

Article

Assessing the Maturity Level of Socio-Technical Contexts Towards Green and Digital Transitions: The Adaptation of the SCIROCCO Tool Applied to Rural Areas

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Abstract

The NewEcoSmart project addresses the need to foster inclusive green and digital transitions in rural habitat sectors by systematically assessing local socio-technical readiness and tailoring capacity-building interventions. We adapted the validated SCIROCCO Exchange Maturity Self-Assessment Tool—selecting eight dimensions relevant to environmental, technological and social innovation—and conducted a two-phase evaluation across three pilot sites in Italy, Portugal and Spain. Phase 1 mapped stakeholder evidence against predefined criteria; Phase 2 engaged local actors (45+ adults, SMEs and micro-firms) in a self-assessment to determine digital, green and entrepreneurial skill gaps. For each domain of the SCIROCCO Tool, local actors can assign a minimum of 0 to a maximum of 5. The final score of the SCIROCCO tool can be a minimum of 0 to a maximum of 40. Quantitative maturity scores revealed heterogeneous profiles (Pacentro and Majella Madre = 5; Yecla = 10; Adelo Area = 23), underscoring diverse ecosystem strengths and limitations. A qualitative analysis, framed by Smart Healthy Age-Friendly Environments (SHAFE) domains, identified emergent training needs that are clustered at three levels: MACRO (community-wide awareness and engagement), MESO (decision-maker capacity for strategic planning and governance) and MICRO (industry-specific practical skills). The adapted SCIROCCO tool effectively proposes the assessment of socio-technical maturity in rural contexts and guides the design of a modular, multi-layered training framework. These findings support the need for scalable deployment of interventions that are targeted to the maturity of the local ecosystems to accelerate innovations through equitable green and digital transformations in complex socio-cultural settings.

Keywords: maturity model; SCIROCCO tool; green transition; digital transition; rural areas; training needs



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1. Introduction

The study of social innovation encompasses a diverse range of methodologies to understand its various dimensions and impacts.

The last few years have brought the adoption of several new methods in the fields of social sciences and social innovation, such as “linear models, mixed methods, systems frameworks, machine learning, and new approaches to fieldwork”. These methods and approaches reflect ongoing efforts to advance the methodologies used in social sciences and social innovation, enabling researchers and practitioners to address complex challenges more effectively and generate actionable insights to drive positive change [1].

Overall, the interdisciplinary nature of social innovation research requires the use of diverse methodological approaches to capture its multifaceted nature and explore its potential [2,3].

Maturity models are widely used as tools to assess the maturity of a context. There are several types, each with a distinct purpose [4]. The concept of maturity models originated in the field of quality management [5]. Still, it gained prominence in the field of software engineering, particularly with models like the Capability Maturity Model Integration (CMMI), which is widely validated, adapted for various industries, and used globally across multiple disciplines [6].

Organisations can use maturity models to evaluate their current state, identify areas for improvement and establish a roadmap for advancing to higher maturity levels [7]. In particular, maturity models in social innovation are understood as tools that facilitate internal and/or external benchmarking while also showcasing future improvement and providing guidelines through the evolutionary process of organisational development and growth [8,9].

The “New circular and social responsible business models within Habitat sectors to revitalise rural areas” (NewEcoSmart) project is aiming at designing an inclusive social innovation approach to re-/up-skill adults above 45 years old from rural areas for adjusting to the green and digital transition in their existing jobs or to find new ones within the Habitat-related sectors, while also promoting social entrepreneurial skills and mindset that enable the adoption of new processes of production and/or consumption aligned with circular and socially responsible business models [10]. The project aims to test and validate the NewEcoSmart (NES) approach at three sites: Pacentro and Majella Madre Community (Abruzzo Region, Italy); Cantanhede, Mealhada, Mira, Montemor-o-Velho, Penacova (Adelo Area, Portugal); Yecla (Murcia Region, Spain). Local implementation is influenced by the maturity of local contexts, so it was necessary to identify a maturity assessment tool capable of consistently adapting the proposed approach and ensuring broad applicability across diverse sociocultural and institutional contexts. The aim of this research is to analyse the level of preparedness in pilot sites for the adoption of innovative approaches to inclusiveness and equity in the “twin transition” and to identify training and education sessions to address these gaps.

This article outlines the approach used to analyse the maturity of pilot sites in adopting innovative approaches to inclusiveness and fairness in the green and digital transition. The study employs a combination of qualitative, quantitative, and mixed methods, focusing on analysing innovation potentials at both the micro- and macro-levels in three different local contexts, understanding and measuring their impact, and trying to uncover the systemic relations behind them [11,12]. The elicitation of requirements to develop targeted engagement and training pathways, both process-wise and technology-wise, along with the training and technological interventions to be implemented to support them, is among the emerging results presented here.

2. Materials and Methods

2.1. Rapid Review

The evolution of emerging technologies has seen a surge of maturity models in academic publications, e.g., web and social media analytics [13]. Maturity models are also increasingly adopting the design science research paradigm and citing procedure model frameworks proposed by Becker et al. [14], De Bruin et al. [6] and Solli-Sæther et al. [15] as methodological steps while designing the models, but also they have mostly been extended as valuable tools to domains such as software engineering, education, health, energy, finance, government, computer science, management and social sciences [5,16,17].

A rapid review was implemented to synthesise the evidence useful for identifying the approach and tool for maturity assessment in the pilot sites. A total of 12 management areas have been identified through research on Organisational Maturity Models: Information Technology, Project Management, Business Management and Strategy, Human Resource, Ergonomics, Health and Safety Management, Industry 4.0 concept, Knowledge Management, Process Management, Performance Management, Quality Management, Supply Chain Management, Risk Management and Innovation Management [7,18].

A capability maturity approach was also used to develop the Digital Health Profile and Maturity Assessment Toolkit (DHPMAT). The stage of maturity is determined by an assessment of the system performance and extent of knowledge sharing at micro, meso and macro levels of the organisation and enterprise. Assessment uses qualitative and/or quantitative information from a range of published and unpublished internal sources [7]. The identified topics were related to diverse areas such as clinical disciplines [19,20], managerial [14,21] and operational matters [22,23], quality improvement [24,25], knowledge management [26], data analytics [27,28], policy [7], governance [29,30] or particular DH constructs such as social media [31,32] software processes, cybersecurity [33] or standards for digital data quality [34] and interoperability [35,36].

