D6.1 Common Innovation Framework & Solutions Portfolio

Regions 4Climate

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List of Acronyms

CIF	Common Innovation Framework
CR	Climate Resilience
CRML	Climate Resilience Maturity Level
EIT	European Institute of Innovation and Technology
EU	European Union

GIS	Geographic Information System
IP	Intellectual Property
IPR	Intellectual Property Rights
KIC	Knowledge and Innovation Community
LAU	Local Administrative Unit
M&E	Monitoring and Evaluation
NDC	National Determined Contribution
NUTS	Nomenclature of Territorial Units for Statistics
RCRD	Regional Climate Resilience Dashboards
R&D	Research & Development
RES	Renewable Energy Sources
R4C	Regions4Climate
RIS	Regional Innovation System
RRI	Responsible Research and Innovation
RRMM	Regional Resilience Maturity Model
S4+	Smart Specialisation Strategies for Sustainable and Inclusive Growth
SDG	Sustainable Development Goals
SME	Small Medium Enterprise
STRM	Socio-Technical Roadmap
SWOT	Strengths, Weaknesses, Opportunities and Threats
UN	United Nations
V&R	Vulnerability and Risk

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Keywords list

- Assumptions of Action
- Common Innovation Framework
- Innovation Management
- Innovation
- Knowledge society
- Quintuple Helix
- Regional Innovation System
- Transformative frame
- Visual Toolbox for system innovation

Disclaimer

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Executive Summary

This document is developed as part of the “Regions4Climate” (R4C) project, which has received funding from the European Climate, Infrastructure and Environment Executive Agency (CINEA), under the Grant Agreement number 101093873.

Deliverable 6.1 (D6.1) – Common Innovation Framework & Solutions Portfolio is a public report that integrates Task 6.1 (T6.1) Innovation Management of Work Package 6 (WP6) Innovation Management & Exploitation, led by SPI. It intends to provide a Common Innovation Framework (CIF) to enable and support innovation processes in each partner region. By providing this framework, this report supports the management of the general steps of the innovation process into clear phases that help leaders’ decisions, allowing: (i) the facilitation of knowledge exchange; (ii) the definition of a common path for the regions to follow when developing their innovation packages; (iii) the enablement of comparison; (iv) the monitoring of the innovation results that arise from the implementation of the innovation packages. Consisting of a plausible, replicable and exploitable model of innovation, for (further) development of region-specific Innovation Packages in pursuit of systemic transformation, the CIF is developed based on relevant concepts and approaches. By covering relevant community systems, the CIF will allow the identification of the conditions of action for the development of the regional innovation packages.

As planned, a variety of tools and methods were applied to get partners’ contribution to T6.1/D6.1, namely:

- Questionnaire: Created to have a deeper understanding of the regional ecosystem, regarding innovation and climate change approach, this questionnaire was addressed to R4C partners involved in the innovation ecosystems of the 12 regions (public authorities, research and technology organisations, public industry, high education institutions and private non-profit organisations). This questionnaire was structured in 3 parts: (i) Partner organisation (its role in the innovation system), (ii) Regional Innovation System (policy framework, enablers and barriers to innovation and climate change resilience), (iii) R4C innovation actions (challenges, enablers and barriers to innovation, stakeholders’ engagement).
- Workshop: All of the above-mentioned institutions were invited to attend a workshop *per* challenge suite (3 workshops). Here, several topics were addressed: (i) the regional innovation system – understanding the dynamics; (ii) stakeholders- understanding the actors; (iii) the road to exploitation – IPR vs. SGD.
- Brainstorming: Partners involved in T6.1 were invited to join a brainstorming to discuss innovation concepts and the Common Innovation Framework (CIF) first draft.

In addition, to keep track of the T6.1/D6.1 progress, monthly WP6 meetings were carried out.

This approach allowed a first look into the regional innovation ecosystems and a deeper understanding of their structure and dynamics. Through collaborative work, the partners were involved in the definition of resilience innovation objectives, barriers and enablers of innovation in each region, and the CIF approach. The result of this collaborative work is reflected in this report.

To accomplish the general goal and purpose of this report its structure is organised as follows:

- **Section 2 – Innovation as a driver to climate resilience**: This section includes preliminary notes about innovation and its role in climate resilience. It describes the pivotal role of innovation in driving progress in

sustainable development and the challenges or barriers that hinder the process of generating, developing, and implementing innovative ideas or solutions for climate resilience.

- **Section 3 - Common Innovation Framework for R4C**: This section describes the proposed CIF within the R4C project. This section also provides guidelines on how to align the objectives defined with the overall project framework and an insight into the further development of Innovation Packages by showcasing the structure and interrelations between the R4C WPs to engage innovation throughout the process. As an open innovation approach, it also describes the proposed public engagement approach to guarantee more effective results and an impact on communities and climate change resilience.

- **Section 4 - Factors for success – enablers and obstacles to innovation**: This section highlights the main enablers and obstacles to innovation by presenting a short theoretical framework and a regional approach.

- **Section 5 – R4C Innovation Assessment**: This section presents the methodology and the type of indicators to be assessed for evaluating innovation packages, monitoring systemic innovation implementation, and identifying improvement areas.

- **Section 6 - Conclusions**: This section provides a summary of a series of interconnected phases and steps that guide the integrated innovation process from idea generation to successful implementation of innovation packages demonstrated by each region.

- **Section 7 - References**: This section consists of the systematisation of studies and sources with valuable information for CIF development.

- **Section 8 - Appendices**:

  Annex 1. CIF references: This section includes preliminary notes about innovation, inspiring concepts and approaches relevant to CIF development, and reasons why those approaches were chosen for the development of Regions4Climate CIF.

  Annex 2. CIF Toolbox: This section showcases a set of tools, methods, and resources for each phase and steps used in the CIF Regions4Climate with a brief description, visual graphics, limitations and important links to obtain further information on each tool which are presented on each step. The CIF is developed by utilising Visual Toolbox for system innovation provided by EIT Climate-KIC.

  Annex 3. IA geographical coverage per Challenge Suites: referring to the administrative units where the Innovation Actions (IA) will take place.

  Annex 4. Administrative authorities in the R4C Consortium per Challenge Suites: regional/local authorities in the R4C Consortium, according to their administration units.

The CIF intends to foster innovation management and exploitation (WP6), with the ultimate goal of achieving systemic transformation (T6.1), evaluating key opportunities and addressing any obstacles to successful post-project exploitation (T6.2) by conducting feasibility studies to upscale the project, making necessary adaptations, and applying a robust replication methodology. Organisations can establish a structured and strategic approach to innovation by implementing the CIF, facilitating effective and sustainable progress towards resilience and growth in each region.

1. Introduction

Climate change is the greatest environmental, social and economic threat facing the planet and humanity today. It encompasses long-term alterations in temperature patterns, precipitation levels, and other weather phenomena within the Earth's climate systems and therefore it has a significant impact on communities' quality of life and even their survival.

Addressing climate change demands global cooperation, transformative innovation, and bold policy measures to ensure the sustainability and preservation of our planet for present and future generations. Urgent action is imperative to mitigate greenhouse gas emissions, adapt to the existing changes, and strengthen resilience against future climate risks. In this sense, there are two main lines of action to address climate change: mitigation and adaptation. While mitigation is the process of reducing the emission of greenhouse gases into the atmosphere, adaptation minimises the negative impacts of climate change on biophysical and socio-economic systems.

The consequences of climate change extend far and wide, impacting ecosystems, economies, and human well-being. A transition towards more sustainable and resilient communities and systems requires that we simultaneously address social inequalities and implement cross-sectoral innovations to build social, economic and environmental resilience to extreme events.

Tackling climate change has become a central objective of the European Union (EU) mission and strategy. This mission aims to make a noteworthy impact by prioritizing innovation and research, fostering collaboration with relevant stakeholders, and engaging societies and communities. The strategy sets four key objectives: smarter adaptation, faster adaptation, systemic adaptation, and scaling up international adaptation efforts.

The EU adaptation strategy primarily targets urban areas (mainly responsible for greenhouse gas emissions), which are often characterized by various levels of government (federal, regional, state, metropolitan, province, county, and municipal) and multiple institutional organisations responsible for providing infrastructure, and services, and promoting growth and environmental well-being. Consequently, disagreements and misunderstandings may arise during the implementation of urban or multilevel climate adaptation strategies. The involvement of multiple stakeholders, sectors, and diverse contexts requires innovative and multilevel governance approaches and novel solutions to foster sustainability transitions.

R4C partners are committed to addressing current and forecasted climate change-related challenges and significantly advancing European regional transitions to climate resilience within an innovative socially engaged, citizen-driven paradigm and practices. The development and implementation of cross-sectoral strategies that incorporate combinations of social, technological, digital, business, governance and environmental solutions to common climate resilience challenges are, at present, constrained by knowledge deficits and uncertainties, as well as science-policy-stakeholder gaps, and therefore, are a priority challenge that we are willing to contribute to.

As explained in the R4C Grant Agreement "a transition towards resilience requires that we simultaneously address social inequalities and implement cross-sectoral innovations to build social, economic and environmental resilience to extreme events."

R4C will bridge these gaps and address existing uncertainties by further developing, adapting and integrating state-of-the-art technical know-how, innovative tools and collaborative practices to support transparent, evidence-based risk and vulnerability analyses and robust decision-making processes.

As the CIF aims to facilitate effective and sustainable progress towards resilience and growth in each region, the purpose of Deliverable 6.1 is to develop a holistic and multi-level model and framework for common innovation complemented by a portfolio of Climate Resilience solutions.

More specifically, the CIF aims to provide specific guidance for regions in their innovation processes towards innovation in climate change/adaptation and mitigation, particularly in R4C innovation packages implementation. Therefore, by combining several approaches and references, the proposed CIF will allow (i) the facilitation of exchange, (ii) the enablement of comparison, (iii) the definition of a common path for the regions to follow when developing their innovation packages and (iv) the monitoring of the innovation results that arise from the implementation of the innovation packages.

Under Task 6.2 and D6.2 “Regional Innovation Roadmaps”, in a work codeveloped with the partners, the CIF will be transposed into each regional context, in order to align the proposed framework with the local/regional features and the R4C innovation packages, including the assumptions of action, it’s contribution to Just Transition, the milestones towards resilience innovation objectives ensuring post-project sustainability and alignment with RRI principles.

2. Innovation as a driver of climate resilience

Innovation demands a blend of diverse knowledge, skills, capabilities, and resources. This is an active process that requires explicit efforts to enhance or establish technological capacities and skills. (Fagerberg, 2003; Lall, 2001). Thus, the innovation process transforms efforts (innovation activities) on innovation outcomes. Innovation activities involve both seeking to generate new knowledge and acquiring, adapting, or developing existing knowledge, as well as increasing the entities' productive and technological capabilities, either in equipment or human resources (Figure 1).

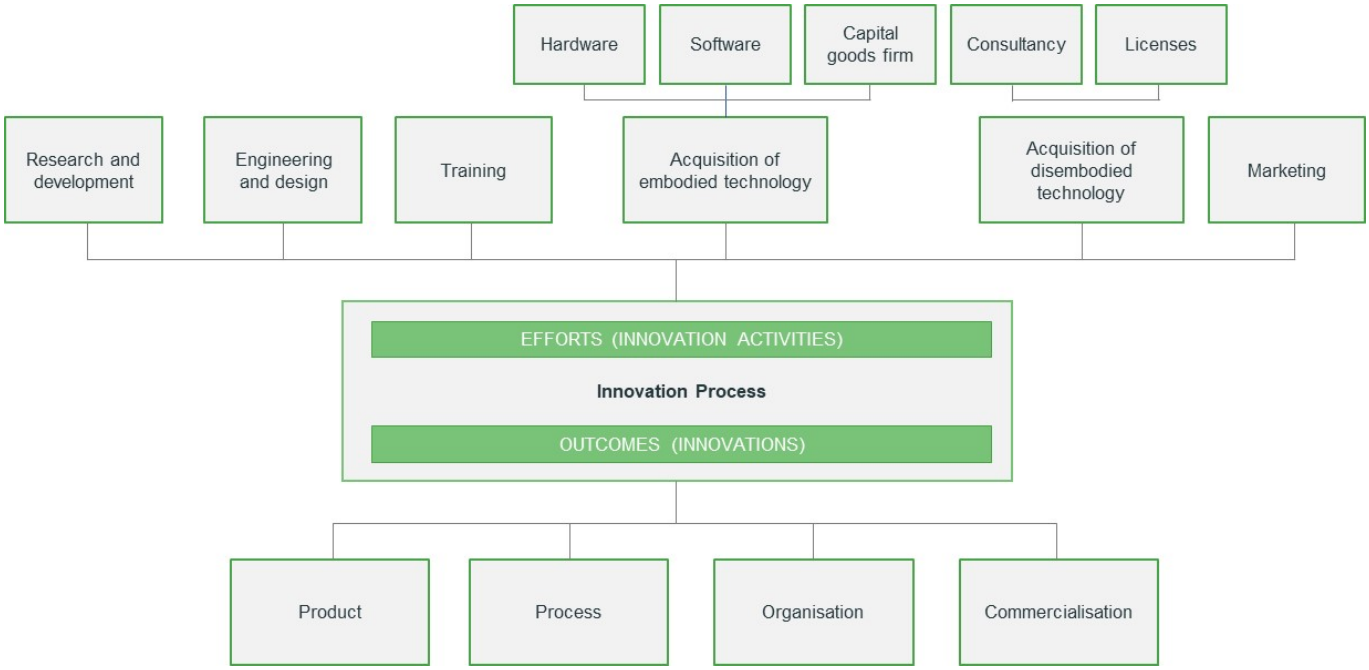

Figure 1. Efforts and outcomes within the innovation process

Source: Modified from Lugones (2009)

In general, innovation means developing original concepts and being able to set a different paradigm to identify new opportunities and the best methods to solve current issues. It means helping to turn challenging problems into manageable solutions (George et al., 2016). Thereby**, innovation should be a continuous process of identifying and solving problems at an operational and delivery level** that implicates the need for a culture of continuous improvement and experimentation along the process. This is clear when it comes to technologies, which eventually pass through four phases: prototype, demonstration, early adoption and maturity. The speed with

which technologies pass through these phases depends on different attributes (including, for instance, their flexibility, the synergies with other technologies and the perception of the users). Also, several generations of innovations may be developed over time, based on the previous ones (learning from early ideas or new ideas arising from previous experiments), as explained in the following figure.

