iCOSHELLs

D1.2 DETERMINATION AND PARAMETRIZATION OF SUCCESS FACTORS FOR LLS

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Executive Summary

This study investigates the success factors that contribute to the long-term viability and transformation of soil health living labs (LLs) into lighthouses (LHs). The objective is to identify key factors that enable LLs to develop and succeed over time, ultimately serving as reference models for sustainable soil health initiatives. The analysis also explores the defining characteristics of LHs and the necessary conditions for an LL to transition into an LH.

To achieve this, an extensive literature review was conducted to identify success factors for LLs. An analytical framework was developed based on seven recurrent factors identified in the literature: strategic alignment, collaboration dynamics, steering structure, operational excellence, implementation, value co-creation and soil literacy. For each factor we introduce a parametrization method aligned with the Technology Readiness Level (TRL) scale, ranging from 1 (least developed) to 9 (fully developed). The parametrization of success factors provided a common language to assess the status of maturity of the LLs and to identify areas requiring targeted interventions.

After identifying the seven success factors, we designed and distributed a structured survey to the iCOSHELLs partners to assess the readiness levels of their respective Living Labs. The survey targeted representatives and participants from LLs, yielding 17 responses. The results of this survey were further validated through a participatory process during a “Train the Trainer” session, which took place on February 17 2025. This session provided an opportunity to discuss the relevance and applicability of the proposed framework and success factors, as well as to refine the methodology based on stakeholder feedback.

The main outcome of this study is an innovative framework and methodology designed to assess the maturity status of LLs across seven distinct focus areas. This report presents (i) a selection of validated parameters for measuring the performance and establishment of LLs and LHs, (ii) a scalable and quantifiable evaluation framework that provides a common language and clear representation of LL maturity levels, and (iii) a baseline analysis of the LLs involved in the project, based on the agreed-upon parameters.

The results indicate that the LLs vary in their maturity and developmental stages, with some being more advanced while others remain in early phases of establishment. The LL in Greece demonstrates higher advancement in steering structures and soil literacy, whereas the LL in Sweden appears to be in its initial stages, with most success factors rated between levels 1 and 3. The LL in Spain excels in strategic alignment, while the Basque LL exhibits strengths in governance structures and value co-creation. The LLs in Italy and Bulgaria share similar development trajectories, with readiness levels generally between 3 and 4.

Altogether, the analysis of iCOSHELLs Living Labs offers insights into the readiness levels of the six participating LLs, highlighting their strengths and areas for improvement. The baseline assessment facilitates the identification of specific challenges and needs across different regions, ensuring that these factors are accounted for in the co-creation of solutions aimed at achieving soil health objectives. Participants emphasized the importance of incorporating additional dimensions, particularly those related to funding strategies, business models, and biodiversity aspects, to enhance the robustness of the framework.

A critical next step involves the development of key performance indicators (KPIs) to systematically monitor LL performance and to establish targeted strategies for advancing along the maturity scale. This will enable a more structured approach to supporting LLs in their transition toward fully developed and impactful LHs.

1. Introduction

1.1. Soil Health Living Labs & Lighthouses

European soils are experiencing a critical decline in health, with 60-70% of EU soils classified as unhealthy due to a combination of pollution, urbanization, intensive agriculture, and the impacts of climate change (Akça et al., 2024). This degradation leads to profound economic, societal, and environmental consequences, such as reduced land productivity, biodiversity loss, and increased rural-urban migration and land abandonment. Addressing this challenge requires a fundamental shift in practices that contribute to these negative outcomes. However, transformative processes are rarely achieved through top-down mandates alone; rather, they necessitate participatory processes and effective networking among diverse actors.

In this context, living labs (LLs) are expected to play a crucial role in addressing one of our most pressing societal challenges: restoring and maintaining soil health. LLs are considered as pivotal platforms for restoring and maintaining soil health. According to the European Soil Mission, living labs are real-world environments in which stakeholders—such as researchers, farmers, local communities, policymakers, and businesses—collaboratively test, develop, and demonstrate sustainable solutions for soil and land management. A living lab is a space where diverse stakeholders collaborate to develop a shared understanding of complex problems and co-create innovative solutions. Living labs exist in various forms, each facilitating experimentation with technical, managerial, and socioeconomic innovations to address specific challenges. Some living labs focus on production or distribution issues within particular sectors, developing business models to introduce new products to the market. Others aim to integrate sustainable technologies into society, while some drive systemic transitions such as fossil-free production.

Lighthouses (LH), on the other hand, are exemplary sites—including farms, forests, industrial areas, or urban green spaces—that demonstrate successful soil management practices and serve as educational centers. While living labs emphasize collaborative innovation and stakeholder-driven development, Lighthouses focus on showcasing proven solutions and promoting their widespread adoption through training and outreach. Together, these approaches form a complementary strategy within the EU's soil health initiative, advancing both experimentation and implementation of sustainable soil management practices.

Policymakers and practitioners increasingly recognize the potential of Living Labs as a mechanism for accelerating the co-creation and uptake of innovations, facilitating transitions toward more resilient and sustainable agricultural systems, fostering scientific collaboration and knowledge exchange, and bridging the gap between long-term policy objectives and the practical realities faced by farmers and land managers. However, despite the growing adoption of LLs, these networks often exhibit significant heterogeneity due to differences in their origins, governance structures, and objectives. Many living labs are still in the developmental stage, and significant progress is required before they become an integral part of broader policy, research, and innovation frameworks. For living labs to reach their full potential, it is essential to establish robust governance frameworks that ensure effective collaboration, foster knowledge exchange, negotiate rules, and align efforts towards shared soil health goals.

1.2. Success factors for Soil Health Living Labs

Success factors play a pivotal role in determining the effectiveness and longevity of soil health living labs. The European Commission (EC) has explored these factors through multiple frameworks, emphasizing their importance in co-creating innovative, human-centered solutions. For instance, the PrepSoil project (https://prepsoil.eu/) identified key guidelines for establishing Soil Health National Hubs and proposed several critical success factors for designing effective living labs. These include: (i) the presence of a dedicated facilitator and secretary to ensure the organization, documentation, and evaluation of meetings; (ii) sufficient funding from national and EU sources to support the engagement of participants; (iii) a clear mandate and specific objectives addressing soil health challenges; (iv) adequate time to foster collaboration, develop a shared vision, and achieve autonomy; and (v) active involvement from national authorities (O´Toole & Panciot, 2023).

Despite previous efforts, significant gaps remain, particularly concerning the standardization and consistency of success factors in assessing interdisciplinary and cross-sectoral aspects of living labs. The lack of uniform benchmarks makes it difficult to compare and evaluate research and innovation funding effectiveness across the EU. Developing standardized assessment frameworks and measurement tools would enhance comparability and facilitate more meaningful analyses. However, achieving this goal requires consensus on defining the dimensions of success and establishing robust criteria for measuring the innovation readiness of soil health living labs.

1.3. Objective of this report

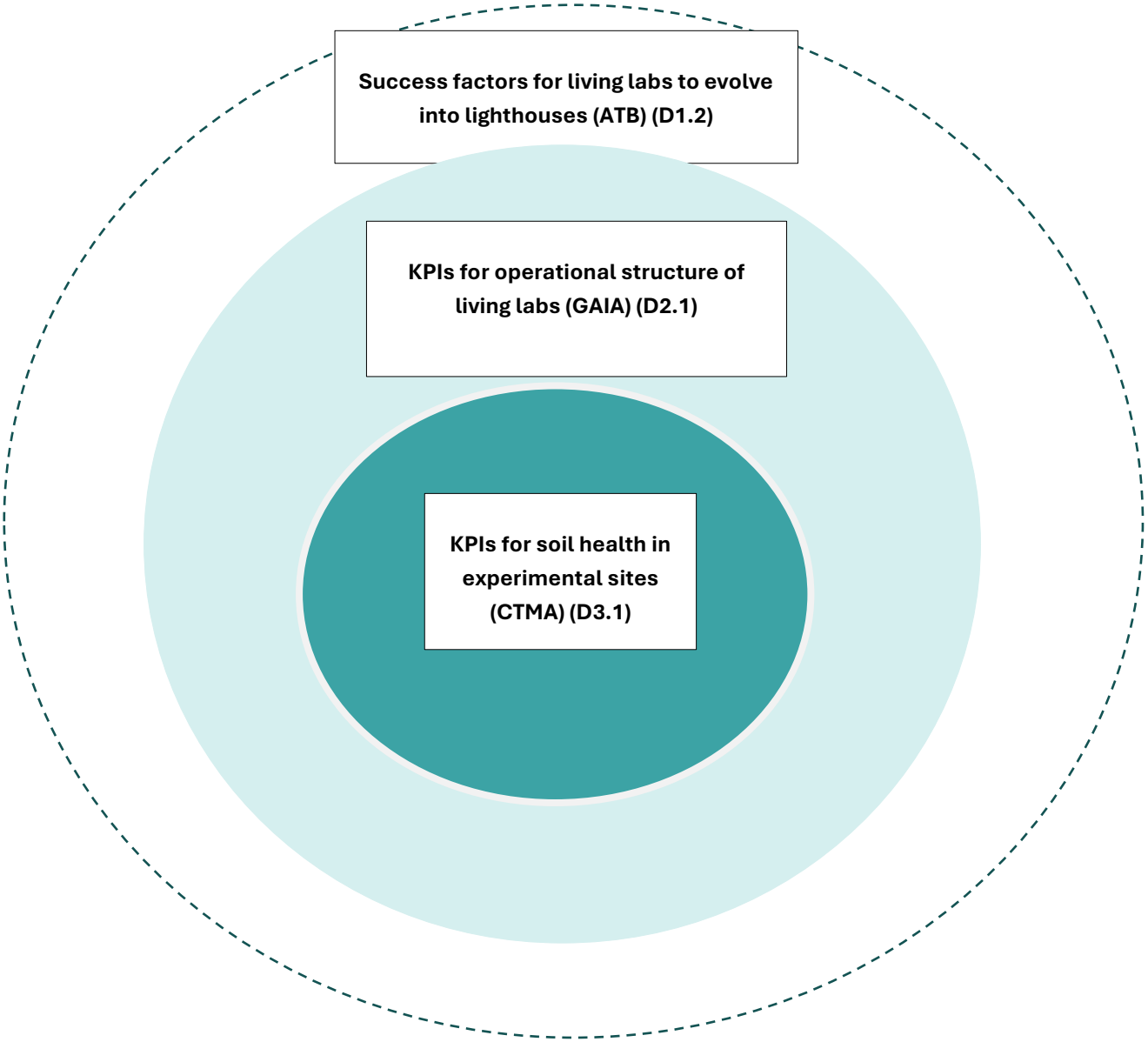
The objective of this study is to identify success factors for soil health living labs and to develop a comprehensive framework to assess their maturity across distinct focus areas. Specifically, we aim to:

1. Identify and validate key parameters for assessing the performance and establishment of Living Labs.
2. Develop a scalable and measurable evaluation framework that fosters a common language for benchmarking the maturity of different Living Labs.
3. Conduct a baseline analysis of Living Labs using the agreed parameters to assess their readiness for innovation and long-term sustainability.