Therefore, maturity models are aimed at solving challenging issues and developed to assist organisations in diagnosing their current positions (as-is) and finally guiding them to reach advanced levels (to-be or desired) [6,14,37] to create competitive power to cut costs and improve quality [6] and also become more effective in the strategic decision-making process, such as investment plans [38].

However, only 15 studies aim to validate the proposed maturity model for maturity assessment and guidance to further levels. Maturity models have three purposes of use in literature: descriptive, prescriptive, and comparative. Descriptive models focus on identifying the current status, while prescriptive models focus on providing improvement guidelines by extending the descriptive purpose. The comparative models focus on benchmarking; however, comparative models do not find a research area in the digital transformation maturity model domain since this concept is still in the exploration stage. The typology of the maturity model refers to the characteristics of the measurement tool that enable companies to conduct maturity assessments [39].

2.2. The SCIROCCO Exchange Maturity Self-Assessment Tool

The SCIROCCO Maturity Model was developed as part of “Scaling Integrated Care into Context—SCIROCCO” European Commission-funded project (Grant Agreement n. 710033), aimed at improving the capacity of healthcare authorities to adopt and scale up integrated care. The main objective was to develop, validate and test the Knowledge Management Hub as a main integrator and facilitator of the evidence-based capacity-building support tailored to the local needs and priorities for improvement. The central component of the Knowledge Management Hub is the SCIROCCO Exchange tool, which is

an online participatory self-assessment tool to address the maturity of the local context for integrated care.

The SCIROCCO Exchange tool is aiming at enabling stakeholders to gain a comprehensive understanding of the local context and conditions necessary for implementing a life-course approach to active and healthy ageing (AHA), including an assessment of existing strengths and areas requiring improvement; the degree of readiness of regions to adopt and scale up innovative services, products, and solutions; the strategic actions undertaken by regions to achieve successful outcomes, thereby facilitating knowledge transfer, twinning, and coaching initiatives aimed at overcoming barriers and accelerating the deployment of demand-driven services, products, and solutions.

Taking into consideration the numerous activities that need to be managed, the Scirocco tool proposes 12 dimensions considered key to deliver integrated care: ‘Readiness to Change’; ‘Structure and Governance’; ‘Digital Transformation’; ‘Stakeholder Coordination’; ‘Funding’; ‘Removal of Inhibitors’; ‘Population Approach’; ‘Citizen Empowerment’; ‘Evaluation Methods’; ‘Breadth of Ambition’; ‘Innovation Management’; ‘Stakeholder Capacity Building and Development’. By considering each dimension, assessing the current situation, and assigning a measure of maturity within that scope, a country or region can develop a radar chart that reveals areas of strength as well as capability gaps. The SCIROCCO maturity model is based on a self-assessment tool to identify areas of strength and gaps in the ability to implement integrated care in a country or region. The use of the SCIROCCO tool needs to engage a wide range of stakeholders, ranging from policy makers, managers, and health and care professionals to digital health service providers, and supports multi-stakeholder dialogue on progress towards the implementation and provision of integrated care. Furthermore, the tool supports the transfer of good practices in integrated care by identifying their maturity requirements and facilitating twinning and coaching activities that help regions and organisations to better understand the local conditions [40].

The Reference Site Collaborative Network (RSCN) [41,42] collaborated with the “SCIROCCO Exchange” European Commission-funded project (Grant Agreement n. 826676) to refine and adapt the validated and tested online self-assessment tool for integrated care to meet the requirements of assessing the maturity of a life course approach to active and healthy ageing [43]. This included the refinements of the objectives and assessment scales of the original Maturity Model for Integrated Care [44].

2.3. *The NewEcoSmart Project and the Scirocco Tool Modified Version*

Within the NES project, the objective of the assessment process was to capture stakeholders’ perceptions and experiences concerning the green, digital, and entrepreneurial skills and training needs of adults aged 45 and above, SMEs, and micro firms. To achieve this, the SCIROCCO Exchange Maturity Self-assessment Tool [45] was preferred to identify context maturity in relation to innovation, training, and skill gaps for the green and digital transition.

The adaptation to the NES projects’ goals was carried out through a collaborative and interdisciplinary approach that included experts in the domain of digital, green and social domains, with the general purpose of focusing on green and digital issues and simplifying the assessment when applied to community stakeholders. A selection of items was made considering those more generalizable, for better capturing stakeholders’ perceptions and experiences in the self-assessment of their context’s ability to favour a change. As a result of the items’ analysis, eight items were selected from the original SCIROCCO tool, because they are in line with its scope of evaluating the maturity of a local ecosystem towards the adoption and implementation of innovations, and specifically to a transition towards ICT

and green economy. Otherwise, four items were excluded because they were too complex and specific to the healthcare context (Stakeholder Coordination, Population Approach, Evaluation Methods, and Breadth of Ambition) (Figure 1).

