (young, educated people leave in search of better living and working conditions) • Insufficient entrepreneurship support (lack of assistance for start-ups, information about EU support, consultations, business premises, connections between businesses) • Insufficient educational and cultural opportunities (youth and senior citizens lack spaces for self-expression, creativity, cultural and physical activities) • No gym (students have to do physical education in the corridors in winter, senior citizens have no opportunities for physical activity) • Economic dependence on traditional agriculture • Insufficient public transport (especially relevant for older people, disabled people, and those who live further from the centre) • Insufficient marketing and awareness of identity (local products, events and culture are not well known outside Slavonia) • Youth migration to cities • Untapped agricultural potential • Lack of knowledge about agrotechnology	• Utilisation of geothermal potential (construction of a 20 MW power plant, development of aquaculture, greenhouses, recreational tourism) • Attracting investment (Babina Greda built a biomass power plant, which attracted foreign investment and created jobs) • Implementation of projects (Zaželi) (18 women work to help senior citizens, while solving problems of social exclusion and unemployment) • Energy-efficient municipal building (low energy consumption), transparent municipal work (broadcasting of council meetings) • A digital agricultural map has been created and soil analysis has been performed (a step towards advanced agriculture) • An active NGO network (strengthens social capital, the preservation of traditions, inter-institutional cooperation) • Activities for youth and education (multi-activity spaces, clubs, trainings, events are planned) • Cooperation: partnership with the University of Zagreb and the EU project Smart Village Lab • Education: training on sustainable agriculture and agrotechnologies

	Challenges facing the village	Smart solutions
Dingle (Ireland)	• Emigration and ageing (the population has declined 58% since 1911, the 0-18 age group has declined from 31% to 23%) • Seasonality of tourism (strong dependence on the summer season, the summer tourist influx puts a strain on infrastructure and reduces the quality of life for local residents) • Lack of youth involvement (young people are not sufficiently involved in decision-making, only 29% believe there are adequate youth spaces) • Lack of housing for local residents (increased AirBnB and second homes have driven up prices, making it difficult for locals to buy or rent housing) • Insufficient public transport (especially in rural areas west of Dingle: residents are dependent on cars) • Limited access to public services (post offices and shops are closing in neighbouring villages, increasing isolation) • Lack of a knowledge economy and public jobs	• Community business: an annual music festival organised by the local community • Youth involvement: programmes to encourage young people to stay (e.g. art workshops) • Collaboration: links with Cork University and EU cultural programmes • Implementation of the Dingle 2030 initiative (aims to become carbon neutral, promotes green energy, climate change maps) • Promotion of digital entrepreneurship, creative industries, creation of collaborative spaces (Dingle Creativity and Innovation Hub) • MaREI collaboration (uses marine and renewable energy solutions, integrates climate change projections) • Participatory democracy (Local Area Advisory Council, LAAC). Residents identify problems and solutions themselves • Use of LEADER and SICAP programmes (supports local business, social inclusion, education, community development) • Planning new residential areas (including retirement villages and building starter homes for locals) • Bioenergy ambassadors (community members spreading information about sustainable energy and smart farming)
Kythera (Greece)	• Demographic exclusion, youth migration • Technology/infrastructure gaps • Underdeveloped entrepreneurship • Energy modernisation is necessary	• Energy Community is being created: a community-based energy production platform involving local businesses and residents • Digital agricultural management tools are being implemented through the FarmGeoBalance application developed by the university • Active youth participation: workshops, digital transformation seminars are being organised, an attractive environment is being created for young people • Smart farming tools are being introduced: sensors in olive farms • Electric vehicles and public transport, e-bike rental models are being included • Data platforms (FarmGeoBalance) for residents and farmers: open information sharing between each other and with institutions is being encouraged • Public Terra Kytheria brand: creation of a quality recognition mark for local products (olive oil, honey) • Partnerships between farmers, marketing agencies and EU project funders are being encouraged • Plans to establish a community energy system: low-load synergy solutions with businesses, SMEs and residents • Community-based business is being developed