1.4. Scope of this report

This report builds upon previous efforts within the iCOSHELLs project. Deliverable 1.1 (D1.1) utilized the PESTLE framework to assess the external political, economic, social, technological, legal, and environmental factors influencing Living Labs. The PESTLE framework facilitated an understanding of how external forces impact the ability of Living Labs to address soil health challenges, thereby informing strategic decision-making and adaptation. The present report shifts the focus to the conditions necessary for a Living Lab to evolve into a Lighthouse, focusing on the governance and management aspects of the Living Labs and their associated experimental sites. This work was carried out in parallel with D2.1, which examined the daily operational structure of the Living Labs to ensure alignment with the overarching objectives of the iCOSHELLs. At the same time, D3.1, examined indicators capable of effectively monitoring soil health at the experimental sites. Together, these aforementioned deliverables (D1.2, D2.1, and D3.1) encompass an integrated framework for monitoring the innovation processes of the living labs from different perspectives (Figure 1). Lessons gathered throughout the project lifetime will serve as a foundation for future assessments in WP6, where best practices from the project will be synthesized. WP6 will further investigate which solutions and management strategies have proven effective in advancing soil health objectives, ensuring that best practices can be refined and scaled for broader impact.

Figure 1. Scope of this report in relation to other tasks and deliverables in iCOSHELLs



1.5. Target group of this report

The primary target group for this report is the iCOSHELLs project consortium, including core partners responsible for implementing project activities. These stakeholders will directly benefit from the proposed framework, which enables systematic tracking of innovation processes and Living Lab development. Additionally, other Work Packages (WPs) working with performance indicators may find this report valuable in aligning their methodologies with a standardized assessment approach.

Beyond the consortium, this report is relevant to a wider range of stakeholders engaged in soil health initiatives. This includes European Mission Soil partners striving to establish 100 Living Labs and Lighthouses by 2030, as well as other related EU-funded projects. Policymakers, NGOs, and investors focusing on soil health and sustainable land management can leverage the readiness level framework and insights from the six regional case studies to inform decision-making, strategy development, and funding allocation.

2. Conceptual Framework

2.1. The Multi-Level Perspective (MLP) in Living Labs

The Multi-Level Perspective (MLP) provides a framework for understanding how Living Labs contribute to socio-technical transitions in agro-food systems. It conceptualizes transitions as the interplay of processes at three levels: macro, meso, and micro (Geels, 2002; Loorbach et al., 2017).

At the macro level, broad societal pressures such as climate change, environmental degradation, and evolving policy frameworks create a landscape that shapes the need for agricultural transformation. Increased awareness of soil degradation and the limitations of conventional farming serve as drivers for innovation in soil health practices (Köhler et al., 2019). The meso level represents the existing regime, including dominant agricultural practices, industry norms, and government policies that influence farming methods. These regimes tend to be resistant to change, as established actors and infrastructures reinforce the status quo (Smith et al., 2005). At the micro level, Living Labs act as niches, where experimental environments foster the development and testing of new soil health practices, governance models, and technological innovations (Schot & Geels, 2008).

The MLP framework emphasizes that niche-level innovations are not isolated but must engage with and influence the regime and landscape to drive systemic change. Although Living Labs provide spaces for experimentation, their impact depends on overcoming barriers from established regimes and aligning with broader societal and policy shifts at the landscape level (Elzen et al., 2004; Hermans et al., 2013). Simply put, the ability of Living Labs to foster innovation depends not only on technological advancements but also on governance, stakeholder engagement, and policy alignment, making the MLP a suitable approach for analyzing transitions in soil health management (Sutherland, 2019).

2.2. Applying the MLP to iCOSHELLs

In this study, we apply the MLP framework to examine how Living Labs evolve within the iCOSHELLs project, particularly through interactions between governance structures and stakeholder networks. Our goal is to uncover the drivers of change within Living Labs, assess how these innovations scale, and identify the factors contributing to long-term success. Given that MLP does not define specific criteria for measuring success, we develop an iterative stakeholder engagement process to refine success factors and ensure their applicability across different contexts.

A key element of the iCOSHELLs approach is the structured assessment of Living Labs' development stages. Instead of treating Living Labs as static experiments, we evaluate their progression using a readiness-level framework that accounts for governance structures, stakeholder collaboration, and institutional integration. This ensures that Living Labs are not only testing innovative solutions but also embedding them within broader agro-food systems for sustainable impact.

2.3. Comparison with existing soil health assessment models

While the MLP provides a strong theoretical lens, it is important to position iCOSHELLs within the broader landscape of EU-funded soil health initiatives. Several projects, such as PrepSoil (https://prepsoil.eu/), SOILL

(https://www.soill2030.eu/), and EJP Soil (https://ejpsoil.eu/), have developed frameworks for soil health assessment, yet iCOSHELLs introduces key distinctions that enhance its applicability for long-term governance and stakeholder-driven innovation. One of the primary differences lies in the readiness-level framework. Unlike PrepSoil, which emphasizes broad soil health indicators, iCOSHELLs structures its assessment to track the progressive maturity of Living Labs, allowing for targeted interventions based on their stage of development. This approach ensures a systematic roadmap for Living Labs to transition from early-stage initiatives to fully integrated governance models.

In terms of stakeholder engagement, EJP Soil focuses on linking research and policy, whereas iCOSHELLs integrates co-creation and governance structures as fundamental success factors. The Train the Trainer (ToT) methodology ensures that knowledge exchange is iterative rather than one-directional, allowing Living Labs to refine their strategies continuously based on practical feedback.

From a systems perspective, iCOSHELLs differentiates itself through its explicit use of the MLP framework to examine governance structures and policy transitions. While Soil Mission Living Labs emphasize cross-regional implementation of best practices, iCOSHELLs employs a multi-level analysis to understand how Living Labs interact with existing policies and socio-economic conditions, ensuring that soil health innovations are both scalable and institutionally embedded.

Lastly, while most existing soil health projects provide policy recommendations, iCOSHELLs goes further by aligning its readiness assessment with real-world policy integration. This structured methodology ensures that Living Labs do not remain isolated experiments but instead follow a clear pathway for long-term institutionalization and systemic impact. By combining MLP analysis, a readiness-level framework, and stakeholder-driven governance strategies, iCOSHELLs offers an advanced model for assessing and scaling Living Labs in soil health. Its structured yet flexible approach ensures that innovations transition from small-scale experimentation to policy-aligned, self-sustaining governance structures, distinguishing it from previous EU-funded projects.

3. Materials & Methods

3.1. Overview of cases

iCOSHELLs aims to restore soil health across the EU by establishing six soil health living labs in different climate zones, Sweden, Spain, Basque region, Italy, Greece and Bulgaria. Each lab will focus on developing and testing new solutions for soil restoration tailored to local conditions. For example, the Basque living lab, spanning Spain and France will work to combat the effects of rising sea levels by creating new sites that enhance soil biodiversity and support community well-being through cultural and creative initiatives. In the Swedish living lab, conventional and organic farmers will jointly develop and test solutions to improve soil health and sustainable agriculture. In western Macedonia, Greece, the aim is to restore soil health and reclaim contaminated mining sites. In norther Italy, soil health will be monitored in agricultural, urban and semi urban areas to better understand the application of different solutions. Finally, the Bulgarian living lab in the Plodiv region aims to improve soil structure and enhance biodiversity by increasing soil organic matter through different practices.

3.2. Overview of Success Factors for Living Labs from the Literature

Several conceptual models provide structured approaches for evaluating the interactions between environmental and societal systems in soil health. The DPSIR framework (Driving Forces, Pressures, State, Impact, Response) is widely applied in soil health assessments and intervention planning, providing a method to analyze how external pressures influence soil conditions and policy responses (Kristensen, 2004). Similarly, the FAO Soil Guidelines emphasize sustainable soil management practices, advocating for measurable outcomes and structured stakeholder engagement to enhance soil restoration efforts (FAO, 2021). These frameworks reinforce the importance of robust evaluation methodologies for assessing the progress and effectiveness of living labs.

The literature further identifies distinct categories of success factors that influence Living Lab performance and long-term sustainability. For instance, SF1 (Balancing scientific and societal goals) and SF3 (Shared vision among stakeholders) highlight the need for strategic alignment to maximize systemic impact. Studies indicate that achieving this alignment requires active stakeholder engagement, clearly defined goals, and actionable strategies (FAO, 2021; citing). In contrast, SF5 (Securing funding) and SF7 (Adaptability) emphasize the importance of sustainable financial planning and the ability to adjust to changing conditions. According to ISO 56002, adaptability in operational workflows is critical for navigating uncertainties, particularly in regions affected by climate variability (ISO, 2018).

Additionally, several success factors underscore the importance of communication and collaboration in Living Labs. SF9 (Active communication) and SF10 (Culture of collaboration) are essential for fostering trust, inclusivity, and collective ownership of solutions (ENOLL, 2020). The European Network of Living Labs (ENOLL) highlights the significance of structured communication channels and joint decision-making processes, ensuring that diverse stakeholder groups collaborate effectively to drive soil health innovation.

Based on previous research and policy frameworks, six key categories of success factors have been identified as essential for the effectiveness and sustainability of Living Labs. These categories serve as the foundation for Living Lab readiness assessments, helping to determine whether initiatives are effectively structured, supported, and adaptable to challenges. Table 1 summarizes these success factors, their associated soil-specific parameters

used for evaluation and associated frameworks and references. It include Strategic Alignment, Operational Excellence, Collaborative Dynamics, Implementation, Participant Engagement, and Value Co-Creation, each playing a critical role in ensuring the success of Living Labs.