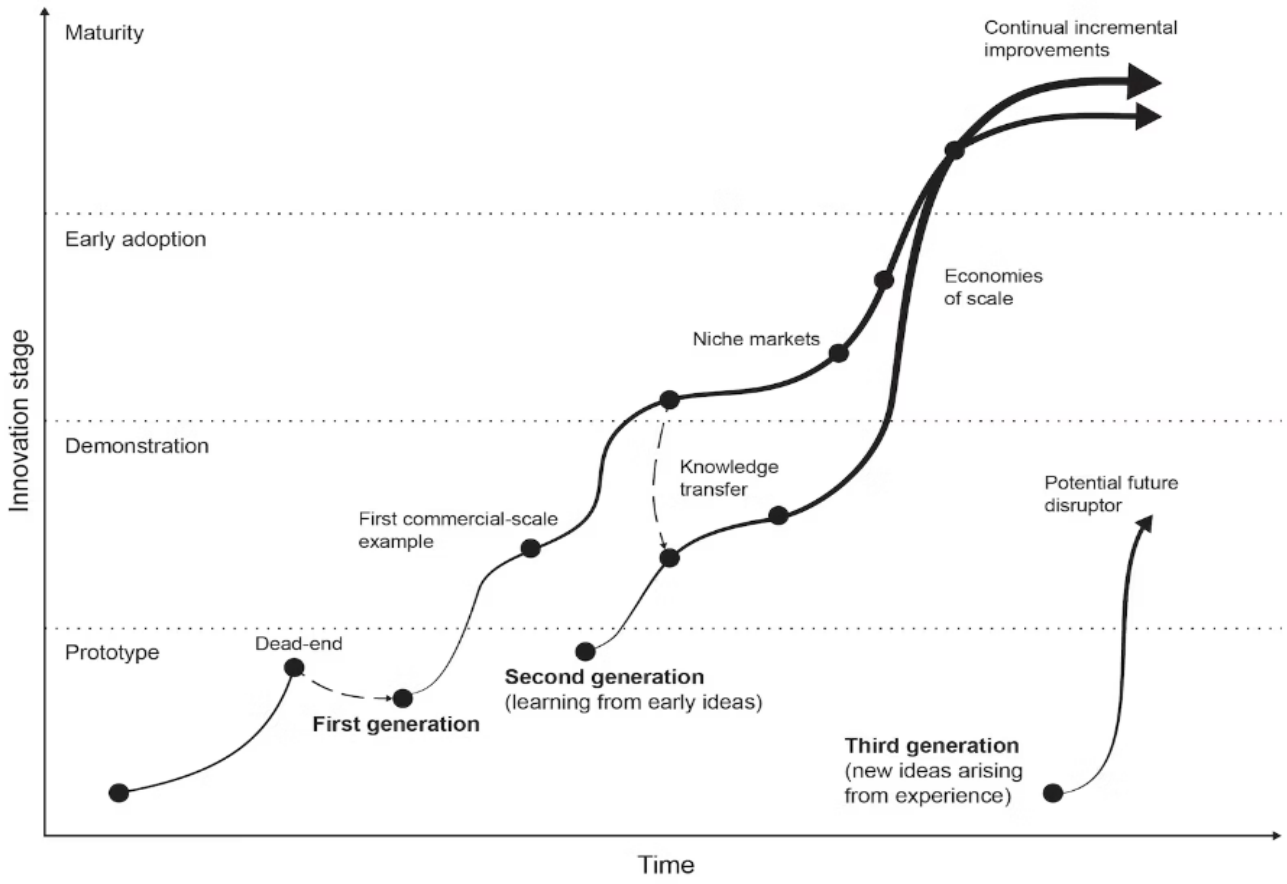

Figure 2. Phases of technology innovation, feedback and spillovers that improve successive generations of designs

Source: International Energy Agency (2020)

The process of innovation is taking place within increasingly networked economies with changing social values and growing environmental pressure. Therefore, successful approaches depend on having flexible, multidisciplinary skills to respond to this changing context. Ultimately, then, on the scope of creating more resilient communities, we must ensure that the actions implemented in the context of an innovation process do not displace or trade-off with each other; and also ensure that the interventions have a permanent impact and little risk of leakage or failure in the future. It depends upon understanding what the public is expecting and being able to meet these needs cost-effectively and without raising alarms and fears.

Innovation provides the means to act smarter and more sustainably but it also creates uncertainties, regarding the consequences of the scale and scope of application. Most innovations aiming at addressing the causes or the impacts of climate change are technologically complex and associated with a high degree of risks and uncertainties (Wu et al., 2020). These technologies often rely on knowledge from different fields and are embedded in innovation ecosystems that involve many different organisations (Cecere et al., 2014). As expected, one consequence of such complexity is the rise in risk and uncertainties to succeed as the need for coordination from all system partners increases (Levinthal and Warglien, 1999).

With the effects of climate change growing, innovation is expected to play a major part in enabling climate change adaptation/resilience. The goal is to reduce risks from the harmful effects of climate change (e.g., sea-level rise, more intense extreme weather events, or food insecurity). It also includes making the most of any potential beneficial opportunities associated with climate change. Technological innovations play an important role: however, addressing global challenges towards climate resilience through innovation also involves organizational, behavioural, social and economic changes.

The connections between the several dimensions of innovation for climate resilience are clearly explained in the Quintuple Helix model (Carayannis and Campbell, 2010), which grasps and specializes in the sum of the social (societal) interactions and the academic exchanges in a state (nation-state) to promote and visualize a cooperation system of knowledge, know-how, and innovation for more sustainable development (Figure 3).

The most important constituent element of the Quintuple Helix - apart from the active ‘human agents’ – is the resource ‘knowledge’, which, through circulation between societal subsystems, changes to innovation and know-how in society and for the economy. Therefore, to analyse sustainability in a Quintuple Helix and to make sustainable development determination for progress, means that each of the five subsystems (helices) - education system, economic system, natural environment, media-based and culture-based public and political system - has a special and necessary asset at its disposal, with a social (societal) and academic (scientific) relevance for use. Therefore, the Quintuple Helix Model shows and demonstrates that **education is key for empowerment, equal opportunities and new knowledge for sustainability and development, as the circulation of knowledge continually stimulates new knowledge.**

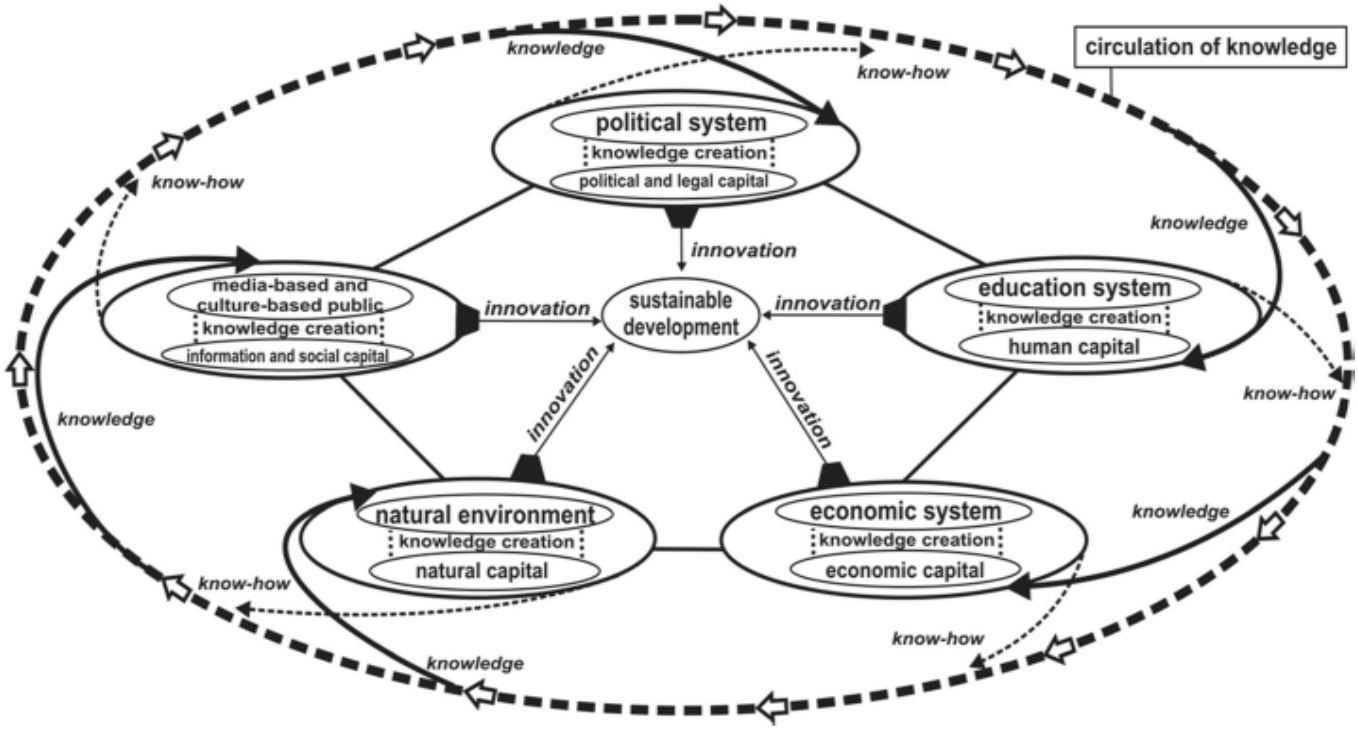

Figure 3. The Quintuple Helix model and its function (functions)

Source: Carayannis (2012)

Public authorities (governments, regional authorities, municipalities and so on) have a particularly central and wide-ranging role to play in this process by defining, organising as well as managing the general conditions of the state, promoting public mobilisation but also investing in education. More investments in education create new impulses and suggestions for knowledge creation in the system, making sustainable development more feasible and directly contributing to other subsystems[1].

[1] Check for more detailed information on the Quintuple Helix Model on the Appendices.

3. Common Innovation Framework for R4C

3.1. Introduction

It is commonly accepted that the innovation approach has changed through the years from simple linear models to more complex integrated network models (Preez and Louw, 2008) and, therefore, implicates a new logic based on openness and collaboration between the diverse components of the model.

The literature widely suggests that most innovation process models involve a pattern of steps or phases. Enhancing that integration between the different functions within the innovation process is of paramount importance and can be the discriminating factor for its success. On the other hand, an innovation process needs to favour a network approach that is focused both on internal and external factors and should consider the exploitation of innovations within the market, seeing that exploitation is a mechanism for the competitiveness and financial survival of entities. So, innovation is not a simple linear process in which one phase follows another, instead is highly interactive and stimulated by diverse factors. Besides, it's important to highlight that each phase of the process also requires different types of incentives to promote the overall goal of innovation and is highly dependent on a participatory process and data assessment and management.

In this context, **the CIF delivers the dimensions that need to be considered and the innovation process that will help the organisations (in particular, the regional authorities in the R4C project) to identify the challenge (Challenge Suites in the R4C project), design and implement solutions to address it, evaluate those solutions throughout the process, and turn the best ideas into a value-add.** The main goal is to manage the general steps of the innovation process into clear phases that help leaders' decisions. In this sense, an innovation framework is intended to provide the structure to create transparency, consistent milestones, and a clear path forward while leaving flexibility for emergent ideas or data that would influence the overall direction.

The literature review[2] gives an important understanding of the most relevant theoretical innovation models that provide a solid basis to address complex challenges, to seek transformative solutions. Aligned with the principles of sustainability and climate change resilience, five approaches must be highlighted, namely the Transformative Innovation Approach (Loorbach et al., 2017; Loorbach et al., 2020), the Quintuple Helix Approach (Carayannis et al., 2012; Carayannis & Morawska-Jancelewicz, 2022), the Experimental Governance Approach (Farzaneh, 2018; Leceta & Könnölä, 2019; Rocle & Salles, 2018; Bernstein & Hoffmann, 2018), the Open Innovation Approach (Chesbrough & Appleyard, 2007; van Genuchten et al. 2019; Angsbo, 2017), and the Bottom-up Approach (Bhave et al., 2014; Hermansen & Sundqvist, 2022).

The following bullets provide a summary of the contribution of the selected approaches:

- **Transformative innovation approach** highlights the importance of deep and systemic change to address the challenges of climate change. It emphasises the involvement of multiple stakeholders, including governments, businesses, academia, civil society and citizens, to create a shared vision and implement innovative

[2] Summarised in Appendices – section 8.1

experiments that lead to transformative change. To be successful, they rely on a supportive ecosystem that nurtures creativity, provides access to essential resources and expertise, and encourages experimentation.

- **Quintuple Helix approach** as an evolution of the traditional triple helix of innovation, including civil society and nature as relevant actors, it promotes a more holistic and inclusive view of innovation, recognising the importance of circular knowledge and collaboration between different sectors of society to drive innovation and sustainability. It combines knowledge, know-how, and the natural-environmental system within an interdisciplinary and transdisciplinary framework.

- **Experimental governance approach**, which emphasises the importance of testing and experimenting with innovative solutions to address complex challenges. Through pilot projects and practical experimentation, experimental governance allows for the identification and evaluation of effective innovation approaches, which is crucial for iterative and adaptive decision-making;

- **Open innovation approach**, based on the idea that organisations can achieve greater success and effectiveness by collaborating with others and leveraging external knowledge to solve complex challenges. Open innovation is based on active collaboration with external partners, with key elements including acquiring external knowledge, creating and maintaining collaborative networks and ecosystems, open intellectual property, spin-in and spin-out activities, applying crowdsourcing platforms and open innovation challenges to harnessing the collective intelligence of the public and external contributors, and involving end-users in the innovation process to ensure that innovation meets their needs;

- **The bottom-up approach** has a strong focus on local knowledge and stakeholder perspectives and their interactions, in the decision-making process. In addition, it considers social vulnerability and adaptive capacity and integrates local knowledge of climate variability from previous top-down studies. This approach helps to address the challenges of uncertainty in technological, digital, environmental, economic, political and social innovation by considering local perspectives on socio-technical scenarios for adaptive decision-making strategies.

These learnings are key to developing the CIF since the R4C project intends to leverage existing local knowledge and recognise the peculiarities of each region as part of its innovation potential (bottom-up approach), to make use of the circular knowledge and collaboration between different sectors of society to drive innovation and sustainability (quintuple helix), as well as engaging the stakeholders and community throughout the process (open innovation). Also, note the importance of relying on a supportive ecosystem for a deep and systemic change (transformative innovation approach) and the importance of testing and experimenting with innovative solutions to address complex challenges such as climate change (experimental governance approach).

Therefore, as explained, all of the approaches mentioned above have a strong alignment with the R4C's main goal of creating resilient communities, more prepared to face the impacts of climate change, supported by an open and innovative approach. Quoting from the Grant Agreement "We aim to develop smarter, more inclusive, more resilient regional ecosystems through cross-sectoral innovation jointly created with stakeholders, by and for people".

3.2. Approach and guidelines for action

As R4C aims to collaboratively develop and demonstrate a socially-just transition to climate resilience, regionally-tailored innovation packages will be co-created and co-implemented with stakeholders within a **common operational framework**, which includes the innovation approach (called CIF - Common Innovation Framework).

