



Towards smart, digitalised rural regions and communities – Policies, best practices and case studies

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A B S T R A C T

Rural communities and regions face specific challenges in terms of thin markets, low population density, and long distances. Also, the demographics of these communities are often skewed towards the elderly, and the socioeconomics is characterized by higher share of low-income populations. While the concept of urban smart communities is quite well established, such as Smart Cities, the concept of smart rural region communities is only beginning to gain scholarly attention. Smart rural communities can be understood as rural areas and communities that build on their existing strengths and assets as well as on developing new opportunities based on the aforementioned. Traditional and new networks and services can be improved by utilizing digital telecommunication technologies, innovations, and better use of data and knowledge to benefit the communities. Investing in both physical and digital connectivity, and building digital environments for innovative services, economic sustainability, jobs, and social capital can be enhanced, thus contributing to active and live rural communities. Consequently, the development of smart rural communities and regions begins to emerge in research. What is becoming evident is that achieving the ambitions of smart rural communities requires not only digital technologies but also innovation of commercial and social services, as well as better digital capabilities and skills to bridge the existing – and in places the widening - divide between rural and urban communities.

1. Introduction

The concept of ‘rurality’ is itself unclear and often contextual, as pointed out by (Hardy et al., 2019), (Hardy et al., 2018). Yet the issues of proximity, demographics, and other social factors remain relatively unchanged throughout different definitions. In this special issue, there is no precise definition of rurality, since such definitions would be meaningless as rurality in Europe has different connotation than rurality in Africa. Also, between countries within regions, such as Southeast Asia, the concept of rurality is not identical. For example, in the United States, [x1] identifies three different definitions of rurality. The Eurostat uses a technical definition based on population density: less than 300 inhabitants per 1 km². Correspondingly, an area is considered urban when the density exceeds 300 inhabitants per square kilometer (Eurostat, 2018).

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thin markets, low population density, and long distances. Also, the demographics of these communities are often skewed towards the elderly, and the socioeconomics is characterized by higher share of low-income populations. While the concept of urban smart communities is quite well established, e.g. Smart Cities (Silva et al., 2018), (Batty et al., 2012), the concept of smart rural region communities is only beginning to gain scholarly attention.

Smart rural communities can be understood as rural areas and communities that build on their existing strengths and assets as well as on developing new opportunities based on the aforementioned. Traditional and new networks and services can be improved by utilizing digital telecommunication technologies, innovations, and better use of data and knowledge to benefit the communities. Investing in both physical and digital connectivity, and building digital environments for innovative services, economic sustainability, jobs, and social capital can be enhanced, thus contributing to active and live rural communities.

This article is part of a special issue entitled: Smart Communities published in Technology in Society.

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<https://doi.org/10.1016/j.techsoc.2025.102824>

Received 26 August 2024; Received in revised form 5 November 2024; Accepted 17 January 2025

Available online 22 January 2025

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Consequently, the development of smart rural communities and regions begins to emerge in research (Naldi et al., 2015). What is becoming evident is that achieving the ambitions of smart rural communities requires not only digital technologies but also innovation of commercial and social services, as well as better digital capabilities and skills to bridge the existing – and in places the widening - divide between rural and urban communities.

Research suggests community-centered approaches, emphasizing that sustainable living in rural areas cannot be achieved only through technology (Irwansyah, 2020). To ensure the sustainability, effectiveness, and usability of new solutions in the long term, the process must be started, adapted, and led by local actors following their actual needs. Learning from smart city research, the involvement of key stakeholders in the process is one of the keys. With a focus in the community, research is also beginning to question the dichotomy between smart cities and smart rural areas. There is a valid argument that many regions in the world are more characterized by towns and villages rather than large mega-cities, the challenges and opportunities of which differ (at least to some extent) from rural areas. Also, the trends in urban and spatial planning under digital transformation call for greater focus on sustainable development (Henriksen et al., 2021).

The rural challenges occur commonly across the world as the papers in this special issue indicate. In Europe, the rural areas are home to 137

million people representing almost 30% of its population and over 80% of its areal territory, when considering all communes and municipalities of the European Union having low population size or density (Eurostat, 2023). Despite the social aspects related to demographics, economics, and education, much of the research and development has been related to technology and its incorporation in rural areas to improve digital connectivity. Obviously, this is one of the critical issues to keep rural communities from further losing their population (Rosario et al., 2021). Although the pandemic (COVID-19) caused some reverse population shifts in places, the big picture of urbanization has not changed (Halfacree, 2024).