Table 1: Collection of success factors and analytical frameworks from the literature

Category	Success Factor (SF)	Archetypal Condition	Soil-Specific Parameters/Indicators	Frameworks and References	Remarks
Strategic Alignment	**SF1: Balance scientific and societal goals**	Society Readiness Level	- Stakeholder satisfaction with soil health initiatives. - Number of societal benefits (e.g., biodiversity restoration).	**DPSIR, FAO Soil Guidelines, Mission Soil Health (Horizon Europe)**	Ensures soil health goals are relevant and accepted by stakeholders.
	SF2: Address needs, interests, and restrictions of practitioners	Customer Readiness Level	- Practitioner feedback on soil health interventions. - Adoption rate of sustainable practices.	**OECD Guidelines, ENOLL, SOILCARE (Horizon 2020)**	Ensures soil health innovations meet practical needs of farmers and land managers.
	SF3: Shared vision among stakeholders	Partnership Readiness Level	- Degree of alignment on soil health objectives across sectors. - Consensus on restoration targets.	**Horizon 2020 (e.g., SOILCARE, LANDSUPPORT)**	Aligns goals across diverse participants toward EU soil health objectives.
	SF4: Consider dependency on external factors	Institutional Development Readiness Level	- Assessment of policy changes affecting soil health. - Risk mitigation strategies for environmental or regulatory shifts.	**DPSIR (Pressures/Responses), EU Soil Framework Directive**	Addresses risks like policy changes or climate variability that impact soil health efforts.
Operational Excellence	**SF5: Secure funding and establish sustainable operational models**	Investment Readiness Level	- Funding allocated to soil health innovations. - Diversification of funding sources for long-term soil health projects.	**EU Mission Soil, ENOLL Best Practices, OECD Guidelines, LANDSUPPORT (Horizon 2020)**	Ensures financial stability for soil health LLs to operate effectively.
	SF6: Provide and acquire sufficient time and financial means	Business Readiness Level	- Availability of resources for soil health interventions. - Time allocated for field testing and stakeholder engagement.	**Horizon Europe Projects, ENOLL Monitoring Systems**	Enables robust implementation of soil health innovations in LLs.
	SF7: Be prepared for adaptability	Team Readiness Level	- Frequency of adaptive changes to account for soil variability. - Team training on climate-smart soil practices.	**ISO 56002, FAO Soil Guidelines, SOILCARE (Horizon 2020)**	Essential for navigating uncertainties and dynamic soil conditions.
	SF8: Implement iterative feedback processes	Innovation Readiness Level	- Stakeholder feedback loops for soil health activities. - Adaptive management based on soil quality monitoring results.	**ISO 56002, OECD Guidelines**	Ensures ongoing refinement of soil health interventions based on feedback and data.
Collaborative Dynamics	**SF9: Actively communicate**	Partnership Readiness Level	- Communication frequency on soil health progress. - Transparency in reporting impacts on soil quality.	**ENOLL Framework, EU Soil Observatory**	Builds trust and transparency while fostering collaboration across sectors.

	SF10: Develop a collaboration culture between science and society	Society Readiness Level	- Joint projects between scientists and local stakeholders. - Co-created soil health solutions.	**Horizon 2020**, **ENOLL Best Practices**	Strengthens collaboration for co-created, science-backed soil health innovations.
	SF11: Collaboration with complementary partners	Partnership Readiness Level	- Number of cross-sectoral partnerships (e.g., NGOs, farmers, researchers). - Diversity of soil health expertise involved.	**ISO 44001**, **Horizon 2020**	Diversifies expertise to address soil health challenges holistically.
	SF12: Orchestration role to coordinate stakeholder interactions	Team Readiness Level	- Stakeholder satisfaction with coordination efforts. - Efficiency of coordination processes.	**OECD Innovation Policy**, **ENOLL Best Practices**	Ensures a cohesive and effective innovation ecosystem.
Implementation	**SF13: Make use of the experimentation concept**	Technology Readiness Level	- Number of soil health technologies tested (e.g., sensors, organic amendments). - Field trial success rates.	**TRL Framework**, **FAO Soil Management**, **Mission Soil Health (Horizon Europe)**	Ensures iterative testing and validation of soil health technologies.
	SF14: Be attached to concrete sites	Technology Integration Readiness Level	- Number and suitability of pilot sites addressing specific soil health issues. - Accessibility for stakeholder visits.	**DPSIR Framework**, **LANDSUPPORT (Horizon 2020)**	Grounds interventions in real-life, site-specific soil health challenges.
	SF15: Create lasting impact and ensure transferability	Technology Integration Readiness Level	- Number of practices adopted across regions. - Stakeholder-reported scalability of soil health innovations.	**ISO 56002**, **Horizon 2020 (LANDSUPPORT, SOILCARE)**	Scales successful soil health interventions to other regions and contexts.
	SF16: Provide research-based learning and reflection	Institutional Development Readiness Level	- Number of soil health research outputs shared. - Participation in training or workshops on soil health practices.	**ENOLL Best Practices**, **FAO Capacity Building Guidelines**	Encourages knowledge sharing and capacity building for sustainable soil management.
Participant Engagement	**SF22: Participants are willing to invest energy in collective goals**	Team Readiness Level	- Attendance rates at LL events. - Volunteer hours contributed to soil health projects.	**ENOLL Framework**, **OECD Guidelines**	Ensures stakeholder commitment and long-term involvement in soil health initiatives.
	SF23: Participants reflect on issues and options collaboratively	Innovation Readiness Level	- Quality of stakeholder collaboration outcomes. - Number of collaborative workshops or meetings.	**ISO 56002**, **OECD Stakeholder Engagement Metrics**	Facilitates holistic problem-solving for soil health challenges.
Value Co-Creation	**SF27: Multi-stakeholder participation**	Partnership Readiness Level	- Inclusivity metrics (e.g., gender, sector diversity). - Number of stakeholder groups participating.	**OECD Engagement Metrics**, **ENOLL Guidelines**	Ensures diverse representation in soil health decision-making.
	SF28: Active user involvement throughout the process	Customer Readiness Level	- Feedback incorporation rate from stakeholders. - User satisfaction with co-created soil health solutions.	**OECD Guidelines**, **ENOLL Monitoring Tools**	Strengthens the relevance and acceptance of soil health interventions.

	SF29: Co-creation of value by and for stakeholders	Innovation Readiness Level	- Number of co-created outputs. - Stakeholder testimonials on co-creation success.	**ISO 56002, Mission Soil Health (Horizon Europe)**	Promotes ownership and sustainability of soil health solutions.

3.3. ICOSHELL success factors: Identification and parametrization

Despite the well-documented importance of the aforementioned success factors, a persistent challenge remains in aligning Living Lab assessment frameworks. Many frameworks and methodologies lack consistency, making it difficult to compare progress across regions and projects. This issue is particularly significant in interdisciplinary settings, where integrating technical, social, and economic dimensions is critical for success. To systematically assess the readiness of living labs in the iCOSHELLs project, we identified seven key success factors based on the literature (Section 3.2). These factors provide a structured approach to evaluating readiness levels and guiding the transition from experimental projects to fully integrated governance models:

1. **Strategic Alignment:** Strategic alignment in living labs refers to the development and execution of a cohesive strategy that unites all stakeholders under a common vision for soil health. This involves clear goals and objectives that address soil degradation, sustainability, and resilience in both the short and long term. A well-aligned strategy ensures that all activities, resources, and research efforts are coordinated, and that they contribute meaningfully to the improvement of soil health. It also supports policy alignment, making Living Labs more relevant for long-term soil governance.
2. **Collaboration Dynamics** – Collaboration dynamics refers to the quality of partnerships and stakeholder engagement in a living lab. This success factor emphasizes the importance of inclusive, transparent, and effective partnerships between diverse stakeholders—such as farmers, scientists, local communities, policymakers, and NGOs. Strong collaboration is essential for knowledge exchange, resource sharing, and collective problem-solving, which are key to successful soil health management.
3. **Steering Structure** – The steering structure defines the governance model and decision-making processes within the living lab. This includes clarity on roles, responsibilities, and authority among stakeholders, as well as the decision-making frameworks that guide actions and resource allocation. A robust governance structure ensures transparency, accountability, and the effective resolution of conflicts. iCOSHELLs will establish a Steering Group which will serve as the operational decision-making body responsible for overseeing daily operations and strategic direction of the LLs. Its primary objective is to ensure that all activities align with the LL´s innovation goals, stakeholder interests and broader soil health policies. This group comprises key representatives from different sectors, a LL Manager, secretary, scientific and technical advisors, industry representatives, public sector officials as well as community and representatives including farmers and land-owners. Together, these members will foster inclusive decision-making and sustainable soil management strategies (D2.1 Establishment of Operational and Management of LLs Experiments).
4. **Operational Excellence** – Operational excellence refers to the effectiveness and efficiency with which processes and workflows are designed, executed, and improved within a living lab. In the context of soil health, this encompasses how soil-related interventions are implemented, how resources are allocated, and how data is collected and analyzed. It also includes the adaptability of these processes to changing conditions, such as climate variability, policy shifts, or new scientific findings. As shown in Figure 1, this success factor targets the operational structure of living labs, extended by GAIA in D2.1.

5. **Implementation** –Implementation focused on the practical execution of soil health strategies and interventions. This includes scaling successful solutions and replicating them in different contexts. Effective implementation also involves overcoming challenges related to resource mobilization, technical expertise, and institutional support. The goal is to ensure that soil health interventions have a lasting impact on agricultural practices and environmental sustainability. Unlike Operational Excellence, which focuses on internal workflows, Implementation measures the real-world deployment of solutions and their effectiveness. This success factor is related to the work in WP5 on scaling up soil health solutions lead by IFAU.
6. **Value Co-Creation** – Value co-creation refers to the process where stakeholders jointly contribute to and benefit from the creation of new solutions, technologies, or knowledge. In the case of soil health, this means that all parties (farmers, researchers, policymakers, communities) collaborate to develop new soil management practices, technologies, and governance models. This process fosters innovation while ensuring that all stakeholders benefit from the outcomes, and embedding co-creation processes into the governance structure of Living Labs. Unlike Collaboration dynamics, which focuses on partnerships, value co-creation is about shared ownership of solutions and direct benefits to stakeholders. This success factor is related to WP1 lead by CSCP but it is overarching across the whole innovation process of iCOSHELLs.
7. **Soil Literacy** (as part of Learning and Innovation) – Soil literacy refers to the systems thinking and understanding of soil health among stakeholders, including farmers, policymakers, researchers, and the broader community. It encompasses training, education and learning about soil functions, challenges, and solutions, the ability to apply this knowledge in practical ways to improve soil management, as well as capacity-building and community engagement. Improving soil literacy is critical for stakeholder empowerment and widespread adoption of best practices in soil health management.

Each of the aforementioned success factors is assessed using a readiness level scale, ranging from 1 (low readiness) to 9 (high readiness). These levels are inspired by the logic of the Technology Readiness Level (TRL) and define clear criteria, milestones, and activities that must be accomplished to progress toward full maturity (Table 2). The selection of readiness levels and success factors was based on a comprehensive review of established frameworks, including the DPSIR model, FAO Soil Guidelines, ISO 56002 (adaptability in innovation systems), and ENOLL best practices. These models provided a foundation for assessing structural, operational, and collaborative maturity in Living Labs.