Under the scope of developing a consistent model to boost innovation for effective climate resilience, and therefore, for (further) development of region-specific Innovation Packages (IP) in pursuit of systemic transformation, the CIF suggests a common path for the regions to follow (Figure 4) regarding the following **strategic objectives**:

SO1. Support a multi-level and multi-scale model of innovation to enhance and improve regional action towards climate change

SO2. Foster innovation and collective action, supported by flexible, adaptable and interoperable tools and processes for climate resilience

SO3. Facilitate cross-sectoral and cross-border knowledge exchange among the innovation ecosystems

SO4. Promote replication, scaling and exploitation of R4C innovations

This framework aims to provide specific guidance for regions in their innovative processes, particularly in R4C innovation package development, but also in similar missions to encourage and disseminate a clear vision, set a direction, and stimulate innovative actions. As a replicable and exploitable framework, it must comprehend monitoring of the innovation results that arise from the implementation of the innovation packages and enable comparison between the regions involved.

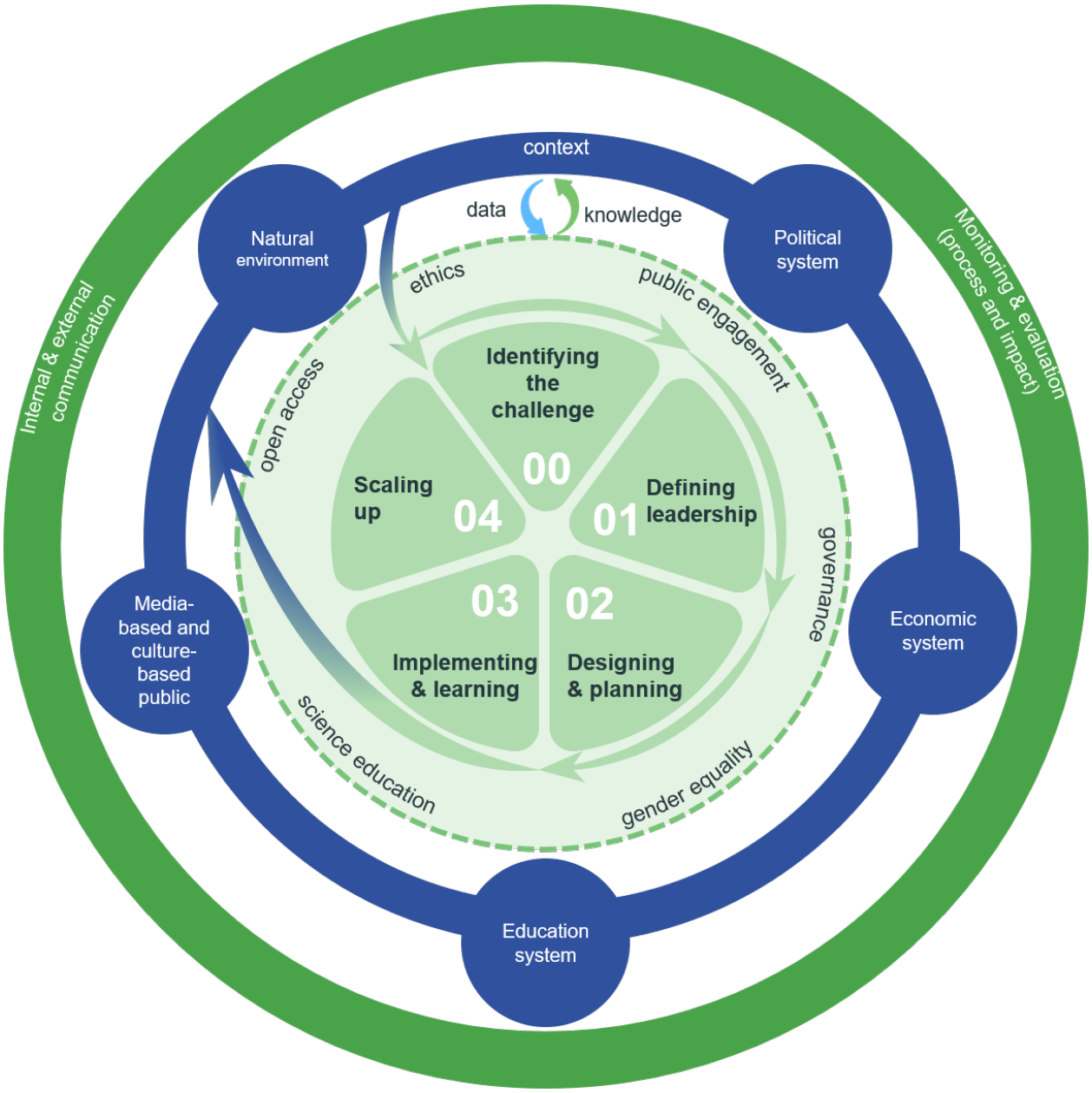

Figure 4. Common Innovation Framework

As described in the previous section, the general pattern that emerges from those references is that innovation is a highly interactive process where ideation and concept design are stimulated by diverse internal and external factors. Also, innovation arises from the intersection of different disciplines and therefore different technical or other knowledge, attitudes, etc.

This framework combines several approaches to addressing innovation in climate change/adaptation and mitigation and illustrates the most important features that must be considered in a holistic and replicable model creating the conditions that contribute to more resilient communities, under the following rationale:

- policy-making action at the territorial/regional level based on a structural combination of innovation and sustainability, adaptable to each region's specific features, through a bottom-up approach but also top-level support (permission, incentives, resources and leadership) to implement significant systemic changes.
- coherence of the multiscale and multilevel approach in integrating informed and sustainable development pathways, as there is a continuous flow between the innovation process and the context, delivering data and knowledge between them;
- inclusive approach due to a strong partnership supported by key stakeholders and community engagement throughout the process;
- a commitment shared among stakeholders, through Responsible Research and Innovation (RRI) that emphasises the relationship amongst societal domains and the dynamics driving social actors as interconnected and not merely intersected;
- effectiveness of the governance system on which the CIF is based, as a powerful means of knowledge acquisition and sharing, through open data platforms to manage, assess and deliver information (open data);
- results-based approach supported by an integrated assessment model that monitors and evaluates both the process performance and its impact on the context, contributing directly to SDG.

Based upon relevant concepts and approaches, **the core of this framework is the innovation process, supported by the regional context**, here represented by the systems of the quintuple helix model - Political system, Economic system, Education system, Media-based and culture-based public, Natural environment.

The quintuple helix model stresses the necessary socio-ecological transition of society and economy and supports the formation of a win-win situation between ecology, knowledge and innovation, creating synergies between economy, society, and democracy. Therefore, it is suitable to the climate change challenge, as it is an ecologically sensitive model: "The natural environments of society and the economy also should be seen as drivers for knowledge production and innovation, therefore defining opportunities for the knowledge economy" (Carayannis et al., 2012).

In this understanding, the sustainable development of a knowledge economy requires coevolution with the knowledge society, a feature that was transposed to R4C CIF as it focuses on the social (societal) exchange and transfer of knowledge inside the subsystems and also between the context and the innovation process. Also, the CIF is intrinsically connected with the United Nations (UN) Sustainable Development Goals (SDG) through the proposed implementation of innovation indicators that reconcile local needs with global challenges, address societal challenges, and build knowledge streams at the global level, amidst exploitation activities.

By covering relevant community systems, the CIF will allow the identification of the conditions of action for the development of the regional innovation package, whose details will be featured in D6.2 Regional Innovation Roadmaps.

Following an open innovation approach, the CIF requires collaborative engagement from stakeholders through a participatory process. This exchange can generate synergies that enrich the innovation process by providing new options. In a knowledge-based regime, the feedback loop between specificity in selections and knowledgeable

decision legitimation stimulates the transition towards organised knowledge production and innovation as a third mechanism of social coordination (Leydesdorff, L., & Ivanova, I.A., 2016).

The methodology to strengthen ongoing stakeholder engagement and upcoming initiatives to seek responsible solutions lies in applying the RRI six keys promoted by the EC: ethics, public engagement, gender equality, science education, open access and governance. The RRI approach aims to foster the ethical acceptability, sustainability, and social desirability of research and innovation outcomes. The RRI keys are tightly linked with the SDG through their focus on a myriad of complementary societal challenges in pursuit of global sustainable development. The SDG ambitions and targets promote societal engagement, responsible governance, and gender equality and have ethical principles embedded in the notion of sustainability. The consideration of both concepts in R4C leads to an integrated framework for responsible and sustainable innovation processes that integrate actors within a systemic approach.

The CIF's innovation process has 5 big phases - (i) identifying the challenge, (ii) defining leadership, (iii) designing and planning, (iv) implementing and learning, and (v) scaling up – where is possible to distinguish several steps that support them.

These phases require continuous revision, learning through monitoring, and ongoing improvements. Monitoring and evaluation is an important feature of the innovation process as it helps to track progress and ensures that activities are on the correct path to achieve the established goals. As explained in more detail in Chapter 5, monitoring must assess two dimensions: i) process (to ensure that activities are on the correct path and the process is going smoothly, according to plan); ii) impact in the context (to measure the positive change that these innovations may have brought to society).

Also, the proposed CIF requires strong internal communication to articulate action between the partners and external communication to provide information/open data regarding ongoing results that can feed the system (context) and contribute to stronger societal engagement.

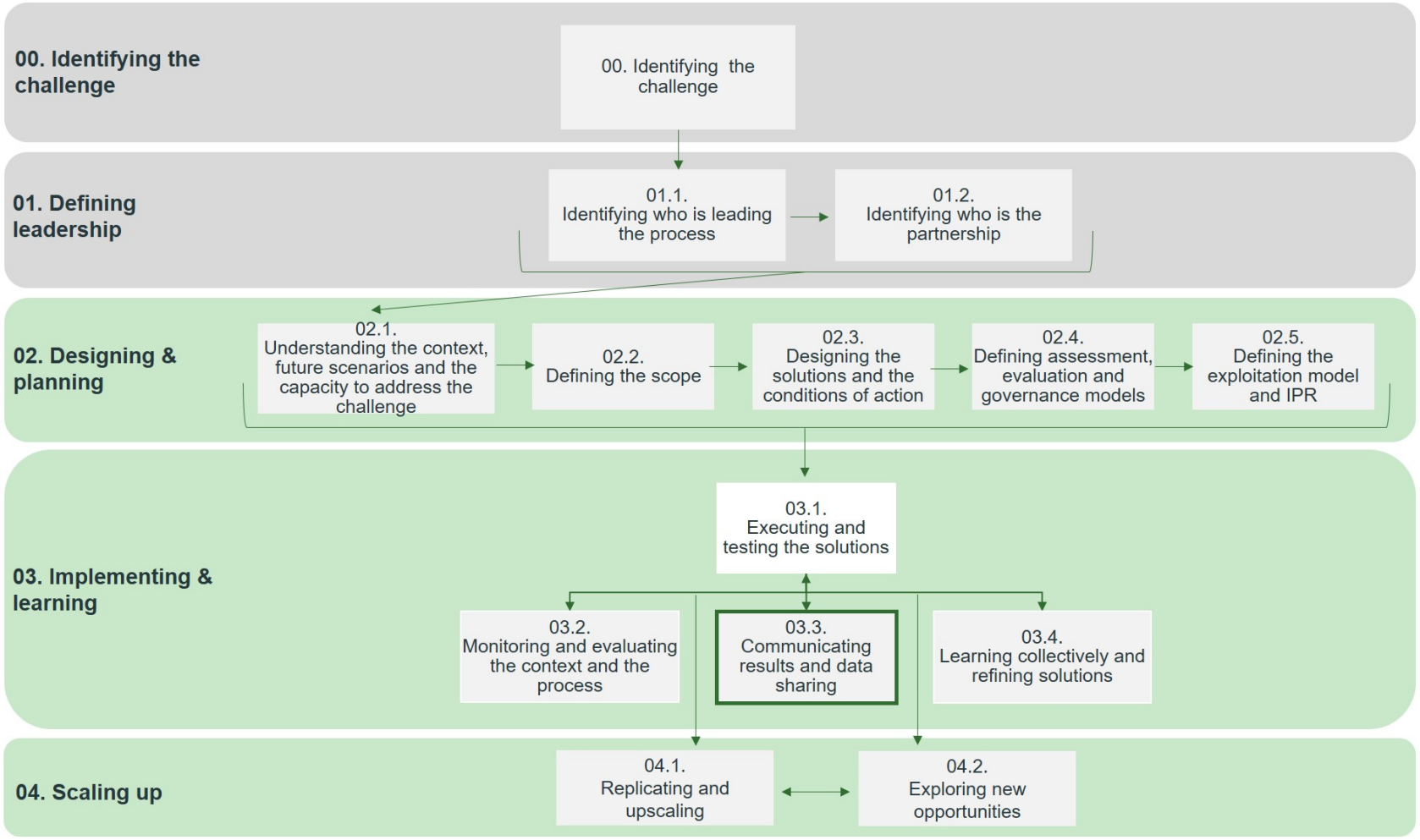

Figure 5. CIF phases and steps within the innovation process, addressing climate change issues

It is relevant to emphasise that, despite this schematic structure, the approach is flexible enough to be adapted to changing global trends, policy mandates, market needs and societal challenges that may arise.

Given the proposed CIF, the following guidelines must be considered to improve the ability to take action:

Phase 00. Identifying the challenge

The motivation for innovation grows from identifying a challenge to solve. Therefore, identifying the strategic issue, (or issues), that must be a fundamental challenge affecting the territory/community, is the heart of the innovation process planning.

Considering the climate change spectrum, datasets of low and high resolutions, including satellite-derived data sets of precipitation, sea-surface temperature and sea levels, greenhouse gas emissions, etc. are the main tools used to identify a challenge/problem. In this current context, strategic issues are identified by exploring compute correlation statistics and climate diagnostics, and it is the convergence of the results that informs how those issues affect the territory. This is an important effort towards the identification of concrete problems that could ignite the process, and, ultimately ensure that the EU will fulfil its ambitious targets to tackle climate change.

To foster public participation in identifying the challenge, a set of tools is suggested (Appendix 8.2).

Phase 01. Defining leadership

Leadership is the key to any small or large-scale transformation. Defining leadership means identifying who is going to **lead the process (01.1)** and who are the **partners to be involved directly in this mission (01.2).**

In the proposed CIF, the leaders of this process must be public authorities[3], with administrative power and governance (territorial management)[4] within a particular sovereign state.

Due to their role in enabling innovation, public authorities must embrace the leadership of the process, as they can act as facilitators and provide the conditions for a collaborative public-private innovation ecosystem. As leaders, the public authorities must align action into a collective direction and coordinate intra and intergovernmental resilience efforts. Also, they must take advantage of shared knowledge and resources while ensuring that the broader community is committed and supports action, promoting cross-border and macro-regional governance and cooperation.

Understanding the public administration characteristics and dynamics in each Member State is critical, in order to provide an effective implementation of the CIF and to respond with a targeted and customised approach that fits the specific needs of the territory.