Rural challenges have been recognized by high-level policymakers and actions have been taken. For example, between 2021 and 2024 the European Commission has financed more than 60 research and innovation projects with a total worth of more than €250 million (European Commission). The objective is to keep the rural economies alive by primarily promoting jobs, but also enhancing social inclusion and sense of community. Many of the research actions have been linked with agriculture and farming (thus related to Common Agriculture Policy, CAP) such as social farming as a value-added function on top of traditional farming (Sgroi, 2022). The idea is not to rely solely on technology, but to invest in social capital and have a sense of identity and common purpose (Falk & Kilpatrick, 2000).

Table 1
Overview of the accepted articles.

Title	Keywords	Authors	Country
1 Developing a handloom through d.schools design thinking approach	Design thinking, handloom, product design, new product development, innovation, innovation management	Ashutosh Samadhiya and Rajat Agrawal	India
2 Mind the gap: The AURORAL ecosystem for the digital transformation of smart communities and rural areas	Smart communities, Internet of Things, interoperability, rural areas, digital transformation	Oihane Gómez-Carmona and David Buján-Carballeda	Spain
3 Antecedents of smart farming adoption to mitigate the digital divide – extended innovation diffusion model	Smart farming adoption, relative advantage, compatibility, ease of use, result demonstrability, perceived risk, government support, visibility	Krishna Dixit et al.	India
4 Use and behavioural intention using digital payment systems among rural residents: Extending the UTAUT-2 model	Digital payment systems, UTAUT-2, rural residents, behavioural intention, PLS-SEM	Mohd Hanafi Azman On et al.	Malaysia
5 Technological or social? Influencing factors and mechanisms of the psychological digital divide in rural Chinese elderly	Psychological digital divide, social exclusion, technology anxiety, relative digital deprivation, IS continuance intention, cognitive age	Weihua Wang et al.	China
6 A literature review of smart technology domains with implications for research on smart rural communities	Literature review, smart technology, smart technology domains, smart rural communities, sociotechnical, empirical	Kine Jakobsen et al.	Norway
7 Key factors for sustainable operation of smart rural communities in aging societies: Voices of Korean community leaders	Smart rural community, aging community, rural area, socio-technical system, analytic hierarchy process (AHP)	Ji Yeon Cho and Soo Kyung Park	South Korea
8 Sustainability of smart rural mobility and tourism: A key performance indicators-based approach	Smart mobility, smart tourism, smart rural community, sustainability, indicators	Shahid Hussain et al.	Finland
9 A break in the cloud: the local sociotechnical affordances underlying global internet infrastructures	Community internet networks, sociotechnical affordance, rural development, data center, internet infrastructure	Janna Z. Huang	United States
10 A DLT-based framework for secure IoT infrastructure in smart communities	Industry 4.0, smart community, IoT, security and privacy, distributed ledger technology, hyperledger fabric, permissioned network, smart contract	Georgios Gkogkos et al.	Greece
11 The role of local community empowerment in the digital transformation of rural tourism development in the Philippines	Community empowerment, digital transformation, rural tourism development, tourism planning and development	Mark Chris M. Lapuz	Philippines
12 WeChat business and place identity construction in rural China: A case study of Beiqishui village, Zhouzhi county	WeChat business, place identity, "Economy–Emotion–Place" framework, rural areas, Beiqishui village	Jiao Zhou et al.	China
13 Contextualizing the rural in digital studies: A computational literature review of rural-digital relations	Rural geography, digital geography, rural-digital relations, context, computational literature review, topic modelling, Qualitative Content Analysis, global, Nordic	Qian Zhang et al.	Sweden
14 Data-driven quantitative analysis of an integrated open digital ecosystems platform for user-centric energy retrofits: A case study in northern Sweden	Energy retrofits, data-driven modelling, Decision Support Systems (DSS), quantitative analysis, open ecosystem platform	Bokai Liu et al.	Sweden
15 Thermal energy community-based multi-dimensional business model framework and critical success factors investigation in the mediterranean region of the EU	Smart rural communities, energy communities, thermal energy communities, business models, bioenergy	Arnau González et al.	Spain
16 Food security, the agriculture value chain, and digital transformation: The case of Jamaica's agricultural business information system (ABIS)	Digital transformation, Jamaica, agriculture, technology	Donavon Johnson	Jamaica
17 Internet over the ocean: A smart IoT-enabled digital ecosystem for empowering coastal fisher communities	Sustainable social change, coastal community empowerment, digital ecosystem, blockchain technology, co-design, digital divide, fishing community	Sruthy Anand et al.	India

The call for papers for this virtual special issue (VSI) was launched in 2022, right after the COVID-19 pandemic had lost its grip on the world. VSI "Towards smart, digitalized rural regions and communities – policies, best practices, and case studies" was initiated by a group of researchers that had just begun a new European project "Architecture for Unified Regional and Open Digital Ecosystems for Smart Communities and Rural Areas Large Scale Application" (AURORAL). The project was funded by the European Commission under the Horizon 2020 research program (<https://cordis.europa.eu/project/id/101016854>), an example of the aforementioned research and innovation actions.