To ensure the practical relevance and applicability of the success factors, an iterative validation process was conducted with living lab representatives through the participatory Train-the-Trainer session. During this process, living lab representatives reviewed the criteria, assessed their applicability within their respective living labs, and refined the definitions to better reflect real-world challenges. Their feedback was instrumental in ensuring that the readiness levels align with operational realities and provide a structured pathway for Living Labs to enhance their governance, stakeholder engagement, and implementation strategies.

Table 2. Identification and Paremetrization of Success Factors for Soil Health Living Labs

Readiness Level	1	2	3	4	5	6	7	8	9
Strategic Alingment	No strategy in place and no awareness among stakeholders about the need for a unified strategy	Stakeholders recognize the need for a strategy but no formal discussions occur.	Initial discussions start; informal agreements emerge.	A draft strategy exists, partially aligned with stakeholder goals.	A formal strategy is developed and begins to guide stakeholder actions	Stakeholders consistently align their efforts with the strategy, showing unified progress.	The strategy integrates systemic initiatives across all stakeholders.	Measurable outcomes demonstrate success; the strategy is refined periodically.	A unified strategy agreed by all stakeholders, aligned with societal needs and achieving systemic soil health improvements.
Collaboration Dynamics	No formal collaboration; partnerships are nonexistent or minimal.	Potential collaborators are identified but remain disengaged.	Initial partnerships are formed with limited interaction.	Formal agreements ensure structured collaboration and communication.	Stakeholders contribute resources and expertise to joint initiatives.	Collaboration drives shared decision-making and iterative reflection.	Stakeholders work together to address systemic challenges effectively.	Partnerships are self-sustaining, fostering innovation and transformation.	A fully collaborative ecosystem achieves shared goals and systemic impact.
Steering Structure	No governance framework; decisions are reactive and unstructured.	Informal coordination begins but lacks defined roles, rules and structure.	Initial governance structures emerge but remain hierarchical with limited inclusivity.	Early efforts balance hierarchical and participatory approaches through regular	Participatory governance is introduced, begins to build trust, accountability, and shared decision-making.	Structures, roles and rules are re-evaluated periodically. Inclusive decision-making structures foster accountability.	Clearly defined, rules, roles and responsibilities drive innovation and transparency.	Governance includes reflexive practices, regularly revisiting and refining decision-making process.	Governance models become scalable benchmarks for systemic change.
Operational Excellence	Soil health efforts are ad hoc and reactive without structure.	Basic workflows are identified but remain inconsistent.	Initial processes for soil monitoring and management are introduced.	Standardized workflows allow consistent tracking of soil health indicators.	Processes are refined periodically to enhance efficiency.	Digital tools are integrated; key performance indicators (KPIs) are actively tracked.	Processes adapt to feedback and challenges; efficiency is benchmarked.	Operations are scalable and promote continuous learning	Fully optimized workflows ensure seamless adaptability to external changes.
Implementation	Ideas to address soil	Sites and initial	Clear soil pilot plans	Small-scale soil pilots	Multi-site soil pilots	Refined pilots applied	Solutions are scaled across	Experimentation	Fully scaled solutions

	health exist but lack concrete plans.	stakeholder networks identified; experimentation discussed.	emerge; one site chosen for early trials.	launched with basic engagement.	expand; early lessons inform adjustments.	across contexts, testing transferability.	regions. Strong partnerships at multiple sites ensure operational stability.	consistently delivers impactful results. Practices are systemically integrated and policy-aligned.	achieve long-term policy, market, and societal change
Value Co-Creation	Little awareness of co-creation benefits exists.	Stakeholders engage informally with no structured outcomes.	Small co-creation efforts yield initial shared value.	Structured processes enable stakeholder co-creation of soil solutions.	Stakeholders generate meaningful shared outcomes consistently.	Value co-creation processes are deeply embedded in the lab's activities, creating substantial value for all participants.	Stakeholders from diverse sectors collaborate seamlessly, creating significant value that aligns with their mutual goals.	Co-created value drives innovation and systems change, with lasting benefits for all stakeholders.	The lab becomes a global benchmark for value-driven innovation.
Soil Literacy	Stakeholders lack awareness and basic knowledge of soil health issues.	Basic awareness of soil health exists among a few stakeholders.	Initial efforts promote awareness via materials and events	Stakeholders engage in knowledge-sharing activities.	Interactive campaigns foster widespread soil literacy.	Practical applications improve stakeholder practices.	Capacity-building programs embed soil literacy into systems	Widespread soil-literate behaviors affect education and policy.	Soil literacy drives systemic change in agriculture, policy, and society.

3.4. Data collection and validation

To ensure the practical relevance and applicability of the success factors, an iterative validation process was conducted with Living Lab (LL) representatives through the participatory Train-the-Trainer session. During this process, LL representatives reviewed the criteria, assessed their applicability within their respective Living Labs, and refined the definitions to better reflect real-world challenges. Their feedback was instrumental in ensuring that the readiness levels align with operational realities and provide a structured pathway for Living Labs to enhance their governance, stakeholder engagement, and implementation strategies.

3.5. Survey

After identifying the seven success factors, we designed and distributed a structured survey to the iCOSHELLs partners to assess the readiness levels of their respective Living Labs. The survey was conducted via Google Forms, launched in December 2024, and remained open until the end of January 2025.

The questionnaire focused on evaluating the maturity of each Living Lab across all seven success factors using a structured readiness scale from 1 (low readiness) to 9 (high readiness), with clearly defined milestones at each level

(see Appendix for survey details). Participants were asked to assess their Living Lab's current status based on these predefined criteria. In addition to the quantitative evaluation, the survey included open-ended questions to gather qualitative insights. These questions invited participants to share feedback on the relevance of the success factors, identify areas requiring more attention, suggest additional factors that might be missing, and reflect on whether they found the assessment exercise useful.

We received a total of 17 responses, ensuring representation from all six Living Labs within the project. The collected data was automatically analyzed using Google Forms' built-in analytics tools, providing an overview of trends, distributions, and key insights. The qualitative responses were further explored during the participatory Train the Trainer (ToT) session, where partners discussed their perspectives on the framework, exchanged experiences, and identified opportunities for refining the evaluation methodology.

3.6. Train the Trainer Session

Following the survey, a Train the Trainer (ToT) session was conducted to further evaluate the survey results, refine success factor applicability, and discuss necessary framework adjustments based on Living Lab representatives' experiences. The session served as a structured discussion where key survey findings—such as common challenges in stakeholder engagement and variation in readiness level assessments—were reviewed. Participants provided practical feedback on the applicability of the success factors and identified potential refinements to enhance the framework's usability in real-world contexts.

The primary objectives of the session were to (i) ensure the relevance of the success factors and readiness levels by assessing their alignment with Living Labs' operational realities, (ii) discuss challenges and barriers that Living Labs face in progressing along the readiness scale, (iii) improve the clarity and structure of the assessment framework based on stakeholder input and (iv) strengthen knowledge exchange by facilitating discussions on best practices and strategies for Living Lab development.

The session was designed as an interactive workshop, allowing participants to critically reflect on the survey findings and share insights from their respective Living Labs. Through facilitated discussions, participants explored how the framework could be tailored to address region-specific conditions while maintaining a consistent methodology for cross-site comparison. Insights from this session provided a valuable foundation for refining the readiness assessment tool, ensuring that it not only captures the complexity of Living Labs but also serves as a practical guide for decision-making and capacity-building. The refinements based on this discussion will be incorporated into the next phase of framework testing and validation within the iCOSHELLs project.

4. Results

Figure 2. Baseline Readiness Level Assessment of iCOSHELLs

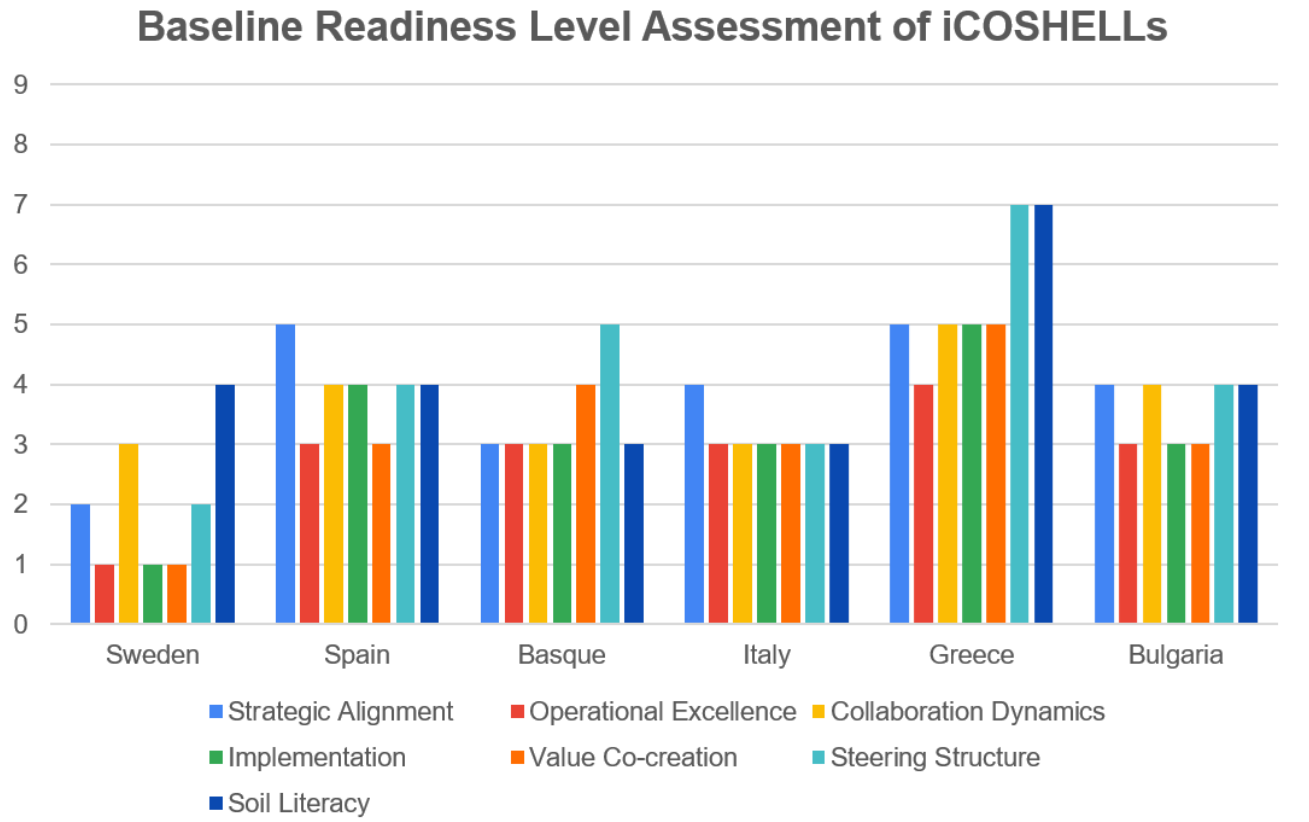


Figure 2 presents an initial evaluation of the readiness levels of six LLs across the seven success factors, illustrating significant variations in LL maturity. Greece demonstrates the highest readiness, particularly in Steering Structures and Strategic Alignment, suggesting that governance mechanisms and stakeholder coordination are well established. Spain, Basque, and Bulgaria exhibit mid-level readiness, indicating moderate stakeholder engagement and operational structures, though with notable gaps in governance and collaboration. Italy and Sweden show lower readiness across several factors, particularly in governance and implementation, highlighting a need for structured decision-making processes and coordination mechanisms.

