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Cultivating Resilience: Best Practices and Innovation in Agriculture under Climate Stress

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Cultivating Resilience:
Best Practices and Innovation in Agriculture under Climate Stress

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Abstract

The climate crisis puts a lot of stress on the agriculture sector, from the extreme weather patterns, water shortages, to deteriorating soil health. Innovation is essential for fostering resilience via climate-smart behaviors, sophisticated technology, and adaptable value chains. The goal of this study is to provide a review of the strategies, and processes that have consistently led to superior outcomes in rural innovation and entrepreneurship in the context of start-up villages located in Europe. Employing a structured evaluative framework, this study dissects successful initiatives by examining critical dimensions such as leadership dynamics, regional readiness levels, core economic sectors and the roles of key players. The analysis further delves into the innovation and creativity embedded within each practice, and the systemic barriers to entrepreneurship encountered across various contexts. Spanning diverse geographic and socio-economic profiles—distinguished by size, proximity to urban centers, and sectoral strengths—the selected case study areas offer a rich comparative lens. The study identifies common success factors and local adaptations, highlighting how strategic resource mobilization, enabling infrastructure, and community-based leadership underpin effective innovation ecosystems. Lessons learned from each context are distilled to assess scalability potential and strategic implications for Startup Village Partners and similar initiatives aiming to foster rural revitalization through sustainable entrepreneurship. By comparing and examining startup villages listed in the European Startup Village Forum, this analysis contributes a replicable framework for identifying and transferring best practices, ultimately supporting more inclusive, place-based innovation policies.

Keywords: Climate resilience, Food security, Innovation, start-up villages, entrepreneurship

1 Introduction

The climate crisis poses a profound challenge for agriculture and rural communities worldwide. Agriculture is both a sufferer and a cause of global climate change, as 20–25% of greenhouse gas emissions come from agricultural operations [1]. Unpredictable weather, extreme weather, and changed rainfall patterns are all linked to this anthropogenic climate change. This poses a serious threat to food security and crop productivity, endangering the fundamentals of human society. At the same time, global food systems are impacted by a number of other significant issues, including expanding populations, changing dietary habits toward more meat consumption, and rising consumer and supply-chain food waste. Together, these pressures highlight the urgent need to address the intertwined relationship between agriculture, rural livelihoods, and the escalating climate crisis. Recent decades have shown that increased human activity, which has changed the planet's atmosphere, has been the main cause of notable changes in the global climate.

Traditional agricultural methods alone are no longer sustainable in addressing the rising demand for food production. Relying on these methods to enhance food production would necessitate the use of additional chemical pesticides and fertilizers, which would have detrimental effects on the environment, the climate, and human health [1]. At the same time, agriculture is the industry most at risk from climate change, due to its enormous scale and susceptibility to weather conditions, which will have a significant negative economic impact [2]. This disruptive reality calls for fresh ideas, approaches, and dedication. To break this cycle, rural innovation and entrepreneurship provide vital solutions. Farmers who adopt entrepreneurial thinking are able to identify and take advantage of new opportunities, many of which go beyond conventional farming operations. Specifically, by assessing farm-based resources in creative ways, they can diversify into new, sometimes non-agricultural markets, strengthening rural economies [3]. As entrepreneurial activity has expanded globally, researchers largely concur that entrepreneurship is a significant way to boost agricultural economic performance and encourage rural economic growth. Innovative agricultural entrepreneurs in rural areas can introduce new technologies and methods to boost farm production and efficiency, which will raise yields and profitability [4].

Proposed by the Startup Village Forum (JRC) of the European Union, a new concept has arisen, named Startup Village. Start-up village is “a place (or a network of small places) that embraces innovation and ambitious entrepreneurship as a way to unlock development potential and support well-being in rural areas” [5]. A startup village aims to create favourable conditions for entrepreneurial and innovative ecosystems by integrating local context, community, and objectives with external knowledge, resources, and markets. The JRC Startup Village Conceptualization identifies five key conceptual building blocks, namely, (a) Innovation, (b) Entrepreneurship, (c) Rural space, (d) Multiple scales, and (d) Ecosystems (see Figure 1). A startup village isn't limited to conventional farming; rather, it seeks to retain or recruit young people in rural areas by incorporating sustainable techniques, digital technologies, and innovative business models.