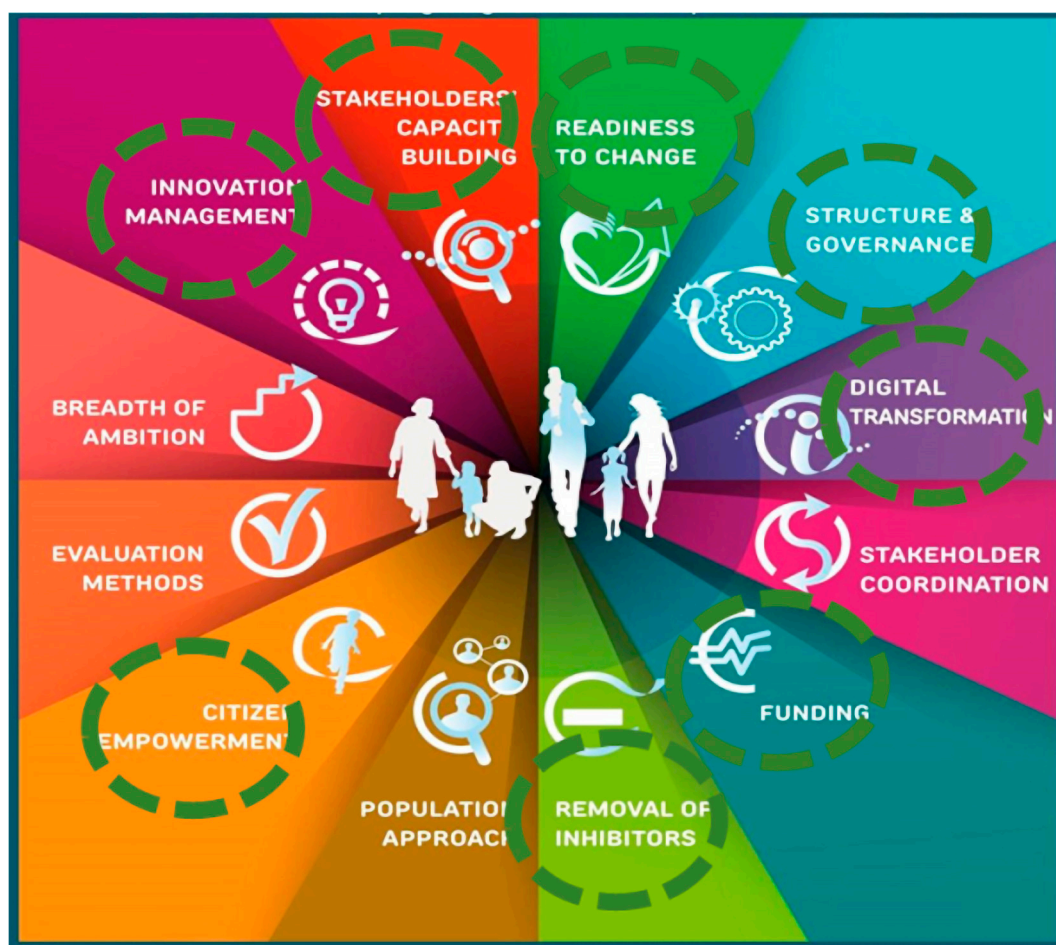


Figure 1. Framework of the adapted version of the SCIROCCO Exchange Maturity Self-assessment Tool for NES.

The adapted version of the SCIROCCO Exchange Tool, like the full version, is not an objective measure or quantitative evaluation, but is rather intended as a way to understand the local context and conditions in the perspective of addressing the gaps in training and skills of adults above 45 years in the habitat sector and the readiness level of a Pilot region to adopt and scale-up new training models and skills considering local strengths and weaknesses.

The NewEcoSmart approach was tested in three different European sites to prove that the pilots foster the inclusiveness and fairness of the twin (green and digital) transition, and that they are widely applicable in different cultural settings and institutional environments.

The assessment was carried out in two phases, the first aimed at collecting information about local contexts across the Pilot sites against the 8 criteria of the adapted Scirocco Model; the second focused on the self-assessment of the Pilot sites applicants, supported by a questionnaire (Table 1).

In Phase 1, information was gathered through group interviews with local stakeholders of the three Pilot Sites, including policy makers, entrepreneurs, nonprofit organisations, and citizens. Based on the interview results, the research team developed desk research to broaden their understanding of local socio-demographic and environmental contexts.

Phase 2 focused on Pilot Site applicants, who undertook a maturity self-assessment of their framework in preparation for the digital and green transition towards sustainable development. Primarily aimed at identifying the green, digital, and entrepreneurial skills and training needs of adults aged 45 and above, SMEs, and micro firms, the self-assessment was made through a questionnaire, administered by the researcher team to the key stakeholders of each pilot municipality during dedicated bilateral meetings, supported by a team of interdisciplinary experts in the different SHAFE domains of people, places and digital [11]. Those meetings stimulated a broader conversation aimed at identifying all limitations and key elements useful to identify the training strategy plan and tailor it to the emerging needs and priorities of local communities.

Table 1. NES-adapted SCIROCCO questionnaire.

Criteria	Definition	Question	Answers
Readiness to Change	extent to which the Pilot site context is inclined to accept, embrace, and adopt a particular plan for implementing transition toward green and digital economy	Are there informal resources available at local level (no profit organizations, digital solutions/training resources made available from local libraries, schools or other organizations)? Are there specific groups to be targeted because at risk of social exclusion or marginalisation (ex. women, older adults, migrants, etc.)? Moreover, following data will be detected: - Social inequalities (emerging from statistical analysis) - Basic infrastructures (High schools, health and social services, transportation/mobility emerging from available data).	0—No acknowledgement of compelling need to change. 1—Compelling need is recognized, but no clear vision or strategic plan. 2—Dialogue and consensus-building underway; plan being developed. 3—Vision or plan embedded in policy; leaders and champions emerging. 4—Leadership, vision and plan clear to the general public, pressure for change. 5—Political consensus; public support; visible stakeholder engagement.
Structure & Governance	extent to which the Pilot site context has multi-year programs with efficient change management, funding and communications, and the power to influence and (sometimes) mandate new working practices for green and digital economy	Is there proper funding (depending upon local priorities): strong training program, program management and change management; workforce development programs, distributed leadership, communication plans, monitoring? Are there funding programs targeting training around environmental and digital initiatives (local, national, international). Are there enabling structures (software, hardware, wi-fi connections etc to implement the new training programs? Are there resources available in terms of Software, Hardware, Wi-fi connections, Dedicated spaces Are there any training programs about environmental and digital matters?	0—Fragmented structure and governance in place. 1—Recognition of the need for structural and governance change. 2—Formation of task forces, alliances and other informal ways of collaborating. 3—Governance established at a regional or national level. 4—Roadmap for a change programme defined and accepted by stakeholders involved. 5—Full, integrated programme established, with funding and a clear mandate.

Table 1. Cont.