Figure 3. Readiness Level Assessment of Success Factors for LLs

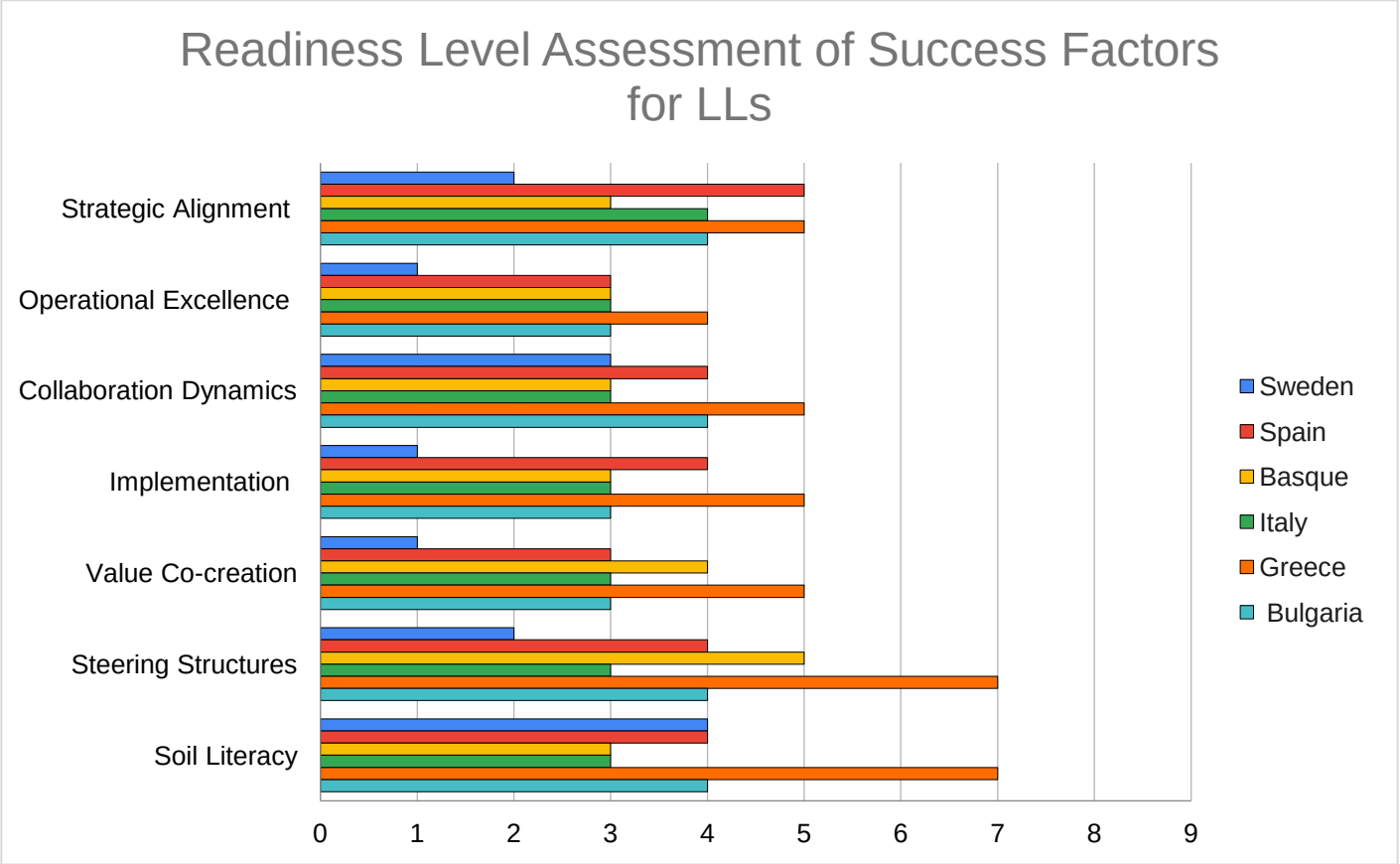


Figure 3 further disaggregates readiness levels assessment of each living lab by success factor. The results show that Strategic Alignment scores are relatively high across all LLs, suggesting that most have a clear vision and objectives. Collaboration Dynamics and Soil Literacy demonstrate moderate progress, indicating active stakeholder engagement but limited structured co-creation. Implementation and Value Co-Creation show the lowest readiness levels, reflecting the early-stage nature of several LLs and the need for mechanisms to scale innovations. Governance, as captured by Steering Structures, remains a critical weakness in several LLs, particularly in Italy and Spain, where coordination and decision-making processes require strengthening.

4.1. Train-the-Trainer (ToT) Results

Following the baseline derived from the survey, a Train-the-Trainer (ToT) session was conducted to validate the readiness assessment, refine the framework, and discuss challenges faced by LLs. The session aimed to assess whether the survey results aligned with real-world LL experiences, identify barriers to progress, and discuss refinements to governance, collaboration, and implementation strategies. The breakout sessions facilitated discussions among LL representatives, focusing on country-specific challenges.

The Greek LL confirmed strong stakeholder engagement and a well-established strategic alignment, reflecting the active involvement of various partners and ongoing synergies with multiple projects. However, implementation remains constrained by external dependencies, particularly the pending soil analysis, which is crucial for determining the next steps in selecting suitable crops and management practices. This delay has temporarily slowed the transition from planning to execution, with LL representatives emphasizing the need for structured co-creation processes to ensure that stakeholder engagement translates into practical interventions. Despite these challenges, there is a strong commitment to moving forward, with the next co-creation session expected to bring stakeholders together to finalize intervention strategies based on soil analysis results and collaboratively plan the upcoming implementation phase. The session also highlighted the importance of adapting to seasonal constraints, as weather conditions will influence decision-making in the following months.

The Italian LL session reinforced that governance is the primary challenge, as stakeholders recognize the lack of a coherent decision-making framework to guide implementation. While the LL benefits from significant experience in stakeholder engagement, collaboration remains fragmented, requiring better coordination among partners to develop a unified vision. Representatives emphasized the need for stronger internal structuring and regular coordination meetings to ensure that stakeholder inputs lead to actionable strategies. A key takeaway from the discussion was the importance of aligning technical assessments with stakeholder-driven processes, allowing the LL to move beyond independent efforts toward a more integrated governance model. The next co-creation session is expected to address these governance challenges more concretely, providing an opportunity to align stakeholder priorities, establish clearer responsibilities, and define a structured pathway for implementation.

The Spanish LL is relatively more advanced in its development, owing to the strong foundation built through years of collaboration among its partners. The established trust and strategic alignment have enabled the LL to create a draft strategy that partially aligns with stakeholder goals. This strategy is further supported by standardized workflows that allow for consistent tracking of soil health indicators. Frequent meetings and active participation from all partners have fostered a cohesive approach to implementation, ensuring that the collaboration is moving steadily toward practical solutions. While there are still external factors to consider, the LL is well-positioned to proceed with the next phase, having already developed a clear vision and strategy. The upcoming co-creation session will focus on refining implementation plans and solidifying stakeholder roles to ensure seamless progress.

The Basque LL is still in the early stages of building trust and fostering accountability among its partners. While significant progress is being made toward participatory governance, the LL has yet to establish the same level of strategic alignment and trust seen in its Spanish case. The partners currently focus on creating a shared decision-making process and aligning efforts with the broader goals of the stakeholders. This phase of development is critical as the Basque LL works to build a stronger foundation of collaboration, where stakeholder inputs will be integrated into the governance model more effectively. The next co-creation session will be pivotal in advancing these processes, helping to align stakeholders' priorities and ensure that governance structures are in place for the next phase of implementation.

The Living Lab (LL) in Sweden, initiated through the ADD project, is currently in its early stages. This is evident across all readiness levels, as confirmed by experts and LL representatives during the Training of Trainers (ToT) session. However, just a few months into the project, participants noted significant progress in readiness levels related to strategic alignment and cooperation. This dynamic development led to varying perceptions among the actors during the validation session, with some advocating for a higher readiness level. Despite these differences, all participants agreed that the upcoming co-creation process will be crucial for advancing the LL's readiness. The ToT session highlighted the focus on implementation efficiency, reflecting a collective desire to move into the implementation phase. Due to the LL's early stage, some representatives acknowledged the potential for both backward and forward shifts in readiness levels, underscoring the non-linear nature of the innovation process.In conclusion, the

validation exercise conducted during the ToT session highlighted significant dynamics within the Living Lab (LL), underscoring the need for continuous and closer monitoring of success factors, particularly with a focus on long-term sustainability. The results also suggest that the discussion and validation of the framework and success factors should be extended to a broader range of actors. This includes not only new and incumbent participants but also those who have left the LL, for a retrospective validation and analysis. Finally, the ToT session emphasized the need to adapt and refine the framework and success factors to enable further parametrization throughout the project's duration.

5. Discussion

In order to identify an empirically-based, complexity-aware set of success factors that contribute to the long-term viability and transformation of soil health LLs into LHs, we draw on several different bodies of theory to develop the analytical framework presented in this report. We identified seven success factors: strategic alignment, collaboration dynamics, steering structure, operational excellence, implementation, value co-creation and soil literary. Within each factor, a detailed readiness level scale from 1 (low readiness) to 9 (high readiness) is provided. Each level is described with clear criteria, milestones, and activities that must be accomplished to move on to the next level. The parametrization of our approach was mainly informed by the Technology Readiness Level (TRL) which is used to measure the maturity of a technology, from concept to actual deployment in a real world environment. Yet, our framework shifts the focus of evaluation from questions related to specific technical solution and the extent and impact of its adoption (although these questions remain) towards questions related to the quality and effectiveness of the innovation process and the resulting system capacities that have been developed. We conducted a survey with LL participants to assess the current status of maturity of the six living labs in iCOSHELLs and identified their specific strengths, challenges and areas for improvement. We now turn to a detailed discussion of how these success factors are applied in practice, considering the challenges and opportunities for the transformation these LLs into LHs.