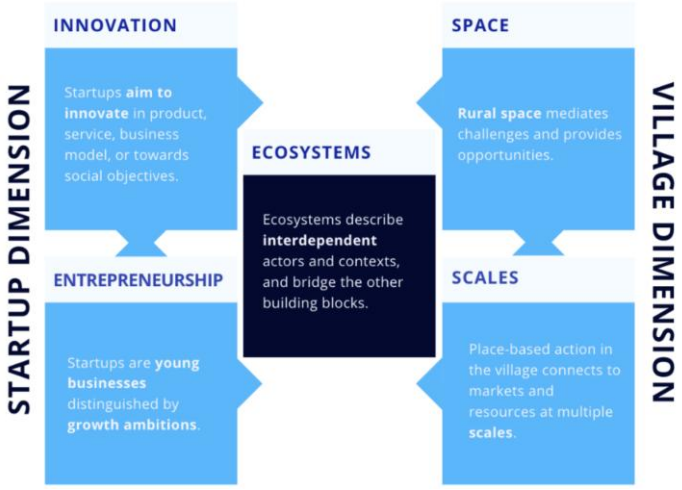

Figure 1 - Startup Village conceptual building blocks (Source: [5])

Startup villages are in line with the systems innovation approach which underscores that sustainable, place-based innovation must be fundamentally anchored in local contexts and influenced by the intricate linkages among social, environmental, and economic systems. A study aiming to examine the Water–Land–Food–Energy

Nexus in Thessaly, Greece, illustrated how a comprehensive systems-innovation framework—merging scientific sinsight with varied stakeholder expertise—can facilitate efficient resource governance and planning [6]. This methodology supports the Startup Village concept by viewing rural areas as interconnected ecosystems, where infrastructure, institutions, and community identity jointly influence innovation potential. Integrating entrepreneurship into the distinctive hydrographic, ecological, and socio-economic characteristics of locations such as Vila Nova de Paiva (for instance, utilising its pristine Paiva River for tourism, agriculture, and ecosystem services) guarantees that the systemic, place-based strategy is contextually aware, resilient, and aligned with local advantages. In the absence of this degree of local embedding—connecting cross-sector collaboration and multi-actor governance—innovation plans are likely to fail because of a discrepancy between generic planning and specific territorial dynamics.

This study delineates prevalent success criteria and regional modifications, emphasising the role of strategic resource mobilisation, supportive infrastructure, and community-driven leadership in fostering effective innovation ecosystems. Insights derived from each environment are synthesised to evaluate scaling possibilities and strategic ramifications for the European Startup Village Partners and analogous programs focused on promoting rural revitalisation via sustainable entrepreneurship. This analysis critically compares 45 startup villages across Europe to provide a reproducible framework for identifying and transferring excellent practices, thereby enhancing inclusive, place-based innovation policies.

2 Methodology

We employed a case study methodology to discover and assess various startup settlements throughout Europe. The preliminary selection was founded on the criteria established by the *European Startup Village Forum*, a significant venue for disseminating information and experiences related to fostering startup-driven innovation in rural regions [7]. To enhance the list, we conducted further online research to guarantee a wide geographical distribution and increased diversity in Startup Villages. The information collected for all the chosen startup villages is primarily based on the European Startup Village Forum. The criteria necessary for recognising a startup village are categorised into two primary groups: (a) Institutions and (b) Resources. The Institutions component encompasses both formal and informal aspects, whereas Resources comprise physical and financial elements, leadership capability, human capital, expertise, market demand, and intermediary services. Consequently, the classification of the communities is directly based on these parameters to provide a uniform and thorough evaluation.

Firstly, the Overview of the Best Practice serves as an introductory narrative, highlighting both Formal and Informal Institutions. It outlines which resources are leveraged and describes the concrete actions and innovations undertaken by each village. This is followed by an assessment of Leadership, focusing on the capacity and willingness of local actors to encourage creativity and maintain momentum for startup-driven growth. Next, we examine the Key Players, which are closely linked to Human Capital and demonstrate how leadership structures and local talent are mobilised in practice. We also analyse the Key Barriers to Innovation and Entrepreneurship to reveal gaps or weaknesses in the enabling conditions — whether related to institutions (formal or informal) or obstacles that limit *Demand* for entrepreneurial activity. Furthermore, Innovation and Creativity are explored as outcomes that reflect access to *Knowledge*, the strength of *Human Capital*, and the presence of supportive informal institutions that nurture creative ideas, risk-taking, and knowledge exchange within the community. Next, we examined Resources and Support Infrastructure, directly linked to *Physical* and *Financial Resources*, as well as *Intermediate Services* that provide essential business support. Finally, Scalability & Implications for Startup Village Partners is closely linked to *Demand*, as it assesses whether entrepreneurs in the village can access external markets to grow their businesses.