Criteria	Definition	Question	Answers
Digital Transformation	extent to which the Pilot site context allows to access to data infrastructure and public digital tools	Are there Citizens' secure and free access to data and digital resources, also across the EU, in terms of data, expertise, computing processing, and storage capacities? Are there digital tools for user feedback? Are there appropriate tech infrastructure for connected cities to improve services on all levels, from healthcare to mobility to security in terms of hardware, software, data, systems, apps, sensors, blockchain, and IT infrastructure (city-wide Wi-Fi, efficient fiber networks, broadband internet access; and strong, scalable cloud-based infrastructure)?	0—There is no digital transformation plan and/or strategy to support green initiatives. 1—There is a recognition of need but there is no strategy and/or plan to support the digital and green transformation. 2—There is a mandate and plan(s) to deploy regional/national digital transformation in addressing digital and green transformation, but it is not yet implemented. 3—Digital infrastructure to address a life-course approach to active and healthy ageing including innovative approaches to independent living, or integrated approaches to health and social care; are piloted but there is not yet region-wide coverage. A set of agreed technical solutions exists for digital tools. Some consolidations of ICT and eHealth solutions are underway. 4—Digital transformation to address digital and green transformation is deployed widely but not by all stakeholders. A unified set of digital solutions and services are widely deployed, and digital tools are available to share data and interact with citizens. 5—Universal, at-scale digital transformation is deployed at regional level. A unified set of digital solutions and services to address digital and green transformation are fully implemented. Stakeholders share data. Citizens' secure access to data is guaranteed and regional digital tools are available to boost citizen empowerment.

Table 1. Cont.

Criteria	Definition	Question	Answers
Funding	extent to which the Pilot site context benefits of ongoing investment and funding	Is there proper funding (depending upon local priorities): strong training program, program management and change management; workforce development programs, distributed leadership, communication plans, monitoring? Are there funding programs targeting training around environmental and digital initiatives (local, national, international).	0—No additional funding is available to support the move towards green and digital transformation in the region. 1—Funding is available but mainly for the pilot projects and testing. 2—Consolidated innovation and digital technology solutions funding available through competitions/grants for individual service delivery organisations and small-scale implementation 3—Regional/national (or European) funding or Public Private Partnership (PPP) for scaling-up is available. 4—Regional/national funding and/or reimbursement schemes for on-going operations is available. 5—Secure multi-year budget and/or reimbursement schemes, accessible to all stakeholders, to enable further service development.
Removal of Inhibitors	extent to which the Pilot site context expresses local situations delaying change or limiting how far change can go	Are there legal issues with data governance? Is there resistance to change from individuals or professional bodies? Are there cultural barriers to the use of innovative digital technology solutions? Are there perverse financial incentives? Is there lack of skills?	0—No awareness of the effects of inhibitors on digital and green transformations 1—Awareness of inhibitors and there are some ongoing efforts within organisations to their management, but no overall strategy is agreed. 2—Strategy for removing inhibitors agreed at a high level. 3—Implementation Plan and process for removing inhibitors have started being implemented locally. 4—Solutions for removal of inhibitors developed and commonly used. 5—High completion rate of projects & programs; inhibitors no longer an issue for service development.

Table 1. Cont.

Criteria	Definition	Question	Answers
Citizen Empowerment	extent to which the Pilot site context offers services and tools that enable convenience, offer choice, and encourage self-service and community engagement	Are there local networks? Are there neighbourhood committees? Are there collaborations with relevant stakeholders on shared projects (i.e., local health agencies, etc.)? Are there data sharing systems (environmental data, social and health data)? Are there community engagement experiences (living labs, etc.)? Are there policies to encourage and facilitate citizen empowerment?	0—Citizen empowerment is not considered as a local priority. 1—Citizen empowerment is recognised as an important factor but effective policies to support citizen empowerment are still in development. 2—Citizen empowerment is recognised as crucial for digital and green transformation, effective policies to support citizen empowerment are in place but citizens do not have access to their information and data. 3—Citizens are consulted on digital and green initiatives and have access to information and data. 4—Incentives and tools exist to motivate and support citizens to co-create innovative and digital technology services and use these services to participate in decision-making processes about their own needs. 5—Citizens are fully engaged in decision-making processes about their needs and are included in decision-making on service delivery and policymaking in addressing digital and green initiatives and processes.
Innovation Management	extent to which the Pilot site context is able to support the innovation process to get the best results for the community and ensure that good ideas are encouraged and rewarded.	Are there innovation incubators for supporting/adopting proven ideas faster? Are there enabling initiatives for innovation from top to bottom, with collection and diffusion of good practices? Are there learning initiatives from the local context, as well as from other regions, to expand thinking and speed up change? Are there initiatives that integrate public authorities, universities and private sector companies and other sectors in the innovation process (i.e., ‘open innovation’)? Are there innovative procurement approaches (Pre-Commercial Procurement, Public Procurement of Innovation, Public Private Partnerships, Shared Risk, Outcome-Based Payment)? Are there European projects and partnerships (e.g., Horizon Europe, Next Generation EU, and other)?	0—No innovation management in place. 1—Innovation is encouraged but there is no overall plan. 2—Innovations are captured and there are some mechanisms in place to encourage knowledge transfer. 3—Formalised innovation management process is planned and partially implemented. 4—Formalised innovation management process is in place and widely implemented. 5—Extensive open innovation combined with supporting procurement and the diffusion of good practice is in place.

Table 1. *Cont.*

Criteria	Definition	Question	Answers
Stakeholder Capacity Building and Development	extent to which the Pilot site context supports the process by which individuals and organisations obtain, improve, and retain the skills and knowledge needed to do their jobs competently	Are there programs of continuous improvement for increasing skills of stakeholders? Are there good practice approaches to change management of stakeholders? Are there private, universities or regional/local tools, processes and platforms to allow organisations to assess themselves and build their own capacity to deliver successful change?	0—Capacity building of stakeholders is not considered for digital and green transformation. 1—Some approaches to capacity building for digital and green transformation are in place. 2—Cooperation on capacity building for digital and green transformation is growing across the region. 3—Learning about digital and green change management is in place but not widely implemented.

3. Results

The NES project aimed to test and validate the NES approach at three sites in Italy (Pacentro and Majella Madre Community, Abruzzo); Portugal (Cantanhede, Mealhada, Mira, Montemor-o-Velho, Penacova, Adelo Area) and Spain (Yecla, Region of Murcia) to prove that the proposed approach can foster the inclusiveness and fairness of the twin green and digital transition locally, and that it can be widely applicable in different sociocultural settings and institutional environments. The local implementation is influenced by the maturity of the local environments; hence, an assessment was carried out to allow the coherent adaptation of the proposed approach. The adapted version of the SCIROCCO assessment tool for NES described above was applied as follows.