	Challenges facing the village	Smart solutions
Penela (Portugal)	• A shortage of digital network services and public transport • Dispersed, low-density population with progressive ageing • Peripheral position relative to urban centres • Scarce job opportunities and long-term unemployment • Lack of policies for demographic attraction, elderly inclusion, and human resource retention • Underutilisation of local cultural and natural resources • Low investment in heritage and building preservation; difficulty financing cultural initiatives • Environmental degradation from forest fires, monoculture and intensive exploitation • Lack of clean water infrastructure and low use of renewable energy systems • Weak territorial competitiveness due to limited business investment	• A community goat centre has been created, supported by local and national partners. It is based on traditional cheese and pasture methods, updated through the digital platform FarmReal, which allows to virtually adopt animals and observe their lives. • Educational programmes related to local resources have been implemented: the water cycle, the honey cycle, bread baking, and herding traditions. The programmes are aimed at students, local guides and tourists, with an educational and sustainability component • The FarmReal platform aims to make animal husbandry more attractive to young people, giving them the opportunity to participate in digital, innovative processes • Young people are involved in the development of strategic plans through meetings and discussions • Strong partnerships with academic institutions (Pedro Nunes Institute [IPN], HIESE innovation incubator) tourism operators (Schist Villages Network [Favacal, Casal de São Simão, Louçainha] joint tourist routes, investment in accommodation) European Living Labs network (collaboration in testing innovative services in real conditions) • Creation of a Village Protection Zone (VPZ): replaced flammable eucalyptus trees with more fire-resistant trees to protect the residential area • Construction of a community shelter: the first such shelter in Portugal, designed to protect residents from fires • Local and regional strategies (the village is included in the Schist Villages Network, which promotes sustainable tourism and the preservation of the cultural heritage. EU support programmes are also used (e.g. Portugal 2020)
Sollstedt (Germany)	• Demographic crisis (almost a third of the population is over 65, and the population continues to decline due to ageing and migration) • Economic decline (after the closure of the potash mine in 1990 (during German reunification), the region experienced an economic downturn, and the lack of businesses limits job creation) • Poor infrastructure (the digital divide: a lack of broadband internet, which limits the possibility to work remotely and attract businesses) • Social services: a lack of attractive public spaces, youth activities, services for senior citizens, and modern housing • Lack of tourism and local economic development: there is not enough infrastructure or services to attract visitors or promote local trade • Lack of digital literacy skills among local residents, as well as social skills	• Broad community participation (the development of the strategy was a collective process involving residents, businesses, the municipal administration and the rural development council) • Development of digital infrastructure (Broadband internet [fibre optics], the main axis of the strategy, designed to attract businesses and encourage remote work. Electric vehicle charging stations: promote clean transport) • New services (digital commerce and medical services: increasing accessibility for rural residents • Dissemination of tourism and events through digital channels: promote visitor flow) • Training: raising the digital literacy of residents so they can use new technologies

	Challenges facing the village	Smart solutions
Tomaszyn (Poland)	• Declining population (a population decline from 228 inhabitants in 1895 to 18 in 2020) • Ageing community and youth migration to cities • Lost services (shops, health posts, school) • Weak agricultural production value chain (too many intermediaries, low profits for farmers) • Lack of cooperation on knowledge and innovation for organic agriculture • Lack of sufficient infrastructure for product storage and processing • Environmental challenges (impact of conventional agriculture on nature; inefficient use of water and energy resources)	• Community business: local product cooperative (Tomaszyn organic products) • Creation of the Ostoja Natury cooperative (united local farmers and provided them with direct market access, without intermediaries) • Implemented organic farming methods (permaculture, renewable agriculture) • Education: training on brand building • Cooperation: partnership with the Grodno region (Belarus) and EU funds • Innovative solutions (BioHub, a distribution platform for local food production: market, online store, Vegemat automatic vending machines). Green energy: renewable sources (biomass, solar energy, wind turbines). Smart water management solutions (the Ost-Oya passive irrigation system, recycling of contaminated water). Ecological construction (hemp concrete, wooden houses, renewable energy sources) • Community involvement (partnership with local government, universities, scientific institutions). Training and educational programmes for farmers (BioTec platform)
Virtsu (Estonia).	• An ageing society and shrinking population: most of the population are elderly, and young people are leaving • Lack of jobs: there are not enough local businesses, so it is difficult for new residents to find work • Poor infrastructure: there are abandoned buildings and untidy public spaces • Disunity in the community: people do not cooperate much, it is difficult to cooperate • Status of a village. After the administrative reform, the village became more distant from the district centre, so it receives less attention and funding • Threat of school closure (it reduces the attractiveness of the village for families) • Unknown identity: Virtsu was known only as a transit port to the island of Saaremaa, and not as a tourist or residential area • Passive tourism: visitors do not stay, there are not enough services or attractions • Outdated knowledge of local residents, poor education	• Community business: the development of fishing tourism (e.g. fishing experiences for tourists) • Education: training in maritime tourism for young people • Cooperation: partnership with Tallinn Technology Park and the EU project Smart Coastal Village • Community activities: Virtsu Arenguselts (development association) actively involves residents in projects, e.g. cultural events, maintenance work for festivals • Preservation of the local school: residents collected signatures to prove that the school is vital • Partnership with universities: cooperation with Tartu University and the Estonian Agricultural University has stimulated scientific and tourism initiatives • Business centre: an entrepreneurship centre is being created to promote new companies (e.g. in the renewable energy sector) • Tourism development: the historic castle complex is being renovated, beach and yacht marinas are being created, and tourist routes are being created • Renewable energy: the potential of wind farms is being exploited, a solar park is being planned • Community financing: a cooperative is being created to invest in local projects (e.g. a composting system, the sharing economy)