The extent literature emphasizes the importance of **strategic alignment,** i.e., a shared strategic vision to guide the efforts of collaborative initiatives in sustainability projects. The concept of strategic alignment has been explored in organizational research, particularly in large-scale environmental projects, where a collective vision leads to more efficient goal achievement (Tessitore et al., 2023). In the context of soil health, strategic alignment facilitates a comprehensive approach to addressing multifaceted challenges, such as soil erosion, nutrient loss, and biodiversity depletion, by ensuring that all stakeholders are committed to sustainable and integrated soil management (Higgins et al., 2023). Strategic alignment ensures that all participants—from farmers and researchers to policymakers and community groups—are working toward the same objectives. This includes aligning the use of resources, technology, and practices, such as agroecological techniques and regenerative agriculture methods, to foster soil recovery and sustainable management practices.

The role of **collaboration** in environmental projects has been well-documented, with research showing that partnerships in sustainability initiatives lead to enhanced innovation and the sharing of best practices (Mariani et al., 2022). In soil health, collaborative efforts can lead to the adoption of best management practices (BMPs) across diverse agricultural systems, promoting both local knowledge and scientific research (Church et al., 2018). Literature also emphasizes the importance of stakeholder inclusion to ensure that solutions are contextually relevant and equitable (De Vita et al., 2016). In a living lab, collaboration dynamics can be evaluated by assessing the quality and diversity of partnerships, as well as the level of trust and communication between stakeholders. For example, the successful co-design of soil health solutions may involve farmers and researchers jointly developing new organic practices, such as alternative fertilization techniques, while engaging policymakers to ensure alignment with local regulations and incentives.

In living labs, the **steering structure** must clearly define how decisions are made and how stakeholders interact with one another. For example, a living lab may have a steering committee consisting of representatives from different sectors (e.g., local farmers, researchers, policymakers) that meets regularly to evaluate progress, adjust strategies, and make collective decisions on soil health interventions. Effective governance is critical for the success of multi-stakeholder projects. Studies on environmental governance emphasize the importance of clear

decision-making structures, stakeholder roles, and accountability mechanisms to foster cooperation and achieve shared objectives (Ostrom, 2009). In soil health initiatives, good governance allows for better coordination, resource allocation, and the ability to adapt to new scientific evidence or policy developments (Emerson & Gerlak, 2014).

The importance of **operational excellence** in managing complex environmental projects has been highlighted by numerous studies (Khuk et al., 2014 ; Greeve et al., 2016; Greve et al., 2017). Successful soil health management, especially in living labs, requires continuous evaluation and adaptation to optimize resource use and adapt interventions. Research on adaptive management in ecological projects (e.g., adaptive management frameworks in sustainable agriculture) has shown that operational efficiency and flexibility are essential for responding to emerging challenges (Kozar et al., 2023). Living labs need to be flexible in adjusting methods based on real-time data and findings. For example, operational excellence could involve continuous monitoring of soil health indicators (e.g., soil pH, microbial activity) and the ability to alter practices such as cover cropping, composting, or irrigation techniques based on feedback. Additionally, fostering collaboration with technology developers and researchers can streamline data collection and analysis, improving efficiency in decision-making.

Research on **implementation** science in sustainability and environmental governance has demonstrated that scaling up successful soil health practices requires both technical feasibility and strong community engagement (Guiliani, 2024). Studies show that successful implementation of soil health practices in diverse agricultural systems depends on overcoming barriers such as insufficient knowledge, resource limitations, and resistance to change (De Vita et al., 2016). Effective scaling strategies include both bottom-up (local) and top-down (policy-driven) approaches. Living labs offer a platform for testing soil health interventions at a smaller scale, before attempting to scale them up. Implementation success can be tracked by evaluating the adoption of new soil management practices (e.g., reduced tillage, agroforestry) in different farming contexts, and monitoring how these practices lead to measurable improvements in soil health and productivity. Scaling these solutions involves adapting them to broader regional contexts, often supported by policy advocacy and public awareness campaigns

The concept of **value co-creation** has been widely discussed in both business and sustainability literature, where it is recognized as a driver of innovation and long-term success in collaborative (Lucchesi & Rutkowski, 2021). In environmental projects, value co-creation is critical for ensuring that solutions are not only scientifically sound but also socially and economically viable. In soil health, collaborative innovation can lead to the development of new farming tools, soil amendments, or policies that benefit all involved parties (Brevik et al., 2020).Living labs enable stakeholders to engage in hands-on innovation, whether by co-developing new farming practices, soil health measurement tools, or policies. Value co-creation in living labs can be measured by evaluating the diversity of contributions and the tangible benefits realized by all stakeholders, including improved soil health outcomes, enhanced farmer knowledge, or more sustainable farming techniques. The living lab could serve as a demonstration of how innovative soil management practices can be scaled up or integrated into policy. By showing the effectiveness of collaborative and sustainable soil practices, the lab can provide valuable evidence to inform policymaking and drive changes in agricultural and environmental regulations.

Research has shown that **soil literacy** plays a crucial role in the adoption of sustainable farming practices. A higher level of soil literacy is linked to better soil management practices and increased willingness to adopt new technologies and methods (Geenhuizen, 2016). Knowledge-sharing initiatives, farmer education programs, and community engagement activities have been shown to improve soil literacy and lead to more sustainable soil management (Følstad, 2008). Living labs promote soil literacy by offering hands-on learning opportunities, workshops, and real-time data sharing. Evaluating soil literacy in a living lab setting involves assessing the level of knowledge and engagement among stakeholders and how this translates into improved practices. For instance, a living lab may track

changes in soil management techniques among local farmers after educational interventions or community workshops.

Altogether, the readiness levels proposed in iCOSHELLs provide a structured approach for tracking the development of Living Labs from early-stage initiatives to mature, impact-driven projects. By linking success factors to these readiness levels, the framework enables a systematic evaluation of LL progress, helping to identify strengths, weaknesses, and targeted interventions. The findings suggest that while these factors provide a strong foundation, their practical application requires contextual adaptation to different Living Lab conditions. On the other hand, the empirical findings demonstrate varying levels of readiness for the factors within each Learning Landscape (LL), indicating that, while these factors are complementary, their development may not occur in a uniform manner. Low levels in one factor may mitigate the potential benefits of high levels in another. Conversely, high levels in one factor can also act as pull factors, driving the development of other factors.

The results also indicate that while some LLs have achieved higher readiness in specific domains, their overall effectiveness is still influenced by external dependencies, institutional settings, and regional governance structures. These findings emphasize the importance of a tailored approach, where each LL's trajectory is assessed based on local priorities, stakeholder composition, and resource availability. Moving forward, iterative tracking of readiness levels will be crucial in guiding strategic improvements and refining governance mechanisms to enhance the success of soil health Living Labs.

5.1. Limitations of the Study

One critical consideration is whether these seven factors fully capture the complexity of soil health Living Labs or whether additional dimensions—such as financial sustainability, institutional integration, or policy engagement—should be considered in future assessments. While the current framework aligns with established environmental governance literature, its adaptability to evolving challenges will determine its long-term relevance. The validation process through the survey and ToT sessions demonstrated that governance and implementation remain key bottlenecks, reinforcing the need for iterative assessments and continuous refinement of readiness criteria. During the participatroy sessions, stakeholders pointed out that the readiness levels are linear and may not fully represent the complexity of the living lab innovation processes. However, the readiness levels represent certain stages of developoment and do not describe development between levels. Furthermore, at this point, a level of simplicity is also required because many stakeholders involved in the Lls may not have much familiarity about how complex these systems behave. Partners also highlighted the need to incorporate aspects related to funding and investment readiness level as well as other contextual factors such as the environmental impact.

This study presents valuable opportunities for improvement in several areas. First, the overlapping and sometimes unclear delimitation of factors highlighted an opportunity to enhance clarity, enabling LL actors to better differentiate between them and provide more precise answers without over-emphasizing specific factors. Furthermore, the limited number of responses, while informative, indicates the potential for broader participation to more fully capture the perspectives of all actors, both past and present. The study also identified an opportunity to increase the granularity of success factor assessments and improve the formalization and parametrization of these factors through the use of standardizable Key Performance Indicators (KPIs), which would aid in more effective assessment, monitoring, and planning. Finally, the absence of a detailed decomposition of the Living Lab (LL) according to the niche (micro), regime (meso), and landscape (macro) levels presents a valuable opportunity for future studies to provide a more comprehensive and nuanced understanding of the success factors across these different contexts.

6. Conclusion & Outlook

The governance of soil health Living Labs (LLs) requires a structured yet adaptable framework to ensure their effectiveness, sustainability, and long-term impact. While various frameworks for assessing success factors exist, they often lack consistency and practical applicability across different contexts. In this study, we developed a more concise and integrated set of success factors, grounded in a literature review and validated through the iCOSHELLs project. By incorporating readiness levels, we contribute to the literature by offering a systematic and accessible approach to evaluating the maturity and effectiveness of LLs.

Through the systematic assessment of success factors within iCOSHELLs, we provide a structured framework for managing and governing LLs effectively, ensuring that soil health interventions are sustainable, scalable, and impactful. The findings highlight the importance of strategic alignment, collaboration, governance structures, and stakeholder-driven innovation in driving long-term success. At the same time, challenges related to implementation, coordination, and resource availability must be continuously addressed. To maximize their impact, soil health LLs must also develop mechanisms for ongoing learning and institutionalized innovation. This requires documenting best practices, sharing operational models, and ensuring knowledge transfer between LLs across different regions. By doing so, successful governance and implementation strategies can be replicated and adapted to diverse environmental and policy contexts. For soil health LLs to drive long-term transformation, it is crucial to build sustainable institutional frameworks that ensure continued engagement and funding beyond individual project lifecycles. Strengthening partnerships with government agencies, NGOs, research institutions, and private-sector actors will provide stability and foster multi-stakeholder collaboration.

Moving forward, establishing clear metrics and key performance indicators (KPIs) will be essential to track the evolution of LLs and their contributions to sustainable soil management. Based on our results we suggest that targeted strategies must be developed to (i) Strengthen governance frameworks by establishing clearer decision-making structures, (ii) enhance co-creation mechanisms to ensure active participation in developing soil health solutions, (iii) improve implementation pathways by addressing external dependencies and regulatory barriers, (iv) track LL progress over time using iterative assessments that adapt to changing conditions.