3.1. Phase 1: Understanding the Socio-Demographic Contexts of the Pilot Sites

The first phase involved a mixed-methods approach, combining the collection of socio-demographic data with qualitative interviews conducted among local stakeholders. This phase aimed to map the composition and social dynamics of the involved communities, with particular attention to identifying socio-economic demands.

To ensure a comprehensive territorial diagnosis, the social analysis was integrated with an assessment of the physical and environmental conditions of the regions under study. This included an examination of morphological, hydrographic, vegetational, agronomic, infrastructural, and regulatory dimensions, with the objective of identifying both structural constraints and opportunities for development. The capacity for local development—and the subsequent design of targeted training programs—is directly influenced by the material resources available and the regulatory frameworks governing land use, ranging from strict protection regimes to conservation and valorisation strategies [46].

The pilot sites, located in marginal inland areas, have been characterised by persistent demographic decline, population ageing, housing deprivation, and limited access to essential services—trends driven largely by outmigration and the collapse of traditional agricultural practices.

Nonetheless, these territories retain significant assets, including high-value landscapes, strong agri-food production, tourism potential, and an active manufacturing sector, particularly in furniture, wine, footwear, and construction materials. These industries represent vital sources of employment and economic resilience. However, the ongoing process of de-anthropisation has created a self-reinforcing cycle of service reduction and demographic shrinkage, further limiting development opportunities.

Thus, NES pilot areas emerge as ambivalent territories: marked by socio-economic vulnerability and environmental fragility on the one hand, and by rich cultural landscapes and untapped economic potential on the other.

3.2. Phase 2: SCIROCCO Questionnaires Filled in by Each Pilot Site

The second phase was carried out through a questionnaire administered by the researcher team to the key stakeholders of each pilot municipality during dedicated bilateral meetings, in which they were asked to self-assess their local contexts in preparation for the digital and green transition towards sustainable development, across the eight items of the adapted version of the SCIROCCO tool. The self-assessment revealed the three different level of maturity of the Pilot Sites, ranging from the minimum score of 5 of Pacentro and Majella Madre (Pilot site 1) to the maximum score of 23 of Adelo Area (Pilot site 2), with Yecla (Pilot site 3), which discloses a score of 10, positioning in the middle (Table 2).

Table 2. Overview of the maturity assessment for NES pilot sites.

Assessment Criteria	Pacentro and Majella Madre (Italy)	Adelo Area (Portugal)	Yecla (Spain)
Readiness to change	1—Compelling need is recognised, but no clear vision or strategic plan	3—Vision or plan embedded in policy; leaders and champions emerging	1—Compelling need is recognised, but no clear vision or strategic plan
Structure & Governance	1—Recognition of the need for structural and governance change	2—Formation of task forces, alliances and other informal ways of collaborating	1—Recognition of the need for structural and governance change
Digital Transformation	1—There is a recognition of need, but there is no strategy and/or plan to support the digital and green transformation	4—A strategy to address digital and green transformation is deployed widely, but not by all stakeholders. A unified set of digital solutions and services is widely deployed, and digital tools are available to share data and interact with citizens. (Still immature systems for data analysis)	1—There is a recognition of need, but there is no strategy and/or plan to support the digital and green transformation
Funding	0—No additional funding is available to support the move towards green and digital transformation in the region	1—Funding is available, but mainly for the pilot projects and testing	1—Funding is available, but mainly for the pilot projects and testing
Removal of Inhibitors	0—No awareness of the effects of inhibitors on digital and green transformations	3—Implementation Plan and process for removing inhibitors have started being implemented locally	1—Awareness of inhibitors and there are some ongoing efforts within organisations for management, but no overall strategy is agreed
Citizen Empowerment	2—Citizen empowerment is recognised as crucial for digital and green transformation, effective policies to support citizen empowerment are in place but citizens do not have access to their information and data	3—Citizens are consulted on digital and green initiatives and have access to information and data	1—Citizen empowerment is recognised as an important factor but effective policies to support citizen empowerment are still in development
Innovation Management	0—No innovation management in place	5—Extensive open innovation combined with supporting procurement and the diffusion of good practice is in place	2—Innovations are captured and there are some mechanisms in place to encourage knowledge transfer

Table 2. *Cont.*

Assessment Criteria	Pacentro and Majella Madre (Italy)	Adelo Area (Portugal)	Yecla (Spain)
Stakeholder Capacity Building and Development	0—Capacity building of stakeholders is not considered for digital and green transformation	2—Cooperation on capacity building for digital and green transformation is growing across the region	2—Cooperation on capacity building for digital and green transformation is growing across the region
Total Scores	5	23	10

Beyond the score differences, the combined analysis of NES areas highlighted several similar challenges that were identified at all three pilot sites: for example, one of the shared challenges is represented by the risk of marginalization for specific population groups (older adults, younger segments of the population, and migrants) that could all take advantage of the training activities as an instrument for joint engagement and social cohesion. A further shared challenge is the shortage of trained labour workers for specific sectors, which could benefit from both the training tools targeting shared and specific training gaps.