In addition to the criteria derived from the European Startup Village Forum, we also included some geographical and spatial characteristics. These are the Country, the Size of the Village as well as the Distance from the nearest main city. Although these characteristics were not listed in the Forum's enabling conditions, they were incorporated to provide a clearer understanding of the geographical diversity, settlement scale and connectivity of each case. By taking these elements into account, we can more effectively evaluate various contexts and comprehend how scale and location affect each startup village's readiness, connectedness, and development potential. To further highlight the concrete results and impacts of the enabling conditions — Institutions, Resources, and Geospatial characteristics — we also incorporated indicators of development status. Specifically, we included Core Economic Sectors (up to three per village) to indicate the primary sources of local revenue and economic activity. We also captured key outcomes—both *socio-economic* and *environmental*

— to demonstrate the tangible effects of innovation and entrepreneurship within each village. Finally, Lessons Learned were documented to provide practical insights that can inform future initiatives, partnerships, and knowledge transfer across the Startup Village network.

Finally, each village was categorised by its Readiness Level to reflect its stage of development within the innovation ecosystem [5]. This includes:

1. Envisioning stage: These villages have an interest in exploring prospects for innovation. However, they may have inadequate resources, human capital, and/or infrastructure. Consequently, they will endeavour to identify the forms of local action and multi-level support required to enhance their capacities and improve their integration into an ecosystem.

2. Experimenting stage: These villages will possess a sufficient baseline capacity, albeit in the process of developing some others. They will be undertaking actions to foster innovation and entrepreneurship within the existing ecosystem, likely having at least one startup in the incubation stage.

3. Demonstrating stage: These villages will have comparatively well-established capacities, ecosystems, and supportive frameworks. They will have dynamic startups that have achieved evidence-based results so they can serve as inspiring examples to other villages at the prior stage.

The data collecting method was primarily executed via the EU Startup Village Forum platform, which offers comprehensive profiles of rural areas involved in startup village activities [7]. Supplementary material was obtained by online desk research, encompassing municipal websites, regional development reports, and pertinent academic and policy documents. This integrated method facilitated the verification and enhancement of profiles with current demographic, economic, and industry information. The analysis employed cross-case comparison, outcome mapping, and qualitative coding to identify commonalities and discrepancies across various startup village environments. These methodologies enabled a systematic analysis of demographic, economic, and governance attributes to identify shared issues and possibilities.

3 Case studies and comparative analysis

The comprehensive review of startup villages in Europe revealed 49 sites throughout Europe. Following the exclusion of ineligible entities according to the definitions established by JRC concerning scope and size [5, 8]. 45 were considered to be relevant. In terms of geographic and demographic scope, startup villages can be villages, clusters of villages, and, in certain instances, small to medium towns that fulfil a rural service function. Thus, large towns with more than 50,000 inhabitants each are excluded from this definition. The startup villages are distributed across various parts of Europe. The mapped villages are located in multiple European countries, covering a range of contexts—from remote mountainous regions to peri-urban rural areas. Specifically, the map illustrates the location of each village, highlighting their presence in the following countries: Austria, Bulgaria, Croatia, Finland, France, Germany, Hungary, Ireland, Italy, Lithuania, the Netherlands, Portugal, Romania, Slovenia, and Spain (see Figure 2).

Figure 3 displays the distribution of startup villages based on their scale. Start-up villages are grouped in five geographic and demographic categories: (1) A village (up to 2,500 inhabitants), (2) A group of villages (each of up to 2,500 inhabitants), (3) A small town (less than 5,000 inhabitants), (4) A medium-sized town (below 50,000 inhabitants), and (5) A medium-sized town (below 50,000 inhabitants) and surrounding villages. As we see the majority falls under the second and fourth categories indicating that startup village activities are mostly focused in rural networks of small villages and in medium-sized towns serving as centres for innovation and service delivery in adjacent rural regions. Figure 4 shows the distribution of startup villages across the most dominant economic sectors. As we see, “Crop and animal production”, “Accommodation & Tourism”, and “Forestry and Logging” are the most prominent sectors developed within the above-mentioned ecosystems. This is valided by the JRC report that argues that the traditional rural sectors remain the backbone of startup village [7]. Specifically, the tourism and hospitality services that are substantially developed, frequently are associated with natural or cultural resources, while forestry, logging, and wood-based industries remain important in mountain and forested areas.