After two years of research contributions and reviewing the vast number of manuscripts, the compiled VSI is published. Out of more than 70 original research manuscripts 17 were finally accepted for publication. The details of the accepted papers including the title, keywords, authors list and country are given in Table 1.

Thematically, the article collection was diversified into several topical areas (see Fig. 1). Digital transformation of rural areas was the most common topic touched on by the researchers. Also, the digital divide between rural and urban areas received high attention. It is noteworthy that rural issues cover all types of economies and countries: highly industrialized and developed countries from Scandinavia, technology giants' home base countries from Northern America, fast-growing Asian economies, and countries that can still be considered as emerging economies. Therefore, we can consider that rural issues do not respect any economic, social, or geographical boundaries but are truly of global concern.

2. Paper contributions

The VSI starts with an Opinion Paper delivered by Gómez-Carmona et al. introducing the AURORAL platform concept that was demonstrated in the respective European project and in multiple pilot locations across the European Union. The fundamental idea of the platform is to provide digital connectivity crossing the domain boundaries, thus creating a sufficient economy of scale that the rural areas often lack. Similar digital tools, but more specific in terms of domain setting, were introduced by Zhou et al., in the small Chinese village of Beiqishui, where the WeChat platform was successfully adopted by villagers making them economically more active and self-aware. Ong et al. report how digital payment systems are affected by behavioral factors, especially in rural areas. Liu et al. propose an open digital ecosystem for energy retrofits, using a case study from Sweden. Finally, Anand et al. show how a fishing community in Kerala, India, co-designed a multi-

purpose digital ecosystem serving the community needs and internal communications.

The digital divide is inherently present especially in rural areas but also regarding different citizen segments, such as socio-economically disadvantaged and elderly. Wang et al. analyze the psychological digital divide among the elderly in rural China. The combination of dividing factors may lead to increasing deprivation. Adopting smart systems and tools is naturally affected by the digital divide, as reported by Dixit et al. when they search for factors that influence adopting smart farming methods. More generally, Cho and Park find that cultural and social factors are key elements of successfully bridging the digital divide, as they present their Korean case study. Therefore, empowering the local communities should be a part of rural support measures. This is also underlined by Lapuz, as local communities are facilitated to actively take part in tourism development. Furthermore, there is the question of trust in the technology and those who manage and govern the technologies, as pointed out by Johnson in the case of the digitalization of Jamaican agriculture.

The lack of infrastructure (both digital and physical) is one of the dividing issues why rural areas are handicapped almost without exception. However, local activism may pay off well, as demonstrated by Huang, showing how Dalles County was able to persuade Google to establish its first data center in their county. Infrastructures need to be reliable and secure, and security technologies such as blockchains may be one option to assure security, as suggested by Gkogkos. In addition to infrastructures, there is a need for working operating and business models on how to make 'smart' realized. This is highlighted by Junca et al. when they study energy community business models in the Mediterranean. Casado-Mansilla et al. argue that also educational infrastructures are inadequate in rural areas. They show how science, technology, engineering, and mathematics (STEM) education can be improved by substituting missing physical experimental laboratories with remote testing facilities.

Two literature reviews were also produced for this VSI. The first is provided by Jakobsen et al. examining empirical research on smart technologies in eight different domains. While smart technologies can potentially contribute to rural well-being and conditions e.g. in mobility, healthcare, and governance, it is not self-evident that these technologies can be straightforwardly brought to rural contexts and that they fit seamlessly to the needs of rural communities. The second one is offered by Zhang et al. considering digitalization studies in rural contexts. The outcome of this review is that the majority of the studies assume an external view and only the minority view digitalization from internal