3.3. Emerging Priorities and Training Needs

Results from Phase 2 were then combined with the different layers emerging from the socio-demographic and environmental data captured in Phase 1. A qualitative analysis of the feedback obtained from the pilot sites was conducted, focusing on the allocation of emerging concerns across the SHAFE domains: people, digital, and places. SHAFE is a holistic approach that optimises social and physical environments, supported by digital tools and services oriented to provide better health and social care by promoting not only independent living, but also equity and active participation in society. This approach follows the United Nations' line-up, with the Sustainable Development Goals (in particular Objectives 3 and 11), stating that sustainable environments for all ages represent the basis for ensuring a better future for the entire population and addressing most of the growing issues of the ageing population in a unique roadmap for the implementation across Europe [47,48]. This approach facilitated the identification of training needs clustered by domain, which were further developed into a Training Framework and a related Training Plan, including targeted training sessions for the different pilot sites. The following tables provide the details about the analysis. The challenges faced by other sectors, such as the ICT industry, the building industry, and urban planning, as well as those concerning health and social care, both at the individual level and within communities, are interlinked. The paradigmatic mind-shift required to respond to these challenges can take advantage of the awareness and support for the creation and implementation of smart, healthy and inclusive environments for present and future generations that enable them to learn, grow, work, socialize and enjoy a healthy life, benefiting from the use of digital innovations, accessibility solutions and adaptable support models in the European context. The community is the physical, social, and cultural ecosystem closest to people, built on relationships of trust, sharing, solidarity, and intimacy, where people find social, cultural, and identity references, socialize, and live their daily lives. The objective conditions of the environment (pollution, accessibility, mobility, safety, comfort) affect the quality of life and well-being of citizens, particularly in the context of climate change, and, thus, affect the whole community circle. Therefore, this approach fosters actions that promote partnerships between technological and digital innovation, architecture, urban planning, social studies and health sciences to design and simulate communities of belonging that leverage on the potential of each sector to promote the existential dignity of all persons, regardless of their age, gender, health,

social, educational, economic, cultural and identity conditions, as well as the levels of development of the region where they live [48] (Table 3).

Table 3. Integration of SCIROCCO dimensions and SHAFE dimensions.

SCIROCCO Dimensions	SHAFE Dimensions			
	Digital	People (Health)	People (Inclusion)	Places (Green)
Readiness to change	Educational offer	Health promotion	Service Availability and accessibility	Environmental protection
Structure & Governance	Adoption of smart tools for organisational management	Wellbeing at the workplace	Horizontal and distributed governance models in place	Green priorities clearly identified in strategic planning
Digital Transformation	Availability of broad wi-fi, smart working stations and spaces, shared databases	Integration of digital tools with hands-on and interpersonal/ social activities	Usability and accessibility of digital services	Green city design and transition for built environment and in-between spaces
Funding	Dedicated funding for the digital and green transitions (ex. environmental certification for industry)			
Removal of Inhibitors	Strategic planning of actions for multi-stakeholders' social engagement to create systematic feedback loops.			
Citizen Empowerment	Social engagement for interactive sociocultural and literacy initiatives to action the green and digital transitions at local level.			
Innovation Management	Creative Hubs for innovation			
Stakeholder Capacity Building and Development	Interdisciplinary and multistakeholders training			

The emerging priorities for each pilot site align with their local strengths, providing guidance towards a more valuable and impactful exploitation of the training offer. Indeed, the influence of cultural differences and gaps has highlighted the need to carry out customized assessments and diagnoses that allow training to be adapted to the needs of the environment. The main concerns driving the training needs for each pilot site, as identified in the analysis, are represented in Tables 4–6.

Table 4. Pacentro and Majella Madre main concerns (Pilot Site 1).

Main Concerns	SHAFE Domains
Younger people are marginalised due to the lack of dedicated spaces and activities	People
Older adults face the risk of exclusion, especially for cultural reasons and low digital literacy	
Even with the availability of resources, change would have been difficult without a concomitant cultural change	
There are not yet training programs about environmental and digital matters	Digital
All data of Pacentro Municipality are collected on cloud but are not accessible to citizens	
No data sharing systems (environmental data, social and health data) are available to citizens nor to professionals	
City wide Wi-Fi is available, but it is not free	Places
The offer for touristic services is not organised either in terms of hospitality or of other services or content	

Table 5. Adelo main concerns (Pilot Site 2).

Main Concerns	SHAFE Domains
The elderly population in Montemor-o-Velho faces a risk of societal exclusion due to their isolation and need for constant care. It is challenging for young people to find employment that aligns with their education, often prompting them to seek opportunities outside the region. Agricultural activities have drawn an immigrant population, which requires careful integration efforts to foster social cohesion. Companies are facing a shortage of skilled labour. The current shortage of human resources poses a significant challenge. While employees are required by law to receive training in specific areas, incorporating this training into practical applications proves challenging. Since the majority of companies in the region are small enterprises with between 1 and 5 employees, organising comprehensive training programs can be challenging. Beyond companies, other sectors, such as non-profit organisations, have also benefited from this type of training offer. However, when considering the social sector, such training opportunities are even more limited. Prioritise training to foster a clear understanding of objectives, implementation strategies, and resource repairments, enabling the formulation of a structured plan. There is a lack of general or customised training on green and digital initiatives tailored to the specific requirements of companies in the region. Training programs about environmental and digital matters are not consistently, rather sporadically. Vocational education programs should typically address these themes. Within the local context, entities can utilise existing platforms, but there are no readily available continuous improvement program models. Each company develops its own approach, but due to the limited adoption of such processes among small and medium-sized enterprises, establishing comprehensive monitoring systems is challenging. There exists a widespread supportive environment for the digital and green transition within our territory. Individuals and companies are consistently willing to embrace the transformative processes underway. However, the dearth of qualified personnel, the financial constraints faced by companies, and the relatively small scale of many enterprises hinder this transformative journey. Beyond financial concerns, there are structural challenges. Their ageing infrastructure is ill-equipped to accommodate fundamental changes. Additionally, there is a persistent lack of adequate training. While we possess a general understanding of the concepts, there is much uncertainty when delving into the intricacies of these areas.	People Digital Places

Table 6. Ayuntamiento Yecla main concerns (Pilot Site 3).

Main Concerns	SHAFE Domains
Yecla is small, and this affects the availability of new training schools and programs. It is a “Death Valley” due to weak business models and sustainability over time. Skills are lacking at many levels. The general population does not know what digitalisation is (beyond smartphones or computers), and even less about the circular economy. Even at the Vocational Training level, if you talk to the teachers, most of them stick to the curriculum (which is usually implemented by those at the top) and do not even know the meaning of concepts such as circular economy, sustainability, and Industry 4.0. Most workers have little education (especially those on production lines) and, therefore, know nothing about these terms. When you go to the offices, some do and some don’t, but even if there are people who know the theoretical concept, its practical application is very limited. Citizens have limited access to data in general, specifically related to the environment. In terms of digital health, the public health portal provides some data, such as the average time of attendance for a surgery, etc. There was one incubator for innovative services, but in the end, the entrepreneurs decided to move to their own offices. The local infrastructure should be improved to create an enabling environment that facilitates the integration of digital solutions. There are no community engagement experiences (living labs, etc.). Nowadays, there are two private co-working spaces.	People Digital Places

3.4. Emerging Training Framework

The above-mentioned analysis of the local concerns was further clustered in macro, meso, and micro layers, which were defined as follows.