[3] Any government or other public administration, including public advisory bodies, at national, regional or local level. According to their jurisdiction, public authorities have responsibility in managing a specific territory, according to NUTS and LAU classification. The NUTS classification subdivides the economic territory of the Member States, as defined in Decision 91/450/EEC, into territorial units. Local Administrative Units (LAUs) compatible with NUTS. These LAUs are the building blocks of the NUTS, and comprise the municipalities and communes of the European Union. (in Regulation (EC) No 1059/2003 of the European Parliament and of the Council of 26 May 2003 on the establishment of a common classification of territorial units for statistics (NUTS).

[4] https://ec.europa.eu/eurostat/web/nuts/national-structures

The EU members have different state systems that promote a centralised and/or decentralised implementation of policies. We can distinguish between the 'separationist model' in which local and central governments have distinct competencies and exercise them independently (mainly Anglo-Saxon and Nordic countries), and the "administrative integrated model" in which the different levels interact strongly and local government exercise both their responsibilities and tasks delegated by the central government, i.e. mainly South European and Central and Eastern European countries (Kuhlmann and Wollmann 2014).

According to EC (2018), the distribution of competencies between government levels may vary between EU members. The large majority of EU Member States has two or three administrative tiers which provide multi-level governance by allocating responsibilities and competencies to different government tiers (within national, regional and local levels). In the majority of countries, legislative function, regulation and funding are concentrated at the central level, while provision is largely shared among the different levels of government.

Particularly in the climate change subject[5], legislative function is strongly connected to central authorities (linked to the EU policy). However, the regulation and funding are commonly under the responsibility of regional or local governments (in several countries in the form of a shared responsibility) and it's usual to have local governments participating in the provision of its services. Furthermore, in the last decades, many EU countries have been adopting decentralisation reforms, through a redistribution of competencies in many areas including those with an impact on climate change, which gives the local authorities more power to act.

Thus, the identification of the public authority to lead the process must take into account the (i) competencies and (ii) autonomy (or strong connection to the deliberative authority), in these 4 main areas:

- Legislative
- Regulatory
- Funding
- Provision

Therefore, according to these competencies, the process should be led, preferably, by local or regional authorities with administrative power focused on territorial management.

Besides their strong connection to the communities, these public authorities may have full autonomy to act/implement actions (provision) or, at least, work very closely with upper levels of the government. Also, there must be a close interaction and mutual trust between the local government and representatives of the local communities.

Concerning regulatory and funding, full autonomy or joint cooperation with the upper levels is needed, depending on the country's administrative system (more or less decentralised).

Finally, for operational purposes, a workforce focused on project management and coordination must be created within the local/regional authority that will be leading the process.

[5] The analysis considers the environmental protection and public utilities as water, energy, waste management and transport, two of the most important domains with impact in climate change.

A set of tools is suggested in Appendix 8.2 to help leaders identify the stakeholders to involve and define the partnership to address the problem/challenge.

Phase 02. Designing & planning

After identifying the challenge and the leadership, this phase requires a strong effort to figure out ways to solve it. Designing refers to detailing the challenge, its nature and its complexity, to conceive an adequate framework for its resolution. Planning is a correlated task, as it refers to the development of the procedures to solve the problem, by generating a plan—a series of executable actions with clear identification of stakeholders involved, responsibilities, deadlines, etc.

In this context, the following steps must be considered:

Understanding the context (02.1) is the main step to having a comprehensive knowledge of the challenge. This means that all factors that shape the setting must be analysed in detail, realizing the structure, dynamics and connections between them. These are the domains that should be considered: (i) political, (ii) economic, (iii) legal, (iv) demographic, (v) social, (vi) cultural, (vii) technological and (viii)environmental. This analysis, entailing a variety of techniques to gather relevant knowledge on the macro environment, is crucial to understanding key factors which may impact (directly or indirectly) the intervention. It is also crucial to identify specific relevant factors - i.e., economic trends, social attitudes, technological developments, etc.- that are significant in the intervention design phase.
Besides understanding the current background, the socioeconomic trends and future scenarios regarding climate change must be acknowledged, using a set of simulation and modelling tools.
Also critical in this step is understanding the capacity of the territory (and its agents) to address the challenge, namely, the means and resources (human/intellectual/physical/monetary, etc.) available to respond properly.
These items will be fundamental to understanding the context and moving to the next steps.

- **Defining the scope (02.2)**, supported by the diagnosis developed in the previous step, the definition of the scope is crucial in strategic planning and includes establishing a shared vision and mission, main strategic goals, and the expected outcomes to be achieved.
- **Designing the solutions and the conditions of action (02.3)** is the next step. By reviewing the findings from the visioning exercise, an action plan to address the challenge must be developed. It involves defining concrete actions based on certain assumptions or premises (studied in step 02.1), setting the conditions of action, such as the mechanisms and resources to assign, tangible results to achieve, partners to involve (engagement process), critical issues and risks to consider and funding needed. Also, defining the relationship between the actions and setting the priorities will launch a comprehensive and coherent plan. Finally, it is crucial to define a set of milestones across the process timeline to keep up the progress. The timeline might reflect the assigned priority level and milestones, including the resources needed to accomplish the tasks if some require short or long-term steps, and whether they need to be implemented in a particular sequence or can be simultaneous.
- **Defining assessment, evaluation and governance models (02.4)** is directly associated with the previous step as the plan to follow must be constantly reviewed and revised. Therefore, a standard process to assess and evaluate the effectiveness of the action plan is essential. It ensures that the partners are on the right path and they meet the intended requirements. For the process to succeed, the monitoring approach

must suit the particular features of the challenge and the context and cover both qualitative and quantitative aspects of evaluation, like analysis of the logical structure of a process goal, creation of corresponding checklists, data collection as well as data processing. A set of measurable and tangible indicators must be identified, taking into consideration that both the process (key performance indicators assessment to track the progress) and the context (impact assessment) must be monitored. In this regard, a governance model should also be defined, establishing the structure, roles and connections between the partners involved in the action.

- Finally, under the phase of designing and planning, there must be an **exploitation model & Intellectual Property Rights (IPR)** definition **(02.5).** Exploitation is about ensuring the sustainability of the process/project, even after its lifetime and facilitates a high impact on the key actors and the general public. Associated with exploitation, innovative products and services developed must be protected which includes the definition of a set of intangible assets owned and legally protected by an entity or individual from outside use or implementation without consent.

As one of the most important phases in the process, public participation is key to making better decisions that more accurately respond to the challenge and reflect the communities' needs and expectations. A suggestion of methods and tools to implement may be found in Appendix 8.2.

Phase 03. Implementing & learning

The execution follows the planning phase, under a continuous management and learning process.

During implementation, these are the important steps to be deployed[6]:

- **Executing and testing the solutions (03.1)** is key, following the plan designed in the previous phase. In this context, executing pilots can uncover operability issues and provide an opportunity to address these issues before the full application rollout. It allows the partnership to validate its approach for full application deployment. To effectively prepare for pilot implementation, a detailed pilot approach must be prepared.
- **Monitoring and evaluating the context and the process (03.2):** linked to 02.4, this step puts into practice the monitoring model, which means, collecting data to assess the performance and evaluate the impact of the actions, as well as the governance model (it may assist the leader in fulfilling their governance roles).
- **Communicating results and data sharing (03.3)**: Delivering and communicating results is a crucial part of execution. In this regard, among communication methods (website, social media, etc.), online platforms are essential tools to disseminate data and share dashboards with other users, as they are also available to all stakeholders and communities (open data) to support decision-making. Ensuring data security, good governance and cooperation, the platform should integrate and work with existing data sources and systems, as it should connect to a variety of data types and sets and handle different data structures or unstructured data. These platforms should provide data quality indicators and alerts that may support decision-making and enable public awareness.
- **Learning collectively and refining solutions (03.4):** After implementing a plan, there must be learning and reflection on the outcomes**.** This phase is supposed to give outputs for procedures, metrics and goals

[6] A set of tools to outline the course of action is suggested in Appendix 8.2.

review, define new measures, and thicken action to tackle the challenges. Therefore, promoting means of peer learning among stakeholders is key to enhancing the process.
To follow up on the progress and refine solutions, regular meetings within the partnership must be held, according to the defined governance model. As part of the learning process, it might be needed to adjust the solutions, adapting the path according to new needs or context.
Also, to promote peer learning and enhance internal and external communication, other suggestions may be considered, such as work groups by thematic/domain and regular events (workshops, forums, seminars, etc.). Active work on sharing knowledge and capacity building is crucial to this stage of the process.

Phase 4. Scaling up

The process of knowledge production from the previous phases contributes to the development of a new context, a so-called **"new normal" that will be shaped by the outcomes (new regulations, new products, new services) of the innovation process**. Therefore, the processed knowledge will be used for the inputs to redo the first step and, the cycle starts again, every time that a new challenge is identified. The outcomes may reveal changes within the impact itself or the impact on policies.

This phase comprehends two steps interconnected:

- **Replication and upscaling (04.1):** After confirming the solutions' readiness, this step comprises the process of planning how to push the solutions into the market and spread it out through dissemination and marketing. As a global priority affecting communities worldwide, it is of major relevance to ensure that Climate Resilience solutions are available for all, stressing out just transition principles that emphasise that no one is left behind.
- **Exploring new opportunities (04.2):** The outcomes of the innovation process must contribute to new approaches, new regulations, new technologies and other new opportunities to explore, developing the narratives for tangible outputs in the five context dimensions.

A set of tools is suggested in Appendix 8.2 to promote replication and upscaling processes and explore new opportunities.

3.3. Insights for further development of Innovation Packages

The CIF for R4C intends to develop a consistent, replicable, and exploitable model of innovation, in pursuit of a systemic transformation[7]. Therefore, it's important to acknowledge how the proposed CIF can be replicable in R4C, by transferring its structure and its features into R4C reality and also by identifying the connections and the process flow. This exercise will allow the Consortium to understand the connections between tasks, based on a solid framework that intends to support R4C innovation actions (implementation) but also its replication, scaling and exploitation.

[7] It will be explored under the development of the Regional Innovation Roadmaps (in D6.2).

Under the scope of Regions4Climate, some considerations will be developed for further development of Innovation Packages, as we need to match the phases and steps of the Common Innovation Framework according to the project's context. This overview is crucial, since innovation can occur at different levels of action and is observable at different scales of analysis (D'Allura et al., 2012).

As shown in the following figure (Figure 6), the innovation framework provides a structure for short-term and long-term planning, supported by each regional context, whose subsystems (based on the quintuple helix model) feed the process with data that will generate knowledge that may influence the context again, transforming it in a new context – hopefully, a more resilient one.

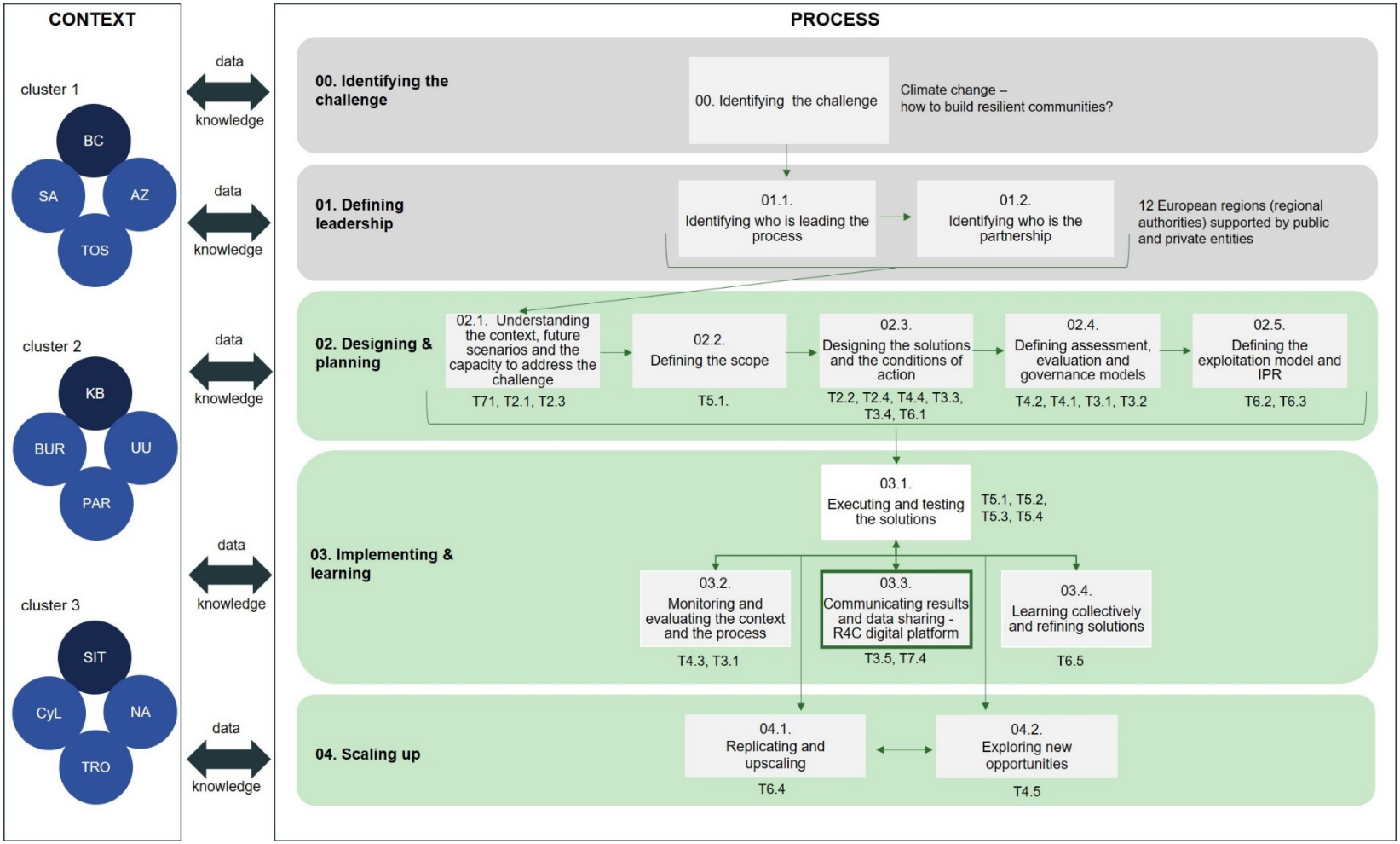

Figure 6. CIF replication in R4C

Assuming the importance of project management (**WP1**) and communication and dissemination (**WP7**) as a basis of the project, the CIF is perfectly transferred into R4C, as the following analysis suggests:

Phase 00. Identifying the challenge

Climate change is causing more frequent and extreme weather events, such as floods, droughts, heatwaves, and hurricanes, which are adversely affecting infrastructure, housing, public health, and the overall quality of life for regions. This has brought significant challenges and the concept of resilience has gained significant traction, as it aims to enhance the adaptive capacity of the regions to climate change, making them sustainable and safe.