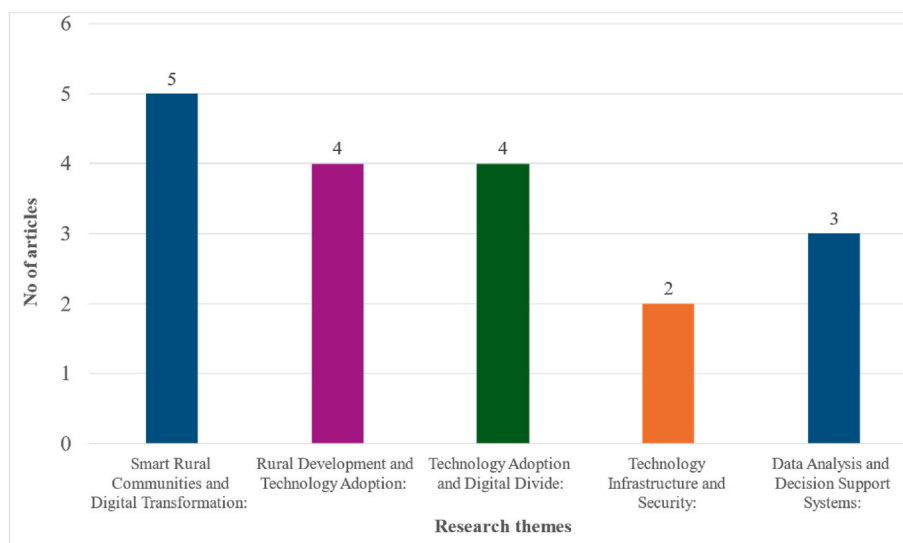


Fig. 1. Topical areas of accepted contributions in the VSI.

perspective, i.e. how communities and individuals are experiencing digital technologies.

Smartness is not only about digitalization, but being able to make use of existing, non-high-tech, resources. This is shown by Samadhiya and Agrawal who study how design-thinking was used to improve the use of hand-loom machines in rural India. Smartness should lead to sustainability too, and this is demonstrated by Hussain et al. by developing a sustainability indicator framework for smart tourism and mobility.

3. Conclusion and acknowledgments

In sum, the papers included in this VSI manifest that the social dimension of technology - especially digital technologies - does call for more research. We need to understand how technology is deployed and put into use to better serve the communities, including the rural and disadvantaged. It would be misleading to assume that simply introducing more technologies to rural communities and populations is progress *per se*. This is not to say that we should underestimate the prospects of new technologies, either. If not earlier, it was the Covid-19 pandemic that proved the power of digital connectivity, allowing people to work remotely and keeping things running and societies functioning.

This special issue has policies, best practices and case studies mentioned in its title. Most of the published articles can be categorized as case studies, showing examples of how rural communities have entered the digital age and how they have applied digital opportunities in many ways. With respect to policies that would be generalizable globally, the examples are few if any. The characteristics of rural communities, their state of maturity in digital skills and infrastructure are so diverse that universal policies are in practice impossible to identify. This means that - as painful it might be to acknowledge - silver bullets do not exist. At least not yet as far as researchers can see. Government support, subsidies, skills development through educational activities are all on the list, but this is something that has already been intuitively quite well recognized by policymakers. Also, with regards to best practices, the same dilemma remains: it seems somewhat overoptimistic to anticipate that the examples brought forth by the case studies could be transferred from one context to another.

However, we should not underestimate the value of encouraging case studies. They do demonstrate that there are solutions, opportunities and valuable lessons to be learned, across the whole spectrum of different types of rural contexts.

Delayed, as is often the case with academic deliverables, but proud and happy we are finally able to publish this VSI. We would like to extend our sincerest thanks and gratitude to all the researchers who invested their precious time to contribute to this VSI - without researchers there would not be any research, and without research, there is less expectation for progress and reflection to the progress that may have taken place. The anonymous reviewers are likewise gratefully acknowledged - they made a great effort to intensify the quality of the included manuscripts. We also thank the invaluable support and advice given by Technology in Society Editors, the journal publisher's editorial staff, and of course the European Commission through its grant no. 101016854 providing us and all the authors the possibility to address

the multiple challenges faced by rural communities and regions. We hope that some of the research results will find their way to policy making and formulation of effective practices for those decision-makers who deal with rural issues.

CRedit authorship contribution statement

Pekka Leviäkangas: Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Formal analysis, Conceptualization. **Signe Sønvisen:** Writing – review & editing, Validation, Project administration. **Diego Casado-Mansilla:** Writing – review & editing, Validation, Project administration, Conceptualization. **Marius Mikalsen:** Writing – review & editing, Project administration, Methodology, Conceptualization. **Andrea Cimmino:** Writing – review & editing, Validation, Project administration. **Anastassios Drosou:** Writing – review & editing, Validation, Project administration, Conceptualization. **Shahid Hussain:** Writing – review & editing, Visualization, Formal analysis.

Data availability

No data was used for the research described in the article.

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