- The Macro layer refers to the common knowledge needs, which translate into training responses to address the local need for social innovation and digital and green empowerment.
- The Meso layer refers to the knowledge sharing required to address the needs of specific target populations clustered across the different pilots.
- The Micro layer refers to targeted training to address specific needs focused on preferred gaps emerging at the local level (Figure 2).

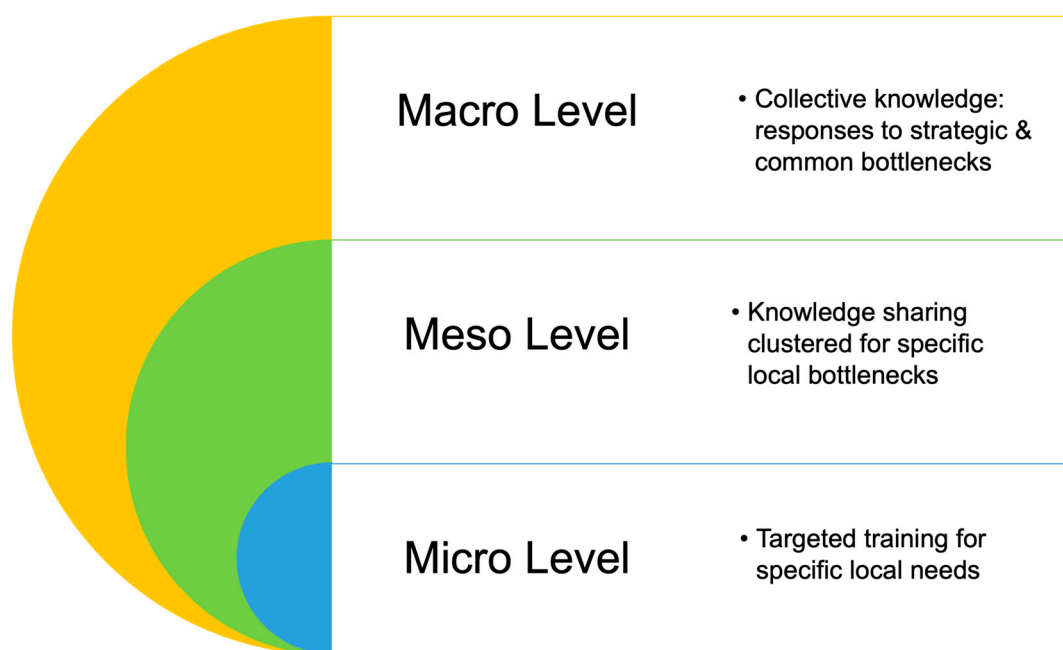


Figure 2. Tailored support for the NES training Pilots community.

The emerging needs at the three pilot sites led to a training framework aligned with the three different layers.

At the macro level, the common need to foster and develop a sociocultural environment where awareness of the opportunities for digital and green transitions can drive sustainable development emerges. Such an environment can help existing sectors evolve and thrive while identifying new emerging industries that can benefit from intergenerational activities. At this level, the training involves social engagement activities where all stakeholders in the local community share knowledge and commit to digital and green empowerment, as well as related transformations. To implement this, social campaigns can leverage social media and all locally available communication channels.

At the Meso level, the training of decision-makers and key figures in public and private (profit and non-profit) organisations responds to the need to overcome current fragmentation and develop a shared training plan. These professionals need to acquire principles of green and digital transitions, guiding an evidence-based and locally relevant approach for identifying strategies, and their planning and implementation. For example, this includes increasing their management capacity through advanced accounting/management software, as well as the use of specific key performance indicators.

At the Micro level, the training framework integrates practical applications targeting specific industry sectors. The bilateral interactions with key stakeholders at each pilot site,

carried out for the maturity assessment, were further developed through a second round of meetings aimed at identifying the preferred industrial sector and related use case to engage in the pilot. This approach enabled the identification of specific training targets aligned with the genuine needs of the sample companies, ensuring that the Micro level of the training is directly applicable to their day-to-day operations.

The competence areas of the training framework are indicated in Table 7.

Table 7. Competence areas and competencies.

Competence Areas and Competencies	
Information and Data Literacy	Navigating, searching, and filtering data, information, and digital content Evaluating data, information, and digital content Managing data, information, and digital content
Communication and Collaboration	Interacting through digital technologies Sharing through digital technologies Civic participation through digital technologies Collaboration through digital technologies Netiquette Managing digital identity
Digital Content Creation	Content development Integration and re-elaboration of digital content Copyright and licensing of intellectual property Programming
Safety	Protection of devices Protection of personal data and privacy Protection of health and well-being Environmental protection
Problem Solving	Solving technical problems Identifying needs and technological responses Creative use of technology Identifying gaps in digital skills

This training framework utilizes a state-of-the-art online tool developed within the NES project, which provides a seamless and user-friendly experience for assessing digital competencies. It is characterized by a multilingual capability, allowing users to switch between various languages effortlessly.

4. Discussion

The adapted version of the SCIROCCO assessment tool for NES provided an overview of the three pilot sites, which differ in terms of maturity, showing a heterogeneous socio-cultural context that influences the training approach for supporting the transition towards a green and digital ecosystem. Results show three levels of maturity, ranging from the minimum score of 5 of Pacentro and Maiella Madre (Pilot site 1) to the maximum score of 23 of AD ELO Area (Pilot site 2), with Yecla (Pilot site 3), which discloses a score of 10, positioning in the middle. The present article provides an overview of the NES approach to developing and implementing a training program that can address the needs towards digital and green transformation of industry sectors according to the maturity of rural area pilot sites. The results allowed the further development of a modular training program organised in three layers where all stakeholders are differentially engaged to ensure harmonious and sustainable capacity building (Figure 3).



Figure 3. Modular approach for the training matrix and plan.