In this regard, the challenge to approach in R4C could be defined as “Climate change – how to build resilient communities?”

Nevertheless, each group of regions (clusters) is facing specific challenges, considering their challenges on climate change and also their capacity to address vulnerabilities and risks (per pre-assessment of Climate Resilience Maturity Level (CRML)). Therefore, specific challenges could be associated with each cluster:

- **Cluster 1. Faster Adaptation Cluster**: this cluster recognises the need for innovation and faster adaptation to combat climate change and reduce climate-related risks while safeguarding coastal ecosystem integrity. It includes Basque Country (ES) as a frontrunner and also South Aquitaine (FR), Azores (PT) and Toscana (IT) as followers.

- **Cluster 2. Smarter Adaptation Cluster**: this cluster recognises that gathering the latest data helps to illustrate the effects of climate change. With a focus on gathering the latest data from diverse sources, the region can bridge the science-stakeholder-policy gap, raise citizens’ awareness and improve the use of existing data. It includes Køge Bay (DK) as the frontrunner and the follower regions of Uusimaa (FI), Burgas (BG) and Pärnumaa (EE).

- **Cluster 3. More Systemic Adaptation Cluster**: this cluster recognises that local citizens and SMEs are key actors in the all-of-society transition towards climate resilience. With a focus on close collaboration with local businesses and citizens, particularly in rural areas, the socio-cultural and economic impacts of climate change can be addressed at all levels of society. It includes the frontrunner region of Eastern Crete/Sitia (EL) and the follower regions of Castilla y León (ES), the Nordic Archipelago (SE/AX/FIN) and Troodos (CY).

According to the Grant Agreement, 3 objectives were defined to address these challenges and achieve the ambition of significantly advancing European transitions to climate resilience:

Objective 1. Develop a comprehensive operational framework to guide and support a wide range of local and regional stakeholders to co-create, test, optimise and replicate scalable, cost-effective, locally-attuned, multi-sectoral and cross-border solutions for enhanced regional resilience to the impacts of climate change.

Objective 2. Scale up and deploy innovative socio-technological climate resilience solutions, through collaboration and “twinning” between front-runner and less experienced regions vulnerable to similar climate risks and impacts.

Objective 3. Generate and validate suitable solutions for just societal transformation and building climate resilience at the regional and local level through tailor-made measures matching local needs.

Phase 01. Defining leadership

The leadership of the process is held by the regional authorities in R4C, namely the 12 European regions, organized into 3 clusters, according to the specific challenges they are facing:

- **Cluster 1. Faster Adaptation Cluster**: it includes Basque Country (ES) as a frontrunner and also South Aquitaine (FR), Azores (PT) and Toscana (IT) as followers.
- **Cluster 2. Smarter Adaptation Cluster**: it includes Køge Bay (DK) as the frontrunner and the follower regions of Uusimaa (FI), Burgas (BG) and Pärnumaa (EE).
- **Cluster 3. More Systemic Adaptation Cluster**: it includes the frontrunner region of Eastern Crete/Sitia (EL) and the follower regions of Castilla y León (ES), the Nordic Archipelago (SE/AX/FIN) and Troodos (CY).

The following table (Table 1) shows the administrative units where the innovation packages (IP) will take place[8]. According to the information available, the IP will be implemented at different administrative levels[9], namely NUTS 2/NUTS 3/LAU1[10].

Table 1. R4C Innovation Actions – location vs. administrative authorities

Challenge Suites	R4C Regions	Administrative units		
		NUTS 2	NUTS 3	LAU 1
Cluster 1 Focus on Faster Adaptation	Basque Country (ES)	●		
	South Aquitaine (FR)			●
	Toscana (IT)			●
	Azores (PT)		●	
Cluster 2 Focus on Smarter Adaptation	Køge Bay (DK)			●
	Burgas (BG)			●
	Uusimaa (FIN)		●	
	Parnumaa (EE)			●
Cluster 3 Focus on More Systemic Adaptation	Sitia, Crete (EL)			●
	Castilla y León (ES)	●		
	The Nordic Archipelago (AX/SUE/FIN)		●	
	Troodos (CY)			●

Legend:

●	**Location – geographic coverage of the Innovation Actions**
	Administrative authorities (regional/local authorities) are part of the Consortium

[8] This information will be confirmed during D6.2 work.
[9] More detail on the Appendices 8.3 and 0
[10] The NUTS classification subdivides the economic territory of the Member States, as defined in Decision 91/450/EEC, into territorial units. The NUTS classification (Nomenclature of territorial units for statistics) is a hierarchical system for dividing up the economic territory of the EU and the UK. LAU (Local Administrative Units) comprise the municipalities and communes of the EU (in Regulation (EC) No 1059/2003 of the European Parliament and of the Council of 26 May 2003 on the establishment of a common classification of territorial units for statistics (NUTS).

Under the Regional Innovation Roadmaps (D6.2) development, it will be properly assessed the specific territory where the actions will take place. Nevertheless, since not all 12 regions have administrative representation in the R4C Consortium, strong communication and linkage between the project and each of the public authorities is required. **To ensure a successful CIF implementation, the public authorities must be strongly involved in the process since its beginning, by engaging them in the design, implementation and assessment of the Innovation Actions.**

To support the leadership, a consortium was created, gathering public and private entities strongly connected to each regional innovation system, with a relevant role in the process. The project partners form a community fostering peer-to-peer, transdisciplinary capacity building between front-runner and follower regions among the 3 clusters, connected with 3 different challenges identified in the previous phase.

The more challenging task is to harness the amount of knowledge and experience that exists in the Consortium and create value through results: 12 more resilient communities/regions.

Phase 02. Designing & planning

With the support of the R4C Consortium, the regions are committed to addressing climate change-related challenges and building more resilient communities within an innovative socially engaged, citizen-driven paradigm.

Regions4Climate aims to bridge these gaps and address existing uncertainties by further developing, adapting and integrating state-of-the-art technical know-how, innovative tools and collaborative practices to support transparent, evidence-based risk and vulnerability analysis and robust decision-making processes.

To understand the context, an important work of stakeholder analysis (**T7.1)** and socio-economic analysis (**T2.1)** will be held. In addition, a representation of regional dynamics of resilience through system dynamic modelling (**T2.3**) will allow the prioritisation and impact assessment for each R4C partner region. The modelling is crucial to understanding relationships among and trade-offs between different resilience innovations, providing tools for informed decision-making tailored to engage stakeholders and support European regions and communities exposed to significant climate change impacts.

The work developed in **T5.1** is transversal, as it starts in the Designing and planning phase by supporting each partner region to define a journey roadmap for planned innovation actions. On the other hand, it keeps supporting the joint assessment by compiling new knowledge from all regional innovation actions (implementation phase). This task aims to foster strong partnerships and common visioning within and between Challenge Suites, and the development of common strategies for cross-border cooperation. T5.1 is the task that meets the scope and helps to guide the partners involved in the Innovation Packages to achieve the planned objectives and goals for each region.

Designing the solutions and the conditions of action for the Innovation Actions (WP5) will be supported by a set of tasks that will give clear directions regarding the just transition framework (**T2.2**) and innovation management (**T6.1**). T2.2 plays a central role in the development of the just transition roadmaps (**T2.4**) and the proposal of policy needs (**T4.4**) out of the alignment of regional CR ambitions and roadmaps for just transition with the existing policy instruments.

Both the Just Transition framework (T2.2) and the Regional Resilience Maturity Model RRMM (T4.1) need to be aligned to the present CIF (T6.1) as they are interconnected. On the other hand, T6.1 supports the exploitation approach (**T6.2** exploitation planning and **T6.3** innovation screening) and is strongly connected to assessment and the learning process in the next phase (T6.5).

Done in close collaboration with the respective technology provider(s) the T6.2 will create a detailed exploitation strategy and action plan to manage exploitation activities, including Intellectual Property (IPR) to identify the most appropriate form of protection.

Finally, the designing step integrates the R4C digital platform design: the **T3.3** ICT Architecture and **T3.4** regarding the interoperability middleware will be designed to link the data, tools, and other information generated by R4C directly to the Climate-ADAPT platform, and to ensure transferability of the R4C Climate Resilience Portal content management system to Climate-ADAPT at project end.

These directions are backed up by resources, management support and good metrics. Therefore, this phase includes also the definition of assessment and evaluation approaches (**T4.1** Regional Resilience Maturity Model (RRMM) and assessment framework, **T3.1** integrated V&R and **T3.2** M&E for each region to implement) and governance models (**T4.2** Governance framework). The Resilience Maturity Model aims to provide a comprehensive framework to assess regional resilience-building, which should include elements of innovation (T6.1) and just transition principles (T2.2).

As explained before, this phase aims to create strong support for the regional authorities (defined in Phase 01) in the implementation of Innovation Packages (phase 03) and the scaling-up process (phase 04), making use of the Consortium expertise to design the solutions, according to each regional context, and taking into account the goals to achieve in order to solve the challenge (phase 00).

Phase 03. Implementing & learning

Based on cross-sectoral roadmaps developed together with regional stakeholders, the project will create and implement innovations combining sociocultural, technological, digital, business, governance, and environmental – the region-specific Innovation Packages (IP), collected in Table 2. Execution and testing of the solutions are the ones foreseen in WP5 (T5.1, T5.2, T5.3 and T5.4.

Table 2. Innovation Packages of R4C

Cluster 1 **Focus on Faster Adaptation**	**Innovation Package**
Basque Country (FRR)	**IP1** Restoration of estuaries **IP2** Monitoring and forecasting extreme events **IP3** Policy for a transformative adaptation **IP4** Stakeholder engagement
South Aquitaine	**IP1** Adaptive use of the waterfront based on real-time risk knowledge **IP2** Long-term Coastal defence strategy
Toscana	**IP1** Coastal dune restoration (including Monitoring)
Azores	**IP1** APPs Azorean Foot Print **IP2** Digital Platforms (marine monitoring)
Cluster 2	**Innovation Package**

Focus on Smarter Adaptation	
Koge Bay (FRR)	**IP1** Mediating climate change impacts through immersive Virtual and Augmented Reality visualization tools: The role of AR/VR in building awareness of climate change challenges and different development trajectories **IP2** Building Social and Health Resilience to Dynamic Coastal Changes: Building community resilience to flooding and addressing public health using the multi-layered safety model **IP3** Providing business models for Multifunctional coastal landscapes: Using nature-based coastal protection measures as a measure to create societal resilience towards flooding and to stimulate natural biodiversity
Burgas	**IP1** Integrated management of Burgas wetlands - increasing the technological and digital capacity of the municipality to withstand flooding as a frequently faced climate-related issue on a local level **IP2** Urban ecosystem and social resilience enhancement - improving the resilience of the urban ecosystem and the local community against climate change through the implementation of innovative green solutions in urban areas **IP3** Smart and climate-resilient city management - incorporating scientifically-based methodological framework and digital toolkit for climate-resilient spatial planning and city development
Uusimaa	**IP1** Demonstrates a human-centric digital twin approach with ML and AI elements for urban and regional resilience planning. Scaling up to regional and interregional levels **IP2** Socio-ecological and other predictive analyses **IP3** Actionable knowledge of trade-offs between construction and development needs **IP4** Knowledge of the need to restore and protect urban nature as an adaptation resource and provider of ecosystem services
Pärnumaa	**IP1** Building resilience in urban planning, design and tools to mitigate the effects of urban heat islands **IP2** Modelling and engineering solutions in landslide risk areas
Cluster 3 Focus on More Systemic Adaptation	**Innovation Package**
Eastern Crete/Sitia (FRR)	**IP1** Sitia UNESCO geopark as a “lighthouse” regional resilience pillar. **IP2** Maintain local traditions and way of life under climate change. Local products of origin with zero carbon footprint and sustainability practices, women entrepreneurs and/or cooperatives **IP3** Water scarcity reduction through citizen participation and open innovation **IP4** Climate Services for enhancing Sitia’s deep climate resilience and promoting innovation
Castilla y León	**IP1** Creation of sustainable and social business models **IP2** Strong relationships among local businesses **IP3** Local resources respectful to economic activities **IP4** Social business models empowering local communities and focussing actions on women **IP5** Application of key innovative technologies (related to NBS and food processing) **IP6** Integration in regional educational programmes with young people **IP7** Reviving rural areas to protect and adapt the local resources
Nordic Archipelago	**IP1** Inter-regional transport, and sustainable energy across the region. **IP2** Understanding of links among key sectors and implementation of socioeconomic renewal activities **IP3** Resource use and opportunities for resource efficient/circular solutions

Troodos	**IP1** Support and training of local businesses, SMEs, local authorities, and citizens in climate-neutral and regenerative tourism **IP2** Climate Change Risk Vulnerability of Troodos Region **IP3** Improvement of the connectivity, including the pathways walkways, and other sustainable mobility options. **IP4** Energy efficiency and RES implementation in tourism

The implementation is going to feed the R4C digital platform (**T3.5**), a user-friendly Climate Resilience Portal digital platform that will enable open knowledge sharing and facilitate efficient collaboration between regional stakeholders and consortium members. It will integrate R4C digital tools and services, in line with the specifications defined, within this single platform and develop individual Regional Climate Resilience Dashboards (RCRDs) for each partner region. At the end of the project, ownership of the digital platform will be transferred to the Climate-ADAPT Platform for integration with the Climate Change Adaptation Mission. This platform is crucial in the process as it will gather, among others, the visualization of climate risks (**T7.4**) an important tool for public awareness.

During Innovation Packages implementation, monitoring and evaluating the process will be fundamental to analyse the performance and also the impact of the actions in the context (**T4.3** CRML assessment and **T3.1** V&R assessment).

At the same time, partner regions will be engaged in knowledge exchange through a continuous learning process, which includes capacity building, coaching and mentoring activities to strengthen the replication potential of R4C beyond the scope and duration of the project (**T6.5** Capacity building).

Phase 4. Scaling up

At last, replication and new opportunities arise from the innovation actions implementation. To transfer critical knowledge regarding best practices and lessons learned, including replicability and techno-economic assessments from the Innovation Packages, replication and innovation scaling planning will be developed in **T6.4**.

Specific policy recommendations that serve as strategic inputs for the ideation of (macro) regional Smart Specialisation Strategies for Sustainable and Inclusive Growth (S4+) in **T4.5**, will be the main outcome to explore, which could have a strong influence on the context transformation.

In this phase, the integration with the Climate Change Adaptation Mission and continued mobilisation of relevant communities of R&I practice and regional climate resilience transformations is key.

The following figure (Figure 7) closely relates the proposed innovation framework with the work to be developed within R4C and the innovation process of the regions. It shows the interconnections between the phase and each step of the CIF and the R4C tasks.