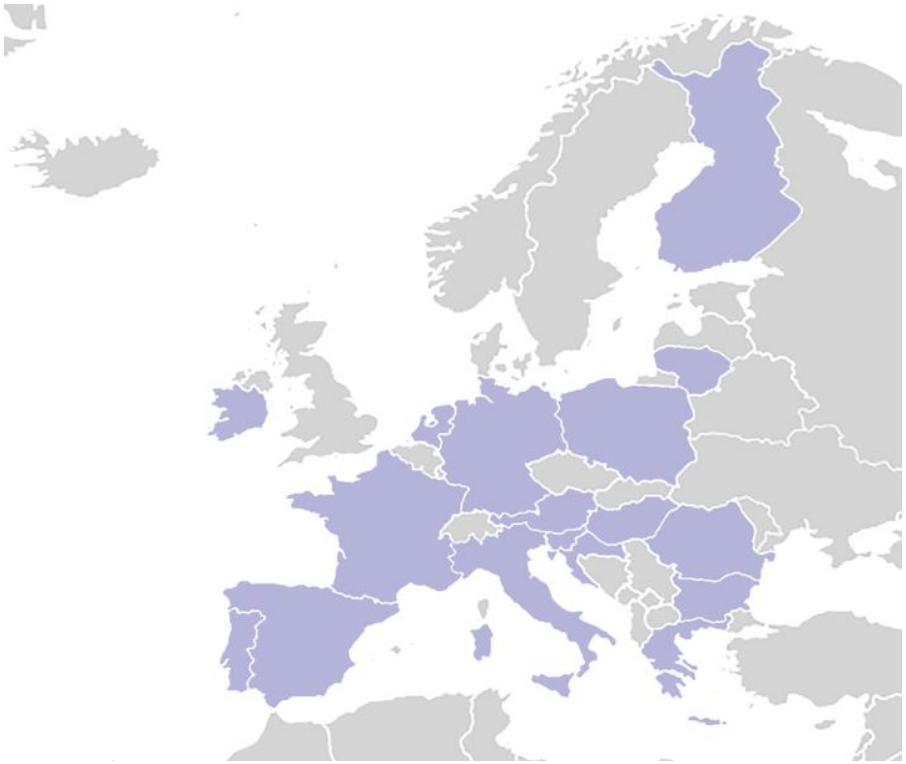

Figure 2 - Distribution of start-up villages across Europe

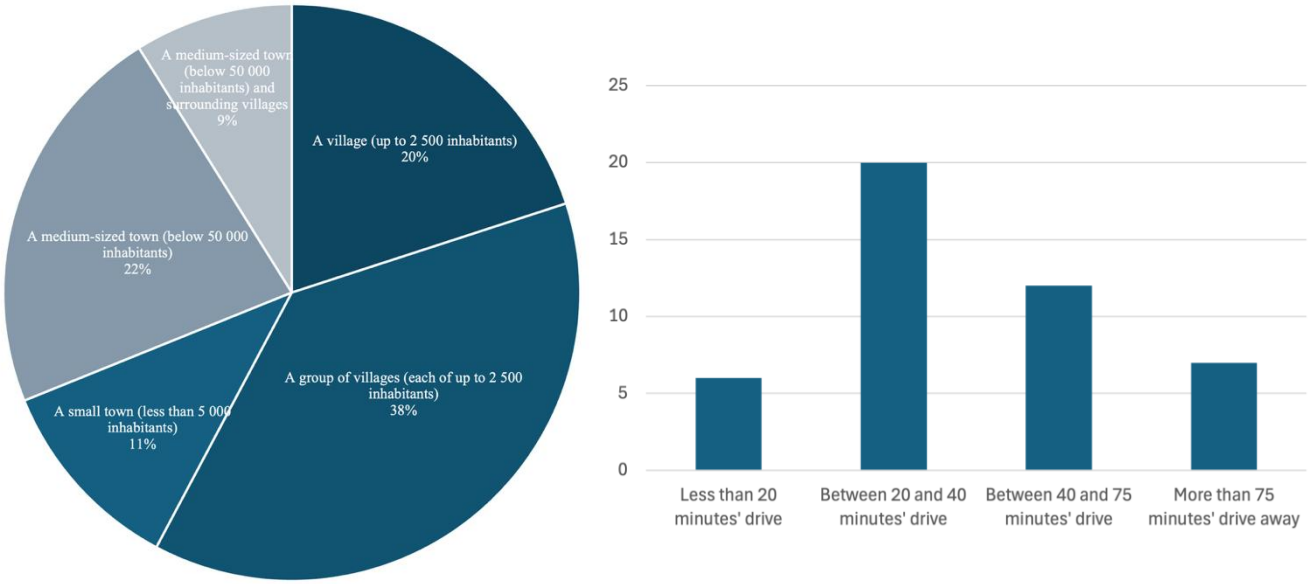

Figure 3 - Distribution of startup villages (left side: categorized by scale, right side: categorized by proximity to the nearest major city)

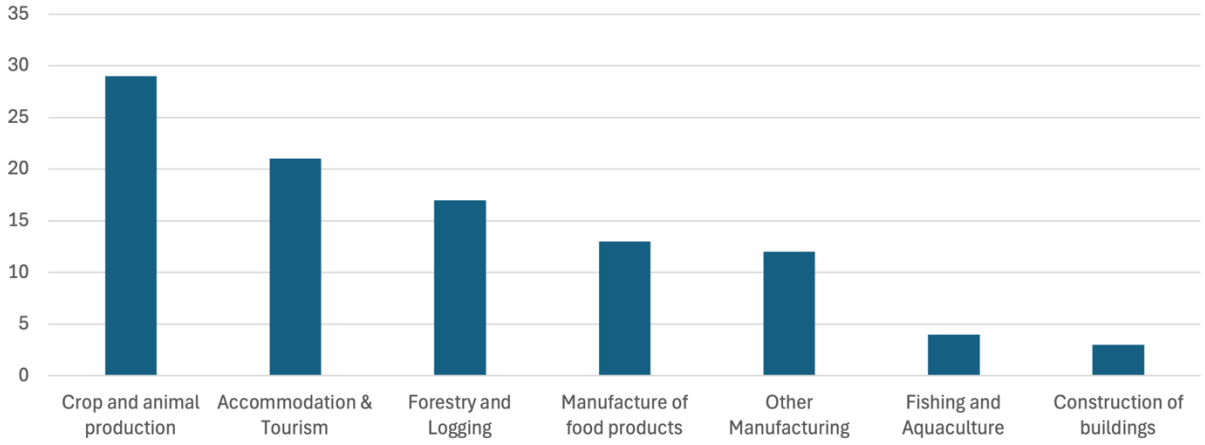

Figure 4 – Number of start-up villages per economic sector

It is observed that towns or local authorities frequently serve as important facilitators of startup village efforts due to their oversight of local development strategies, access to EU rural development subsidies, and coordination of participatory processes, with universities and research centres tending to participate as external partners rather than local leaders [7]. However, there are some cases where leadership is distributed among the municipality and other key players in the area. For instance, Horst America (Netherlands) exemplifies a robust public-private partnership, wherein the municipality engages in close collaboration with horticultural technology firms, mirroring the village's agribusiness-orientated economy. Likewise, Hilvarenbeek (Netherlands) is governed by the municipality but depends significantly on collaboration with local private firms in agriculture and recreation, which are essential for maintaining economic viability. In Central Istria (Croatia), governance adheres to the LEADER methodology, wherein public authorities orchestrate rural development efforts using participatory strategies including local stakeholders. In addition, Kitzbühel (Austria) shows how tourism enterprises can serve as significant economic catalysts, yet strategic planning and coordination are governed by municipal and regional tourism authorities.

Startup villages around Europe encounter a series of interconnected demographic, economic, infrastructural, and social challenges that limit their developmental prospects. Numerous rural regions face depopulation, an ageing demographic, and the emigration of youthful talent, prompted by insufficient employment prospects, inadequate wages, elevated living expenses, and a deficiency of quality amenities like education, childcare, and cultural activities. The gap of skilled labour and the lack of higher education institutions further diminish local innovation potential, while economic diversification is constrained, with numerous regions heavily dependent on traditional industries or tourism, jeopardising their status as "open museums" devoid of dynamic and resilient communities. Inadequate transport and digital infrastructure, coupled with delays in digitalisation efforts and limited access to capital, impede entrepreneurship and connectivity. Furthermore, fragile community frameworks and restricted participatory governance hinder effective collaboration, while environmental challenges—such as land degradation from urban sprawl, elevated traffic levels, and the necessity to reconcile agricultural conservation with increasing tourism—complicate the situation. Confronting these systemic problems is crucial for startup villages to realise their complete innovation and growth potential.