Still, there are several challenges: indeed, rural areas may differ in terms of maturity as referred to their capacity to progress along the local evolutionary process of organizational development and growth. Such differences influence the uptake and adherence to digital tools that provide knowledge and training. The engagement of the key stakeholders proved pivotal in driving the local community together and identifying shared priorities and goals that could be achieved using the NES tools. Especially relevant are the diversified challenges that such tools could directly or indirectly help to overcome.

In the case of Pacentro and Majella Madre Community (Pilot Site 1), the collaboration across sectors fostered by the municipality enabled the involvement of the city of “L’Aquila” local health agency. It aligned the training priorities with the need to address digital health literacy for health promotion, particularly among older adults. Access to care is often compromised in this area due to several factors, including lower density of health services, difficulty in travelling, and shortage of medical personnel. In line with the National Strategy for Internal Areas (54), the Pacentro and Maiella Madre ecosystem set up training priorities to strengthen health services, promoting innovative care models based on community effort and leveraging digitalisation. This was pivotal in starting the conversation at the local level for establishing a local initiative centred on the concepts of citizen science and living labs. Relying on the strong tourist and naturalistic imprint of this area, training priorities have included medical treatments that combine wellness experiences, to increase the offer of tourist services and employment opportunities.

In the case of Yecla (Pilot Site 2), the local community collaborated with the project team to address a range of interconnected challenges, including environmental hazards and socioeconomic development. The collaboration between the municipality and regional stakeholders highlighted the need for targeted training strategies in areas such as circular business models or 4.0 digital technologies. In line with broader regional strategic plans, Yecla’s involvement in the project has been pivotal in promoting intersectoral collaboration. Training initiatives have been oriented to support improvements in post-compulsory

education, particularly in anticipation of rising demands from local communities to learn more about the twin transition. With a strong identity tied to its furniture and agricultural industries, Yecla's ecosystem is today leveraging NewEcoSmart tools to boost employment, address social inclusion, and integrate sustainable practices, marking the first steps toward creating a local innovation dynamic grounded in territorial resilience and shared heritage values.

In the case of AD ELO (Pilot Site 3), the NES project addressed fragmented digital and green readiness across a rural area in central Portugal. The adoption of the NES training framework enabled the identification of significant gaps in digital literacy, sustainability awareness, and entrepreneurial capacity—particularly in habitat-related sectors. Leveraging NES tools, the Portuguese pilot focused on empowering adults over 45 and small businesses through flexible, community-driven training initiatives. Training actions were designed accordingly and delivered through a blended model combining in-person sessions and remote support, ensuring adaptability to local circumstances. The NES approach also fostered closer collaboration between local authorities and community organisations, aligning capacity-building efforts with the region's socioeconomic characteristics. This localised application of the NES model encouraged hands-on engagement with digital tools and sustainable practices, reinforcing territorial resilience and promoting inclusive green and digital transitions tailored to the real needs of the community.

Limitations

The study presents several limitations that should be addressed in future studies. The study proposes and demonstrates the use of an adapted version of the SCIROCCO maturity self-assessment tool to identify skills gaps and develop training proposals to address them in the digital and green transition sector among citizens from three rural areas of Italy, Portugal, and Spain. The small sample size and limited knowledge of the stakeholders involved in the study prevented the advantages and challenges of the sociotechnical approach used from being highlighted. In the future, it would be desirable to involve local stakeholders involved in the maturity assessment in the methodology development process. The study focused primarily on the adaptability of the SCIROCCO tool to a context other than that of health and care. To transform the SCIROCCO approach into a systemic sociotechnical approach, a more in-depth discussion of the assessment criteria and dimensions, including consideration of the interrelationships between them, is needed.

5. Conclusions

The application of the adapted SCIROCCO model supported the identification of the immature communities' levels, unveiling a sociocultural tissue that was not yet "innovation-friendly". In such contexts, efforts to stimulate social cohesion are crucial to ensuring that a positive and nurturing environment fosters the development of a knowledge economy, including in rural areas. Integrating digital tools within the framework of collaborative activities that engage local stakeholders, addressing specific and locally relevant challenges, remains the most effective approach to ensure uptake, adherence, and scale-up, especially for training tools. Early involvement of local anchors, such as schools, churches, and civil servants, accelerates the identification of specific needs and the corresponding adaptation of the training package with targeted modules. The NewEcoSmart (NES) project proved successful in supporting and implementing the training tools in the digital, green, and entrepreneurial domains, contributing to building capacity and driving social innovation in rural areas. Emerging evidence suggests that such initiatives can indeed contribute to breaking down isolation and creating a stimulating environment, thereby nurturing

a knowledge-driven and connected economy. Moreover, the NES project is grounded in the SHAFE concept, aiming to develop, validate, and implement an innovative and sustainable approach to strengthen digital and green skills and competences in rural areas. The SHAFE community has been supporting the Sirene project (www.sireneproject.eu) in the development of a workable framework for investment and the broad adoption of high-quality innovative living solutions, which combines the housing sector, green infrastructure, and ICT. The SHAFE framework focuses on good practices on responsive, inclusive, smart, age-friendly living environments that were categorised under six main topics—Policy and Funding, Social Innovation, Health and Social Sciences, Community Intervention and Care, ICT for independent living, Information technology, Urban transformation, Housing, Architecture and Design—taking inspiration from the eight domains of the WHO Age-friendly environments approach and identified as key to comprehensively address the expertise and transversal areas of intervention that are relevant to the field of SHAFE. Based on the maturity levels, the NES project matched the gaps emerging from each pilot community along the SHAFE domains. It focused on the identification of the key features of the applicable domains for each of them, thus ensuring that an operational approach towards the green and digital transition is supported at the policy and strategic level through a personalised Social Innovation Framework. Towards this end, the required social innovation concepts, methods, and skills can be transferred through NES integrated training tools to support entrepreneurs in identifying potential business opportunities, securing funding, and attracting investment around SHAFE, and creating alliances and synergies between stakeholders and ecosystems to co-design policy actions. This multi-layered approach to training is in line with the features that are explicitly mentioned by the World Health Organisation about SHAFE initiatives, and require all societal levels to be involved, at community and strategic level: free from physical and social barriers and supported by policies, services and infrastructure that promote health and allow people to maintain their full mental physical capacity throughout their entire life or for as long as possible.

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