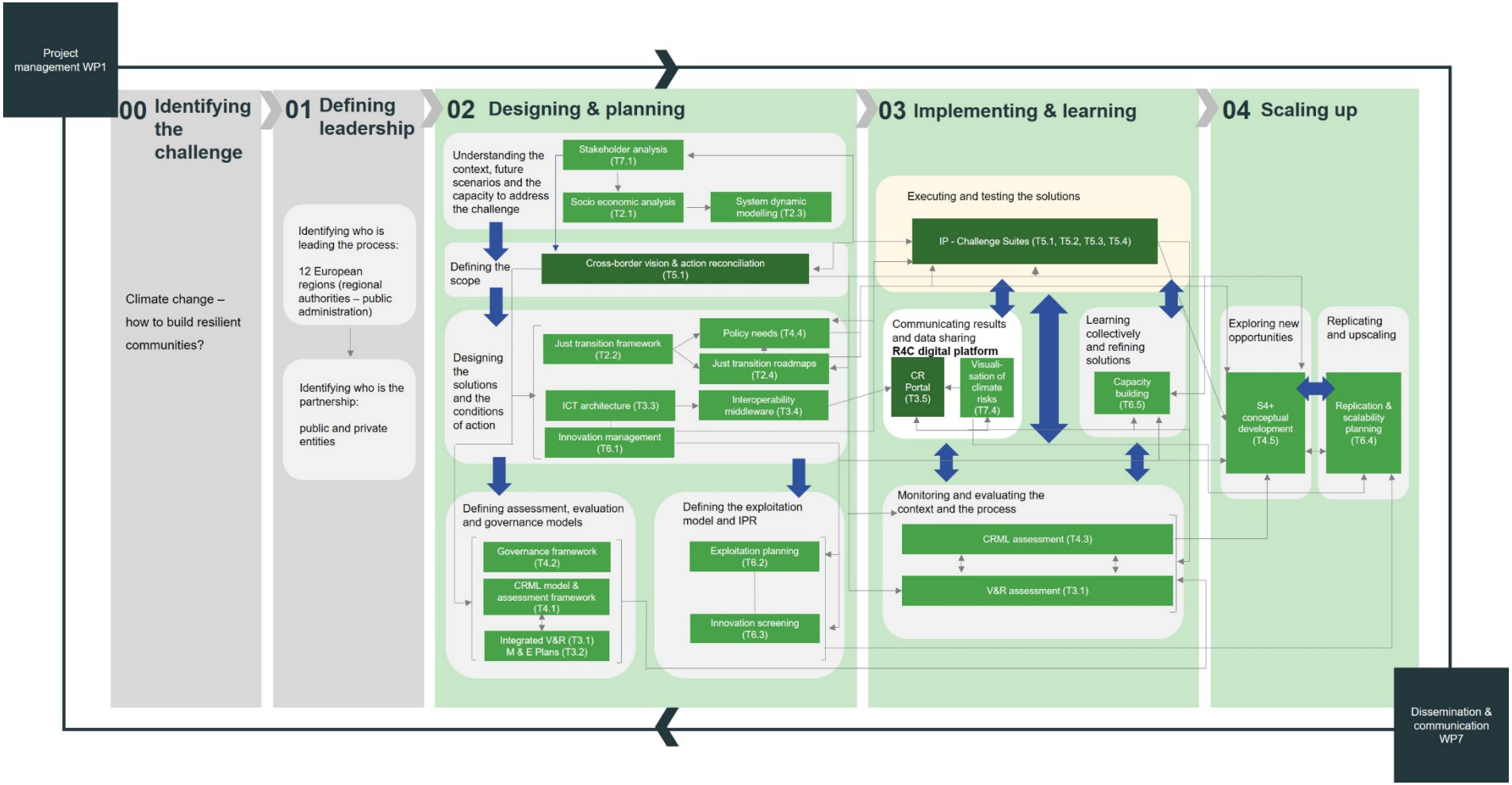

Figure 7. Connections between CIF phases and R4C tasks

3.4. Public engagement through an open innovation process

One of the main R4C objectives is to “develop a comprehensive operational framework to guide and support a wide range of local and regional stakeholders to co-create, test, optimise and replicate scalable, cost-effective, locally-attuned, multi-sectoral and cross-border solutions for enhanced regional resilience to the impacts of climate change”.

A significant part of developing a common innovation framework is a reliable, in-depth strategic analysis where all components should be scrutinized, guiding decision-making. By conducting a structured analysis, the process can gain valuable insights, as they become key inputs for the strategic planning process, helping leadership to make well-informed decisions to thrive and achieve the expected goals and impact. This means using several data sets throughout the process (in all phases) along with a strong public involvement (Figure 8).

As an open innovation approach where Responsible Research and Innovation (RRI) is key, CIF relies on public engagement to guarantee strong awareness and commitment, which is expected to have more effective results and impact on the communities and climate change resilience. Besides, engaging the public/stakeholders has a strong contribution to the other dimensions of RRI, namely, ethics, gender equality, science education, open access and governance. Therefore, it’s crucial to engage citizens and local/regional stakeholders throughout the process in codesigning and validating solutions to reach the most suitable for a just societal transformation and build strong resilient communities.

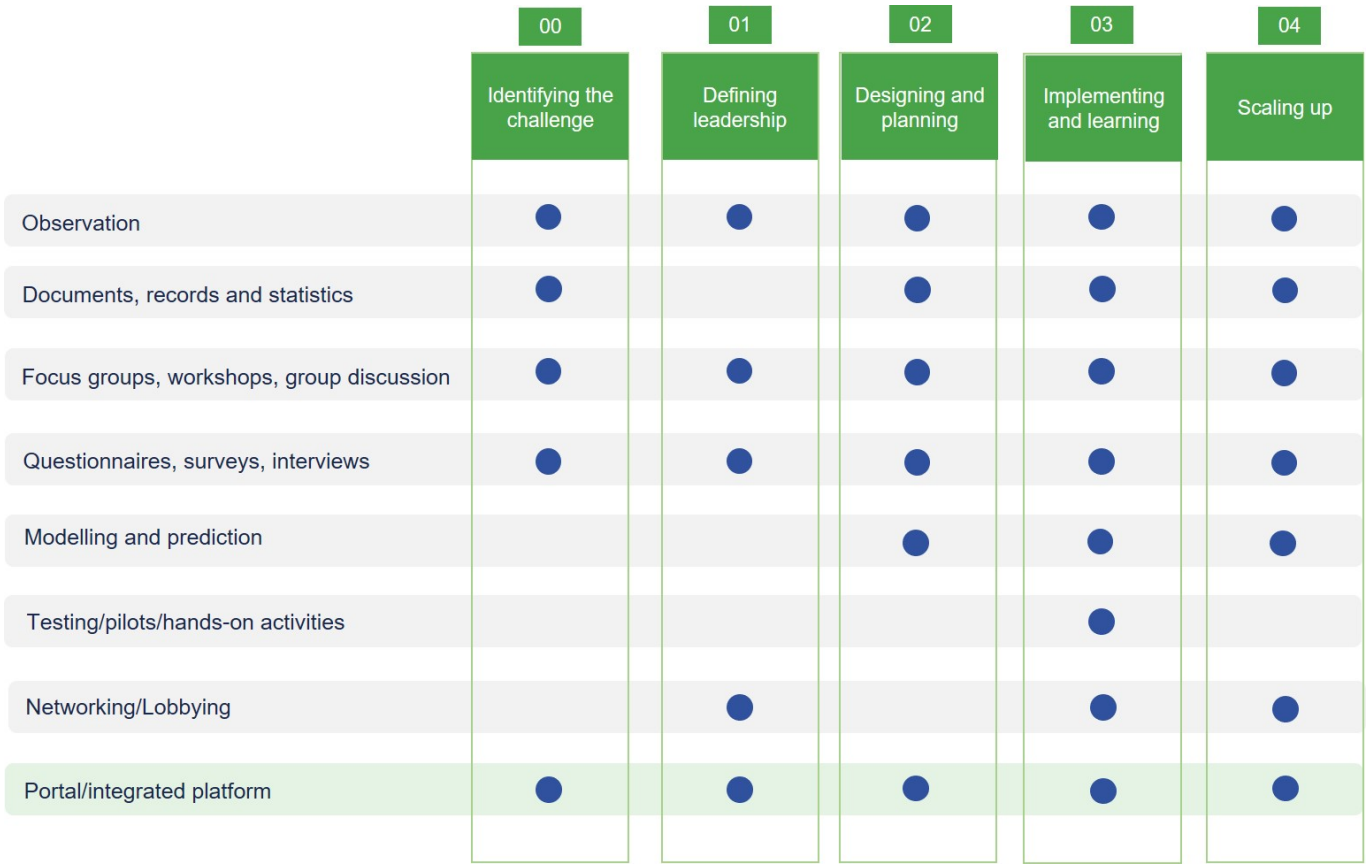

Figure 8. Methods to collect data during the CIF process implementation

From phase 00 to phase 02, several interactive tools must be implemented to promote public engagement. To assess the challenge (in particular the vulnerability to climate change), data sets describing the current state of the art must be collected, using observation, documents, records and statistics, but also questionnaires and other tools. In what concerns this specific challenge, modelling (System-Dynamics models) and predicting is also a very useful tool that enables us to understand the structure and dynamics of a complex system such as climate. When designing and planning group discussions, it might be the most effective method to gather information/data and engage the public/stakeholders.

During the **implementation and learning phase (03),** piloting is key to testing the impact of specific actions through small-scale experiments before implementing them on a larger scale. By testing hypotheses, the partnership better understands factors that may influence outcomes. Empirical data is collected and analysed iteratively to determine success, make adjustments, and provide validated information for decision-making.

Finally, in the **scaling-up phase (04)** it is important to enable networking and lobbying, not only to facilitate replication and scaling up but also to find opportunities to contribute to the context change. In this regard, meetings with both national and sectorial entities, as well as the industry, might ensure that the outcomes have a meaningful impact and are effectively integrated into the context.

Throughout the process, creating an open data platform as a collaborative tool that will integrate all results during the project is crucial. It must gather all data/information that might accelerate innovation and foster valuable

knowledge, available to all stakeholders and the general public. This promotes transparency, collaboration and decision-making based on easily accessible data.

Taking into account these methods, a **CIF toolbox (generic)** is presented in Appendix 8.2, as a means to unfold and anticipate the complexity that characterises the innovation process and its results, through adaptable and flexible tools and methods. Making use of the Visual Toolbox for system innovation, produced in the Climate-KIC[11], some suggestions of methods and tools are presented in Annex – Appendices 8.2. These tools aim to overtake the difficulties of applying the theories and perspectives to day-to-day practice, using a more horizontal approach, where both, stakeholders and challenge owners (the regional authorities, in the case of R4C), work side by side. Besides these, other tools[12] are also suggested, which might be valuable for the work ahead.

Several considerations must be underlined when choosing the right method/tool for innovation purposes:

- Selecting the right method, starts with understanding the challenge systematically and framing it correctly.
- Climate change subject needs an interdisciplinary approach to understand how different parts of the systems relate to each other, how systems work and evolve and what outcomes they produce. As they tend to be time and resource-intensive, a sustainable and long-term commitment is needed.
- Each tool is related to the aforementioned dimensions (challenges; assumptions of action; context; mechanisms) and a specific phase/step in the innovation process.
- Each tool must reflect the starting point, frame the situation and offer concrete leverage points to take action.
- The methods/tools suggested for each step must be adapted to each regional context, as they will be explored under the development of the Regional Innovation Roadmaps (in D6.2).
- Under T6.1, a workshop/training session must occur, to give the regions some insights about each suggested tool and its connection to the CIF. The use of the CIF toolbox will be encouraged.

[11] Intending to improve understanding of new sustainability innovations, the EIT Climate-KIC Transitions Hub has developed a comprehensive resource book for practitioners to map, analyse and facilitate systemic change (on the EIT Climate-KIC website).
[12] Besides the analysis methods and other engagement tools suggested in Appendice 8.2, other tools might be considered (ex.: https://oecd-opsi.org/)

4. Factors for success – enablers and obstacles to innovation

An enabler can be defined as that which contributes to or favours innovation success, whereas a barrier, on the other hand, slows down or completely hinders success. By understanding the enablers and obstacles to innovation, the entities can embrace best practices towards the creation of an enabling environment that supports the successful implementation of a transformative innovation process (Mutegi & Van Belle, 2021).

The main challenge seems to be the implementation of an innovation process that could influence a favourable policy (re)formulation and the targeting of funding to support and stimulate innovation. As delivering innovation is a joint activity with relevant participants involved in the process, it is essential to consider the role of inter-organizational factors in implementing a successful innovation (Ozorhon, 2014).

According to Govindarajan (2011), there are diverse factors that can contribute to a transformative innovation process. First, the innovation needs to be compelling and understandable, therefore all the stakeholders must understand why the innovative process is necessary, so it seems that the key factor for both a robust and realistic process of innovation is the ability to show a direct path to the achievements and then try to communicate the innovation value to the public, to validate the process.

Bajada et al. (2022), on the other hand, organized the enablers of innovation in four building blocks, namely: 1) Drivers, 2) Cultivators; 3) Infrastructure and 4) Networking. As shown in Figure 9, each building block comprises several attributes, that can be measured. However, it's important to highlight that each one can be influenced by context-specific factors and also by the phase of development of innovation activities. According to Wagner et al. (2017), it is crucial to understand the different spatial formats of innovation locations as important criteria to define and develop the enabling conditions for successful and long-term innovation.