When it comes to the readiness level defined above, Table 1 maps the identified start-up villages onto the three readiness levels (envisioning, experimenting, and demonstrating). It is noticeable that the majority (48.9%) are located in the middle stage, where they possess a baseline capacity and have at least one startup in the incubation stage. Then, there is a significant share (33.3%) located in the first stage, which shows that these startup villages are interested in investigating opportunities for innovation, but they may not have enough money, human capital, or infrastructure. As a result, they are in the phase of identifying the types of local action and multi-level support needed to strengthen their capacities and integrate into an ecosystem. Finally, there are a few (17.8%) who have established capacities, ecosystems, and support frameworks, as well as dynamic companies that have achieved evidence-based successes, so they can serve as role models for other communities at an earlier stage.

Table 1 - Readiness Level of the start-up villages in Europe

Envisioning	**Experimenting**	**Demonstrating**
Petrestii de jos and Ciurila(Romania)	Kerry County(Ireland)	Kočevje (Slovenia)
Stambolovo municipality (Bulgaria)	Subequana Valley(Italy)	Horst America(Netherlands)
Figueira de Castelo Rodrigo´s Municipality (Portugal)	Angra of Heroísmo(Portugal)	Kitzbühel(Austria)
Aguiar da Beira(Portugal)	Hilvarenbeek(Netherlands)	City of Zwoenitz(Germany)
Cocorastii Mislii(Romania)	Central Istria(Croatia)	Municipality of Idanha-a-Nova (Portugal)
Fornos de Algodres(Portugal)	Alsómocsolád(Hungary)	Piran(Slovenia)
Grapice(Poland)	Alytus district municipality(Lithuania)	Ponta do Sol, Madeira(Portugal)
Merindad de Cuesta Urria(Spain)	County of Zala (Hungary)	SETÚBAL REGION (Portugal)
Mourão (Portugal)	Mancomunidad de servicios Andia(Spain)	
Municipality of Vila Nova de Paiva(Portugal)	Monti Dauni(Italy)	
Municipio de Castelo de Vide (Portugal)	Municipality of Consuegra(Spain)	
Navea Valley (Spain)	Município de Arcos de Valdevez(Portugal)	
Općina Sveti Đurđ(Croatia)	Município de Arruda-dos-Vinhos(Portugal)	
Plaiuri(Romania)	Município de Marco de Canaveses(Portugal)	
Vilares da Vilariça(Portugal)	Município Ferreira do Zêzere(Portugal)	
	Sabugal(Portugal)	
	Sallent, Cabrianes i Cornet(Spain)	
	Sierra de Béjar, Sierra de Francia y Entresierras(Spain)	
	Sierra de la Demanda(Spain)	
	Sydänsuomessa(Finland)	
	Tullnerfeld East(Austria)	
	Zona Media de Navarra (Spain)	

4 Success Factors and Scalability

Focusing on the startup villages that are in the demonstrating phases presented in Table 1, we notice that they share several common traits of success despite differences in geography and economic specialisation (see Figure 5). First, they are characterised by strong local leadership and governance that includes well-coordinated public-private partnerships. For example, Kočevje established a circular bioeconomy hub through municipal cooperation, whereas Horst America combines municipal leadership with strong agritech industrial ties. In addition, each community creates competitive niches by leveraging its distinct local assets. For instance, Kočevje focused on wood processing and bioeconomy; Horst America on high-tech horticulture; Kitzbühel-Alpine on tourism and leisure innovation; Ponta do Sol created a hotspot for tech startups and digital nomads; and Idanha-a-Nova gave space to creative industries (Boom Festival) and sustainable farming.

The existence of business incubators, co-working spaces, or cluster organisations that attract and support startups seems to be another success trait (e.g., Ponta do Sol and the Setubal region use digital infrastructure and international networks to attract external talent). Many of them also integrate green economic principles (bioeconomy, circular economy, renewable energy) with innovation, with Setubal region and Kočevje being excellent instances of blue economy and circular economy, respectively. Funding and networking with international stakeholders seem to be additional parameters, as participation in EU programmes (e.g., Horizon Europe, Interreg) and the ability to secure external finance and investors provide incentives for new innovative solutions to uptake. For instance, Zwoenitz is recognised for digital innovation, thanks in part to EU-supported smart village initiatives. Finally, active community participation in development plans, as well as strong place-based branding, are used to attract visitors, talent, and investors, with Kitzbühel and Piran being excellent examples of how great branding improves economic resilience.