Over time, LLs should evolve into platforms for systemic learning, not only testing technical innovations but also experimenting with new governance models, stakeholder dynamics, and policy mechanisms. By integrating insights from diverse regional contexts, LLs can serve as hubs for institutional innovation, where sustainable soil management policies and practices are continuously refined and improved.

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Appendix A: Survey

Success Factors for Living Labs

Dear iCOSHELLs partners,

this survey is part of T1.2, in which we will research the factors that make a Living Lab (LL) successful and the necessary conditions for a LL site to be transformed into a Lighthouse.

A set of seven success factors were selected from the literature: Strategic Alignment, Operational Excellence, Collaboration Dynamics, Implementation, Value Co-Creation, Steering Structure & Soil Literacy.

Within each factor, a detailed readiness level scale from 1 (low readiness) to 9 (high readiness) is provided. Each level is described with clear criteria, milestones, and activities that must be accomplished to move on to the next level. Your feedback will help us understand the level of maturity of the living labs in each of the factors.

Please answer all questions specifically for your LL location. We understand that each LL includes multiple different sites. If possible, please answer the questions in a way that is generally true to all sites. If some sites stand out, please make a comment in the last section and describe how they are different.

We estimate that filling in this survey should take you 15-20 minutes.
Thank you for your time and contribution to this important endeavor.

Yours sincerely,
The ATB team (Richard, Trang & Philipp)

Success Factors for Living Labs

Success Factors Readiness Levels

The following success factors were selected from the literature and provide (i) a common language to assess the status and maturity of the living labs (ii) structure and guidance on which areas need to be addressed and (iii) a scalable, flow effective and measurable process.

Instructions to assess the readiness levels

Each factor uses a 9-point scale to describe readiness levels. These can be broadly understood as:

- **1-3 (Low Readiness):** Early stages of development or awareness.
- **4-6 (Medium Readiness):** Progress established with partial integration and effectiveness.
- **7-9 (High Readiness):** Fully operational, integrated, and impactful

Please assess the current readiness level in each success factor, from 1 to 9, in a way that is generally true to all sites.

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Strategic Alignment *(Development and implementation of a shared strategy for soil health)*

- (1) No strategy in place and no awareness among stakeholders about the need for a unified strategy.
- (2) Stakeholders recognize the need for a strategy but no formal discussions occur.
- (3) Initial discussions start; informal agreements emerge.
- (4) A draft strategy exists, partially aligned with stakeholder goals.
- (5) A formal strategy is developed and begins to guide stakeholder actions.
- (6) Stakeholders consistently align their efforts with the strategy, showing unified progress.
- (7) The strategy integrates systemic initiatives across all stakeholders.
- (8) Measurable outcomes demonstrate success; the strategy is refined periodically.
- (9) A unified strategy agreed by all stakeholders, aligned with societal needs and achieving systemic soil health improvements.

Operational Excellence **(***Efficiency and adaptability of processes and workflows)* *

- ◯ (1) Soil health efforts are ad hoc and reactive without structure.
- ◯ (2) Basic workflows are identified but remain inconsistent.
- ◯ (3) Initial processes for soil monitoring and management are introduced.
- ◯ (4) Standardized workflows allow consistent tracking of soil health indicators..
- ◯ (5) Processes are refined periodically to enhance efficiency.
- ◯ (6) Digital tools are integrated; key performance indicators (KPIs) are actively tracked.
- ◯ (7) Processes adapt to feedback and challenges; efficiency is benchmarked.
- ◯ (8) Operations are scalable and promote continuous learning.
- ◯ (9) Fully optimized workflows ensure seamless adaptability to external changes.

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Implementation (*Execution and scaling of soil health solutions*)

- ◯ (1) Ideas to address soil health exist but lack concrete plans.
- ◯ (2) Sites and initial stakeholder networks identified; experimentation discussed.
- ◯ (3) Clear soil pilot plans emerge; one site chosen for early trials.
- ◯ (4) Small-scale soil pilots launched with basic engagement.
- ◯ (5) Multi-site soil pilots expand; early lessons inform adjustments.
- ◯ (6) Refined pilots applied across contexts, testing transferability.
- ◯ (7) Solutions are scaled across regions. Strong partnerships at multiple sites ensure operational stability.
- ◯ (8) Experimentation consistently delivers impactful results. Practices are systemically integrated and policy-aligned.
- ◯ (9) Fully scaled solutions achieve long-term policy, market, and societal change

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Value Co-Creation (*Joint creation of value through collaboration, learning, and innovation)*

- ◯ (1) Little awareness of co-creation benefits exists.
- ◯ (2) Stakeholders engage informally with no structured outcomes.
- ◯ (3) Small co-creation efforts yield initial shared value.
- ◯ (4) Structured processes enable stakeholder co-creation of soil solutions.
- ◯ (5) Stakeholders generate meaningful shared outcomes consistently.
- ◯ (6) Value co-creation processes are deeply embedded in the lab's activities, creating substantial value for all participants.
- ◯ (7) Stakeholders from diverse sectors collaborate seamlessly, creating significant value that aligns with their mutual goals.
- ◯ (8) Co-created value drives innovation and systems change, with lasting benefits for all stakeholders.
- ◯ (9) The lab becomes a global benchmark for value-driven innovation.

Collaboration Dynamics (*Strength and inclusivity of partnerships*) *

- ◯ (1) No formal collaboration; partnerships are nonexistent or minimal.
- ◯ (2) Potential collaborators are identified but remain disengaged.
- ◯ (3) Initial partnerships are formed with limited interaction.
- ◯ (4) Formal agreements ensure structured collaboration and communication.
- ◯ (5) Stakeholders contribute resources and expertise to joint initiatives.
- ◯ (6) Collaboration drives shared decision-making and iterative reflection.
- ◯ (7) Stakeholders work together to address systemic challenges effectively.
- ◯ (8) Partnerships are self-sustaining, fostering innovation and transformation.
- ◯ (9) A fully collaborative ecosystem achieves shared goals and systemic impact.

Learning & Innovation (*Stakeholder knowledge and practices regarding soil health)*

- ◯ (1) Stakeholders lack awareness and basic knowledge of soil health issues.
- ◯ (2) Basic awareness of soil health exists among a few stakeholders.
- ◯ (3) Initial efforts promote awareness via materials and events
- ◯ (4) Stakeholders engage in knowledge-sharing activities.
- ◯ (5) Interactive campaigns foster widespread soil literacy.
- ◯ (6) Practical applications improve stakeholder practices.
- ◯ (7) Capacity-building programs embed soil literacy into systems
- ◯ (8) Widespread soil-literate behaviors affect education and policy.
- ◯ (9) Soil literacy drives systemic change in agriculture, policy, and society.

Closing Questions

Which success factor requires the most attention to improve the overall performance of the living lab?

- ○ Strategic Alignment (Development and implementation of a shared strategy for soil health)
- ○ Operational Excellence (Efficiency and adaptability of processes and workflows)
- ○ Collaboration Dynamics (Strength and inclusivity of partnerships)
- ○ Implementation (Execution and scaling of soil health solutions)
- ○ Value Co-Creation (Joint creation of value through collaboration, learning, and innovation)
- ○ Steering Structure (Governance, roles, and decision-making frameworks)
- ○ Soil Literacy (Stakeholder knowledge and practices regarding soil health)

Are there additional factors critical for the success of your Living Lab?
(E.g. funding models, business models, policy mechanisms, unique stakeholder needs…)

Tu respuesta

What specificities about your Living Lab should we consider?
(Regional challenges or opportunities influencing the performance of the Living Lab)

Tu respuesta

Do you have any additional comments or insights about your Living Lab that you would like to share?