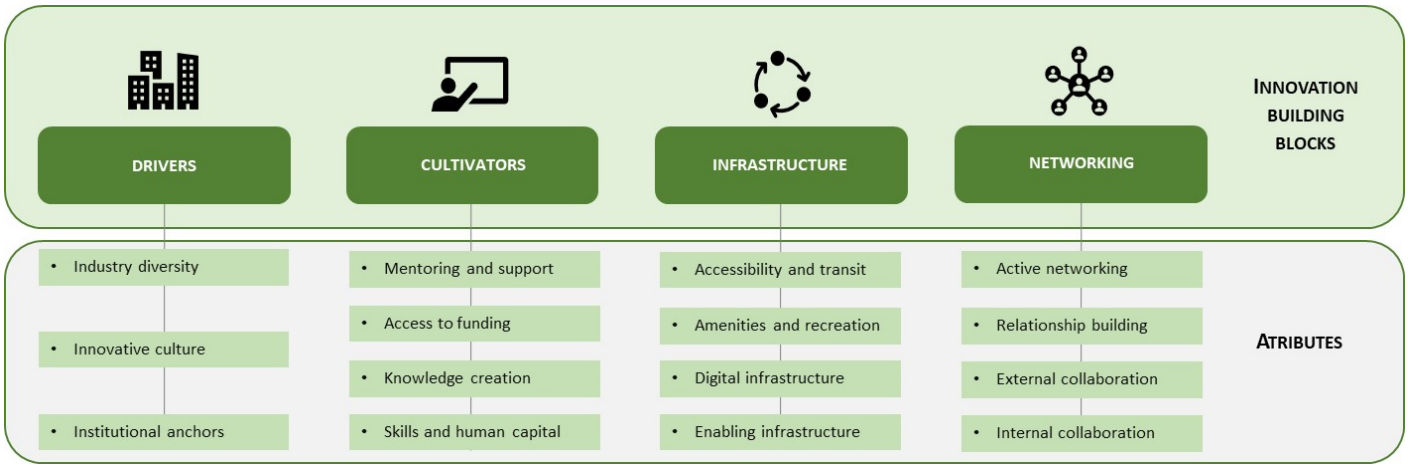

Figure 9. Building blocks for innovation

Source: Modified from Bajada et al. (2022)

Successful innovation depends on an inspiring and shared vision of the future, so if an entity could develop hypotheses about the future and have a holistic view of the future, it would be easier to recognize tidal forces of change. For an innovation process to be successful, it is crucial to have a strategic innovation agenda that must be well-aligned with the overall goals. This requires active involvement from the entities' leaders, who must ensure that the strategy is clear and comprehensible to all stakeholders. Decision metrics should also be clearly defined so that progress can be tracked and evaluated. Finally, it is important to settle models that are effective and efficient, in order to ensure that the innovation process is as smooth and seamless as possible. By taking these steps, organisations can maximize their chances of success when it comes to innovation.

Osterwalder et al. (2020) point out that a successful and impactful innovation process should consider some categories of innovation enablers. In their opinion three categories of innovation enablers can be settled: 1) Leadership support; 2) Organizational Design and 3) Innovation practice, as listed in the following figure.

Considering that the process of innovation is quite complex and sometimes hard to understand, regarding the obstacles to innovation, in a study conducted by Ozorhom (2014), the findings suggest that resistance to change is one of the main barriers to innovation. Osterwalder et al. (2020) also identified some potential obstacles to innovation, such as the excessive focus of leaders on developing business based on the current model and not putting enough effort into developing a new idea and, consequently, validating it. On the other hand, considering that entities do not have the same practices and resources, namely economic, technological and cultural, achieving a certain degree of innovation, can be quite hard and complex.

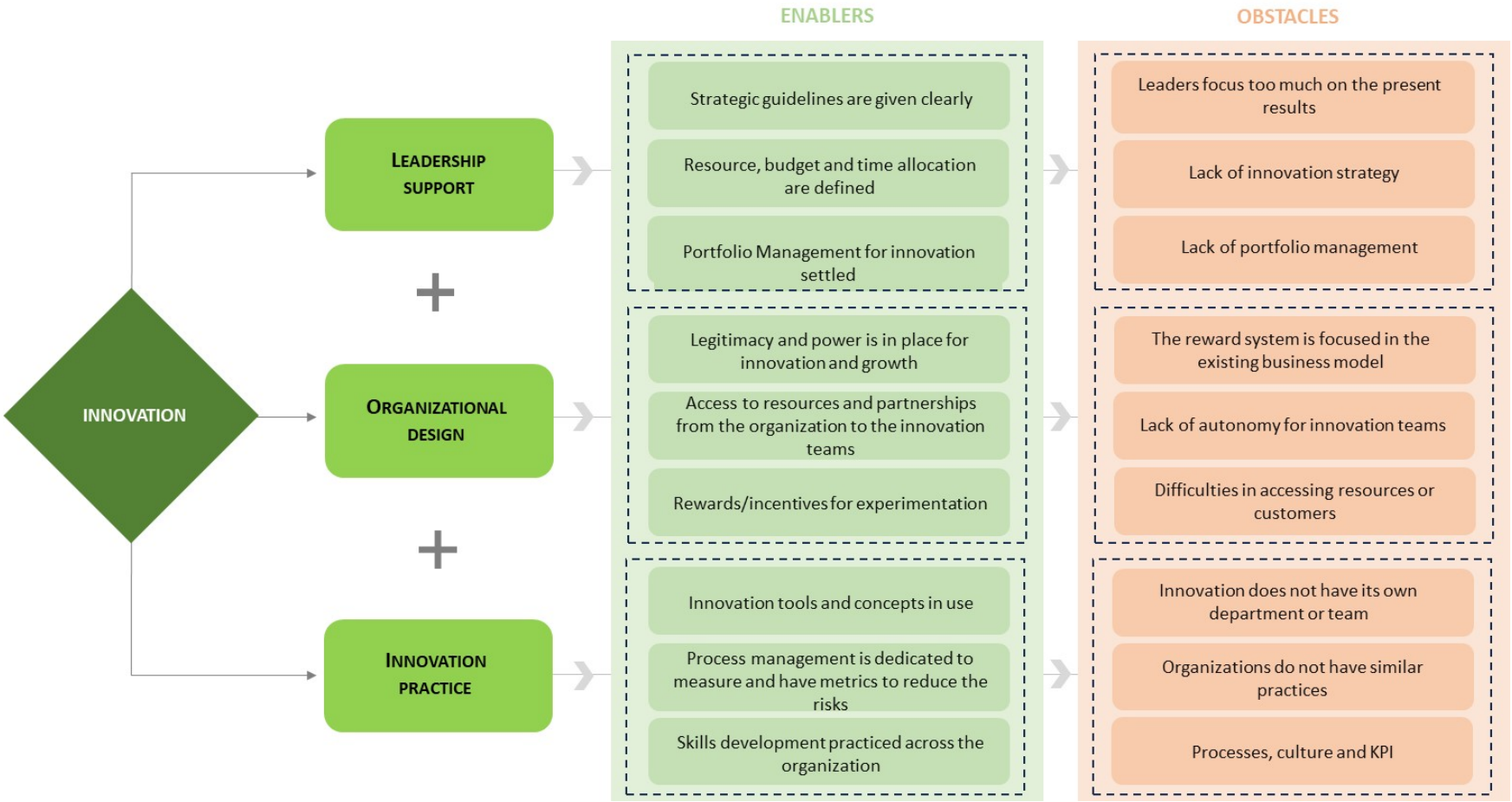

Figure 10. Enablers of and barriers to innovation

Source: Modified from Osterwalder et al. (2020)

There is an emerging trend, among some sectors, to work together, forming clusters to share some knowledge, capabilities, technologies, networks, infrastructure and other elements to improve their individual and collective productivity and economic performance (Bajada et al., 2022).

Managing innovation at a large scale can, sometimes, seem impossible, considering the need to engage multiple stakeholders, the existence of an infinite number of data points and the need to avoid a multitude of barriers. A study conducted by Fan et al. (2019) demonstrated the importance of establishing a relationship between collaborative innovation and innovation efficiency, however, few studies have integrated intra-regional and inter-regional collaborative innovations into a unified framework to analyse the overall impact of regional innovation efficiency. The same study emphasises that both intra-regional and inter-regional collaborative innovations (IRCI) promote regional innovation efficiency, but internal factors are the primary influences on regional innovation efficiency.

Furthermore, intra-regional collaborative innovation not only promotes local regional innovation but also promotes innovation efficiency in other regions effectively. In this case, the study highlights the fact that the degree of innovation is higher in the local region than in others (Fan et al., 2019). On the other hand, it's important to emphasize that collaborative innovation is effective only after a certain period of cooperation and that it isn't a short-term process nor can be solely focused on short-term results.

Innovation applied to a regional context must consider that regions represent a heterogeneous system in terms of technological infrastructures, institutional and political conditions, and economic and social development. Consequently, the innovation actions must be different for each region, because they have a multitude of variations that can influence, for better or for worse, the development of innovation.

Investments in infrastructure, skills, innovation and governance continued to drive convergence towards sustainable development. In this regard, recent studies show that the effectiveness of these investments depends on both institutional and macroeconomic frameworks. Therefore, the capacity of regions to innovate relies on their Regional Innovation System (RIS) and its capacity to enhance development and spur the generation and diffusion of innovation.

According to Asheim and Coenen (2005), "The regional innovation system can be thought of as the institutional infrastructure supporting innovation within the production structure of a region". The components of a system are the operating parts for building, management, and support purposes related to system processes and outcomes (Guheen, Mitchell, & Barrese, 2005). Therefore, organisations and institutions are crucial components of the RIS as the character of different regions results in large part from the institutions helping the creation of networks and connecting organizations within the system (Whittington, Owen-Smith, and Powell, 2009). The balance between innovation and replication underlies the dynamics of regional innovation systems, depending in turn on their internal coherence and ability to access external information.

In climate resilience, the approach is similar, as the public entities must lead the process.

Under task 6.1 (WP6) all R4C partners involved in each regional innovation ecosystem were asked to fill out a questionnaire[13]. The questionnaire was addressed to R4C partners[14] involved in each regional innovation ecosystem, namely: public authorities, research and technology organisations, public industry, high education institutions and private non-profit organisations.

It is essential to recognize that this approach of multiple answers per region has inherent limitations in this context. For instance, the responses obtained may be influenced by the levels of expertise, perspectives, and experiences of the respondents. Therefore, it is important to interpret the results of the questionnaire with caution, taking into account the potential biases that may be present. For example, this can limit the generalizability of the findings and raise some concerns about the validity of the conclusions drawn from the questionnaire data.

The questionnaire was designed to gain a comprehensive understanding of the regional ecosystem concerning innovation and climate resilience and some of the results (regarding the enablers and obstacles to innovation) were incorporated in this report. Most of the results obtained from the questionnaire will be applied to the development of Regional Innovation Roadmaps (D6.2). The data collected will contribute to identifying potential areas of improvement in the region's innovation and climate resilience strategies, as well as opportunities for innovation and growth that are tailored to the specific needs and circumstances of the region.

In this specific context, the R4C regions were asked to classify the factors that enable innovation in climate change and climate resilience (including adaptation and/or mitigation). The classification was based on their relevance, ranging from 1 (not relevant) to 5 (completely relevant). The classification was done for both the regional innovation ecosystem (question 11) and specific innovation actions (question 17). The assigned scores varied between 1 and 5, with 4 and 5 being the most relevant enablers. For analysis purposes, the number of responses with the values of 4 and 5, corresponding to the most relevant enablers, were summed.

Figure 11 shows the relationship between the most relevant enablers of innovation in the regional ecosystem system and the specific innovation actions. The analysis indicates that considering each regional context, the innovative active businesses, the access to funding, the human capital skills/qualifications and digital infrastructure are the most relevant enablers of innovation. These results are aligned with the analysis of the enablers related to innovation actions, which highlight access to funding and human capital skills/qualifications as the most relevant enablers of innovation. In both cases, the less relevant enablers of innovation are patents/trademarks, age clusters – the young/adult population and the mentorship and support through accelerators and incubators, as well as private collaboration (joint buying, joint production, joint marketing, integrated supply chain...) at a regional level.

[13] 22 respondents, one of each organisation (this questionnaire was addressed to 36 organisations/partners). There were no answers from the partners involved in the regions of Sitia-Crete (EL) and The Nordic Archipelago (AX/SUE/FIN).
[14] Multiple individuals from each organisation could respond or be accountable for filling out different questionnaire sections. However, there was only one respondent per organisation.

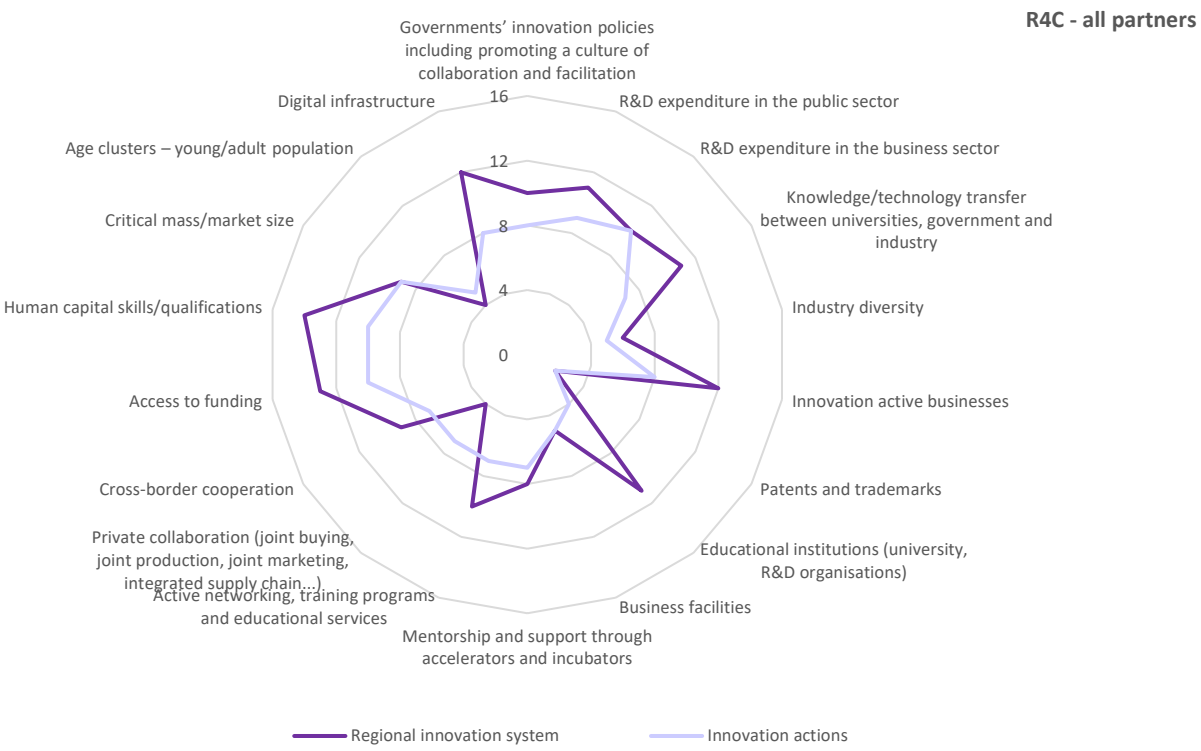

Figure 11. The most relevant enablers of innovation in the regional innovation system and innovation actions, according to R4C partners

Source: WP6 – Questionnaire "Innovation management (T6.1)"

The responses were analysed by cluster. As depicted in Figure 12, R&D expenditure in the public sector was identified as the main enabler of innovation within the Challenge Suite 1 - Focus on Faster, which considers innovation actions focused on developing and rolling out multi-scale and multi-sectoral adaptation solutions to help reduce climate-related risk, increase climate protection and safeguard coastal ecosystem integrity. With a significant score, the following enablers regarding the regional ecosystem also stand out: 1) knowledge/technology transfer between universities, government and industry, 2) educational institutions (university, R&D organisations), 3) access to funding and 4) human capital skills/qualifications.

It's interesting to observe that, regarding specific innovation actions, the R&D expenditure in the public sector and human capital skills/qualifications are also seen as enablers of innovation, but in this case, the R&D expenditure in the business sector is also considered as a relevant enabler.