Figure 5 - Success traits of startup villages in the demonstrating phase

5 Conclusions

This study illustrates that startup villages constitute a viable strategy for tackling the interconnected issues of rural depopulation, economic stagnation, and climate-related concerns. Startup villages facilitate the diversification of the economic foundation in rural areas, bolster resilience, and retain or recruit youthful talent by incorporating entrepreneurial ideas into local surroundings. The comparative examination of 45 startup villages throughout Europe reveals that the majority are still in the experimental phase (48.9%), suggesting developing yet maturing ecosystems, while a minority of villages in the showcasing phase (17.8%) exemplify successful rural innovation. Multiple prevalent success criteria were recognised throughout the communities in the exhibiting stage. Strong local leadership and governance, often combining municipal coordination with public-private partnerships, is crucial for mobilising resources and sustaining innovation momentum. Utilising distinctive local resources to establish competitive niches—such as bioeconomy in Kočevje, high-tech horticulture in Horst America, tourism and leisure in Kitzbühel, digital nomad hubs in Ponta do Sol, or creative industries in Idanha-a-Nova—is essential for developing sustainable economic ecosystems. Moreover, supportive infrastructures, like company incubators, co-working spaces, and cluster organisations, are crucial in promoting entrepreneurship and attracting external talent, as evidenced in the Setúbal Region and Zwoenitz. The incorporation of green and blue economy ideas, encompassing circular bioeconomy and renewable energy, is a hallmark of successful instances. Engagement in EU projects (Horizon Europe, Interreg, Leader) and international networking offers supplementary financial and intellectual resources that facilitate the acceleration of innovation adoption.

Notwithstanding these favourable instances, the analysis underscores enduring structural obstacles. Numerous startup villages persist in facing challenges such as depopulation, ageing demographics, low-skilled workforce, and insufficient diversity, while inadequate transportation, digital infrastructure, and access to financing are prevalent impediments. Confronting these issues necessitates a comprehensive, place-based strategy, consistent with the Startup Village Forum's conceptual framework, wherein local context, community identity, and cross-sector engagement are pivotal to ecosystem development. Transferring successful methods from demonstrating-stage villages to those in the envisioning or experimenting stages will need context-specific knowledge transmission, strategic resource mobilisation, and participatory governance. Startup villages present a viable framework for sustainable rural development, illustrating how entrepreneurship and innovation, when effectively integrated into local ecosystems, can enhance economic diversification, climate resilience, and overall quality of life in rural regions. The results provide actionable insights for policymakers and Startup Village Partners, indicating that investments in leadership development, supportive infrastructures, and community-driven innovation networks are essential for attaining sustainable rural revitalisation.

6 Limitations and Future Research

This study possesses some limitations that need to be aknowledged. The analysis predominantly depends on data from the EU Startup Village Forum platform and additional desk research, which may not comprehensively reflect the latest local developments or informal entrepreneurial activities occurring beyond publicly documented initiatives. The evaluation of preparedness levels and success variables relied predominantly on qualitative case study analysis, which, although providing valuable contextual insights, may include subjective interpretations and restrict the comparability of results across various geographical contexts. The study primarily concentrated on institutional and resource-based enabling conditions, neglecting other significant aspects such as social capital, cultural attitudes towards entrepreneurship, and individual entrepreneurial impulses. The chosen case studies are predominantly situated in Europe, hindering the generalisation of findings to other rural innovation contexts worldwide.

Subsequent research must rectify these constraints by employing a mixed-methods strategy that amalgamates quantitative measurements (e.g., startup survival rates, job creation, and environmental performance indicators) with qualitative insights to enhance the rigour of findings. Comparative longitudinal studies could monitor the development of startup villages over time, offering evidence on the shift of preparedness levels and identifying treatments that expedite progress. Additionally, an in-depth examination of knowledge transfer processes, methods for retaining youth and talent, and the scalability of effective approaches could offer significant insights for policymakers and Startup Village Partners. Ultimately, broadening the analysis to encompass non-European contexts would provide a more comprehensive knowledge of how various governance types, socio-cultural characteristics, and market conditions influence rural innovation ecosystems.

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