Tu respuesta

Appendix B: Readiness Assessment of iCOSHELLs

Figure 4. Readiness Assessment of Swedish Living Lab

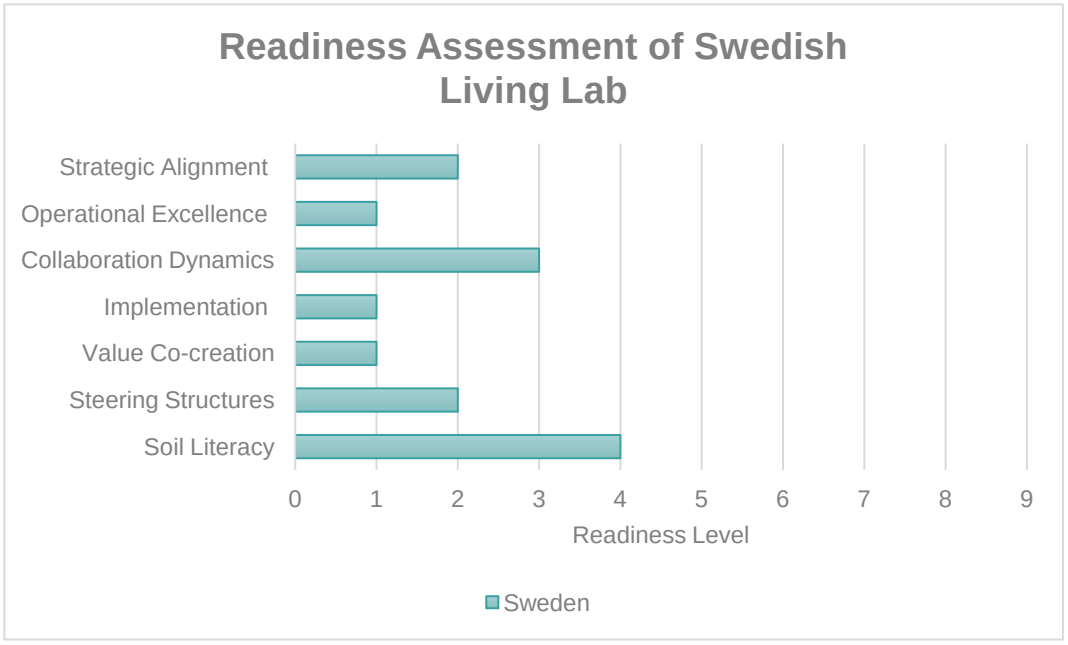


Figure 5. Readiness Assessment of Spanish Living Lab

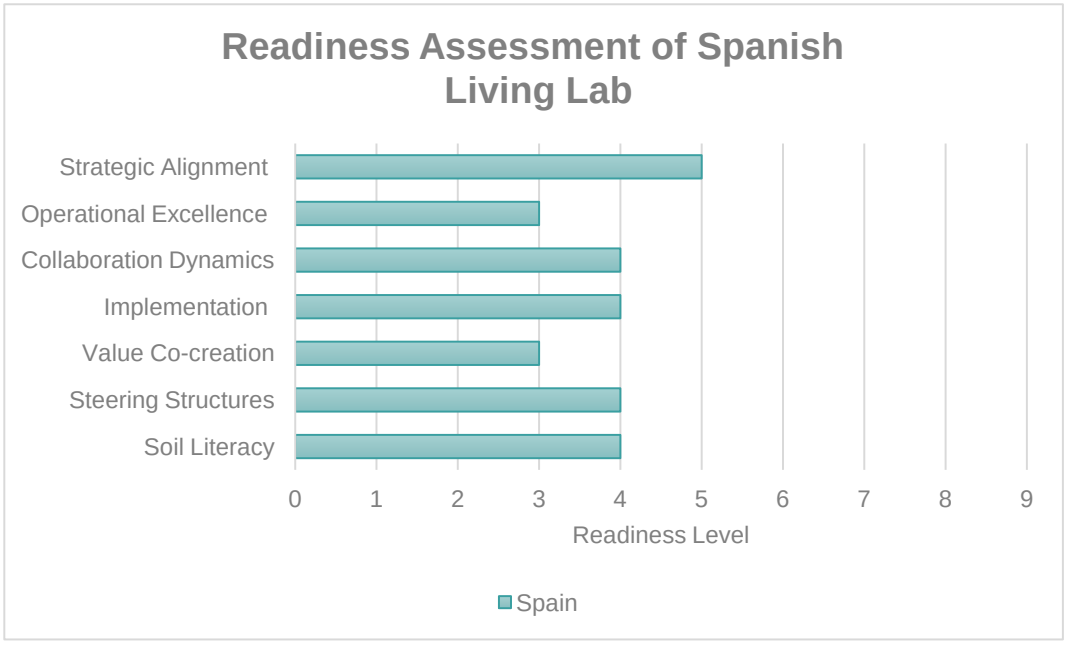


Figure 6. Readiness Assessment of Basque Living Lab

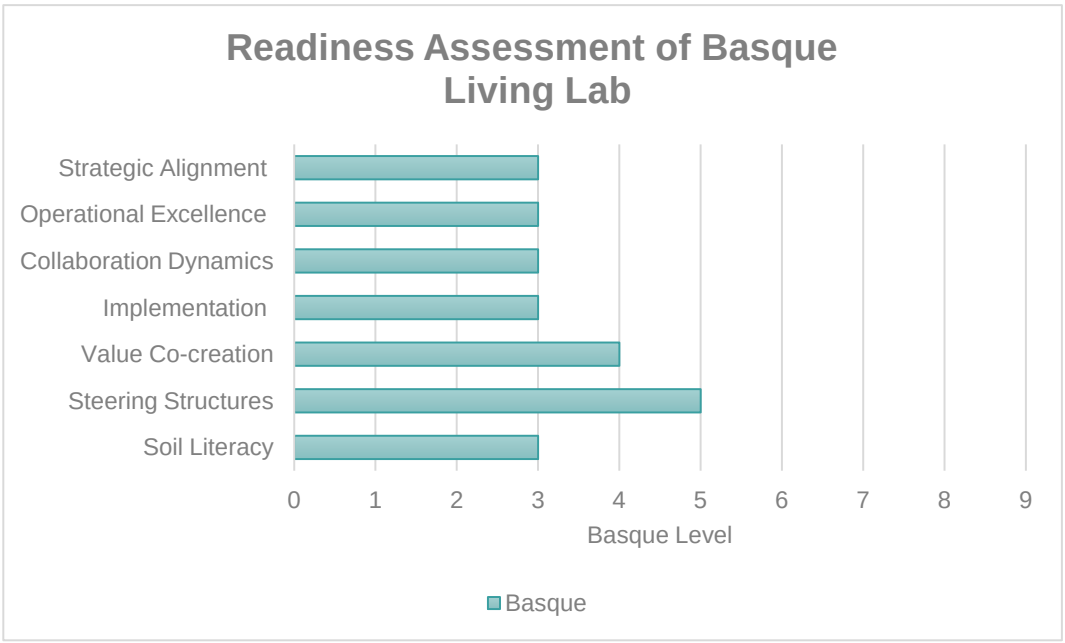


Figure 7. Readiness Assessment of Italian Living Lab

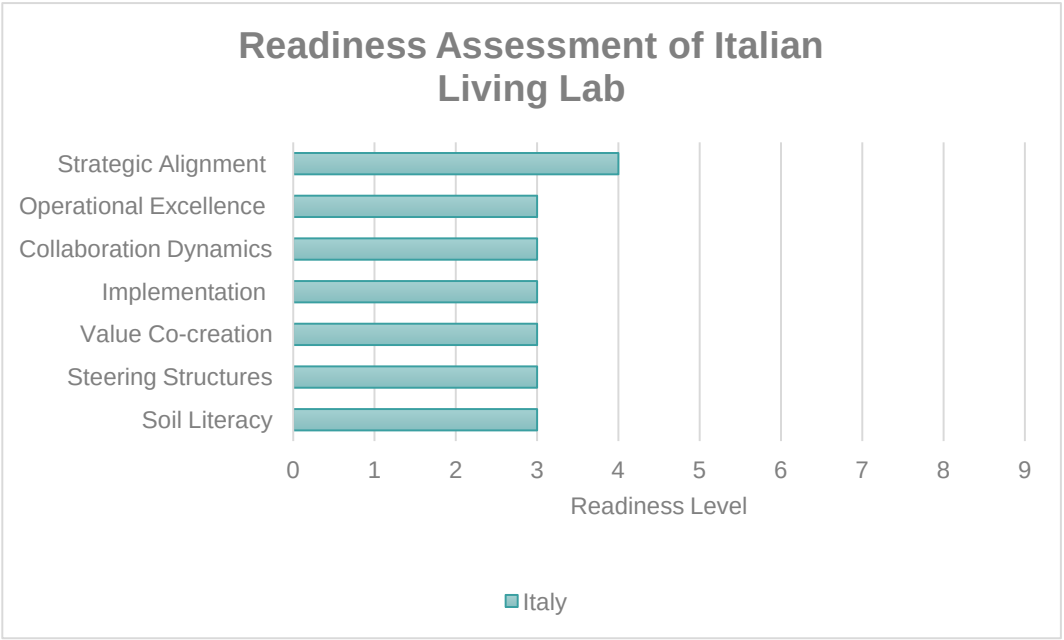


Figure 8. Readiness Assessment of Greek Living Lab

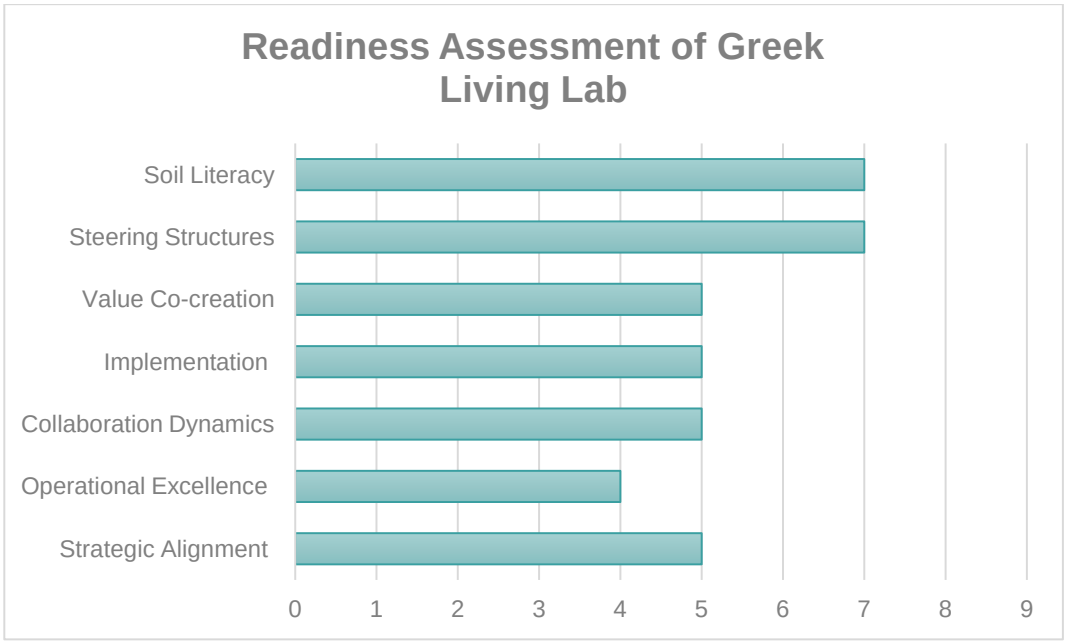
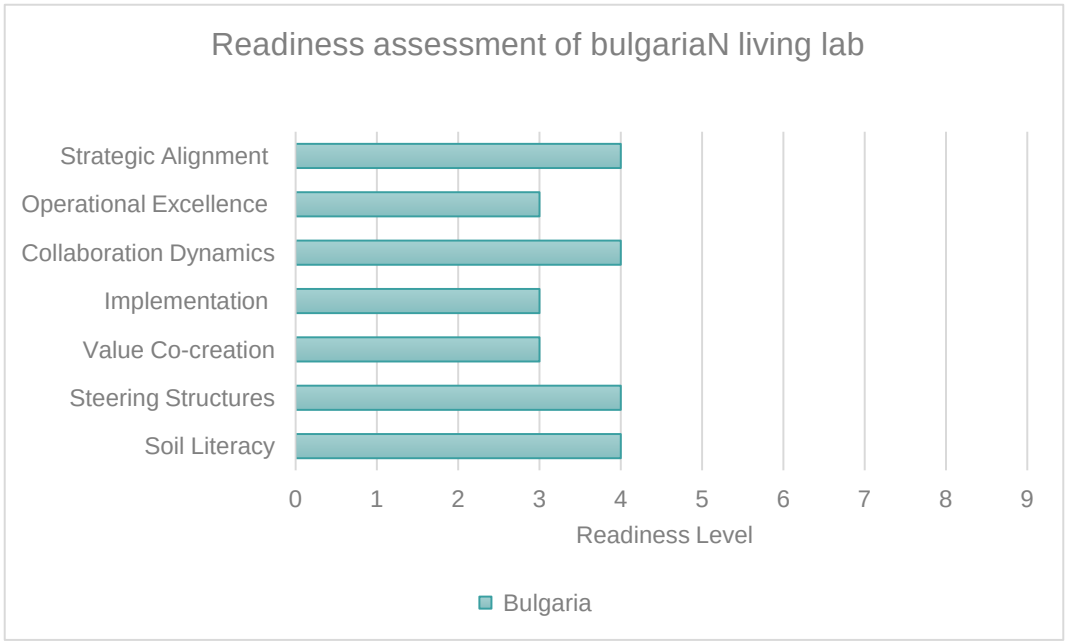


Figure 9. Readiness Assessment of Bulgarian Living Lab



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