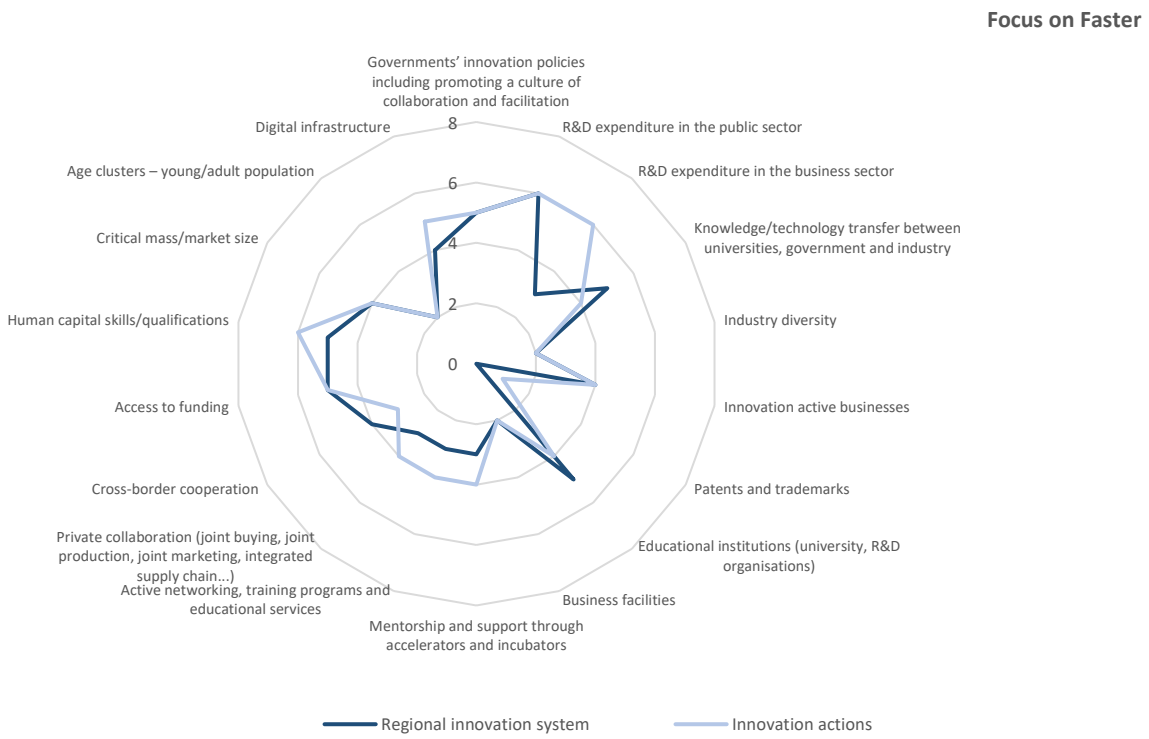

Figure 12. The most relevant enablers of innovation in the regional innovation systems and innovation actions | Challenge Suite 1– Focus on Faster

Source: WP6 - Questionnaire "Innovation management (T6.1)"

The following analysis is focused on Challenge Suite 2 – Focus on Smarter[15], which considers innovation actions that advance the frontiers of knowledge on adaptation to gather more and better data on climate-related risks and losses, and enhance Climate-ADAPT as the European platform for adaptation knowledge. Considering the regional ecosystem, the main enablers of innovation are 1) innovation-active businesses; 2) active networking, training programs and educational services; 3) human capital skills/qualifications; and 4) digital infrastructure.

It is interesting to note that, regarding the specific actions, the enablers vary completely from those previously stated. The more relevant enablers regarding Challenge Suite 2 are 1) knowledge/technology transfer between universities, government, and industry; 2) cross-border cooperation; 3) access to funding; and 4) critical mass/market size (Figure 13). This significant difference could be related, as mentioned before, to the point of view and expertise of respondents.

[15] 11 respondents

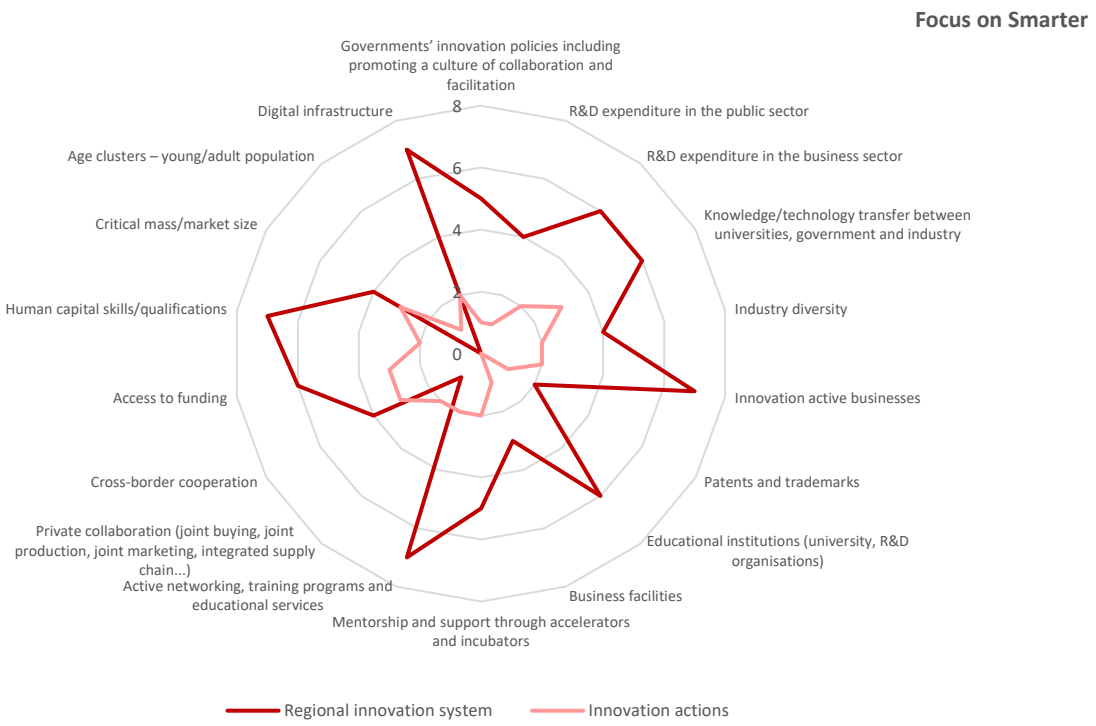

Figure 13. The most relevant enablers of innovation in the regional innovation system and innovation actions | Challenge Suite 2 – Focus on Smarter

Source: WP6 - Questionnaire "Innovation management (T6.1)"

The responses given by each region of the **Challenge Suite 3 – Focus on More Systemic**[16] focused on an integrated, cross-sectoral innovation to address the critical socioeconomic impacts of climate change at all levels of society were also analysed. In this context, the main factors that contribute to a successful innovation process within the regional innovation ecosystem are 1) access to funding; 2) human capital skills/qualifications; and 3) age clusters – young/adult population.

From a different perspective, and considering the specific innovation actions besides the three factors previously identified, the regions also highlighted the following enablers of innovation: 1) Governments' innovation policies including promoting a culture of collaboration and facilitation; 2) R&D expenditure in the public sector; 3) R&D expenditure in the business sector; 4) Innovation active businesses; 5) Business facilities; 6) Critical mass/market size (Figure 14).

[16] 3 respondents (Sitia-Crete (EL) and The Nordic Archipelago (AX/SUE/FIN) didn´t respond to the questionnaire)

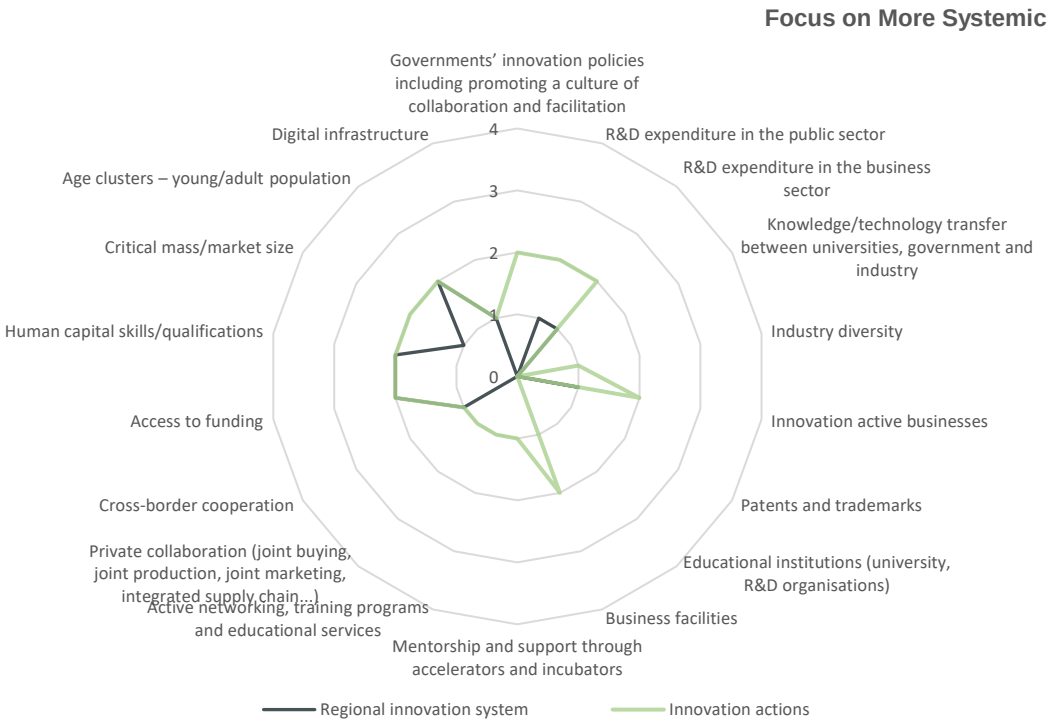

Figure 14. The most relevant enablers of innovation in the regional innovation systems and innovation actions, by Challenge Suite 3 – Focus on More Systemic

Source: WP6 - Questionnaire "Innovation management (T6.1)"

The R4C regions were also asked to classify the barriers to innovation in climate change and climate resilience (including adaptation and/or mitigation) according to their relevance 1 - not relevant to 5 - completely relevant). As mentioned above, the scores assigned by the regions varied between a minimum score of 1 and a maximum score of 5. As mentioned before, and for analysis purposes, the number of responses with the values of 4 and 5, corresponding to the most relevant obstacles, were summed, both on the regional innovation ecosystem (question 10) and specific innovation actions (question 16).

Regarding the obstacles to innovation within the regional ecosystem, the answers given[17] (Figure 15) highlighted the lack of human resources and the lack of urgency/prioritisation as principal obstacles to innovation. On the other hand, the difficulty/lack of collaboration/connection among the stakeholders is one of the main barriers regarding the specific innovation actions but is important to highlight that the lack of necessary knowledge or understanding, the lack of human resources and the lack of funding were also identified as relevant obstacles to innovation. Thus, it seems that the lack of human resources is an important obstacle identified at different scales.

[17] 22 respondents (Sitia-Crete (EL) and The Nordic Archipelago (AX/SUE/FIN) didn´t respond to the questionnaire)

As the less relevant obstacles, regions indicated the lack of strategy/vision and solutions that are not suitable for local features, considering the regional ecosystem. Regarding specific innovation actions the following obstacles were identified as less significant: 1) fear of failure/fear of the risk and the uncertainty; 2) lack of leadership; 3) lack of resources and/or capacity regarding technical issues and knowledge; and 4) solutions not suitable for local features.

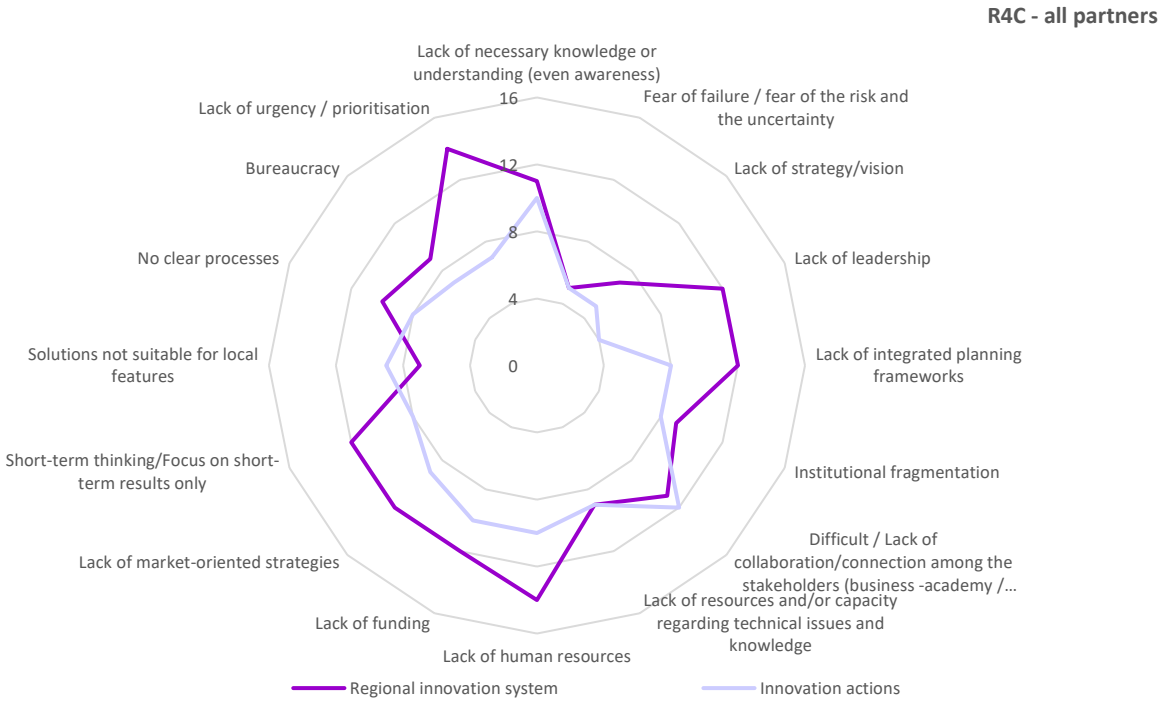

Figure 15. The most relevant obstacles to innovation in the regional innovation systems and innovation actions, according to R4C partners

Source: WP6 - Questionnaire "Innovation management (T6.1)"

Analysing the responses by Challenge Suite, significant changes in the identified obstacles to innovation emerged, as depicted in Figures 16 to 18. These changes could be attributed to cultural, social, political and economic features, but also to the natural environment. Bajada et al. (2022) support this observation, stating that each innovation has unique strengths and characteristics that are influenced by local conditions, relevant policy stimuli, infrastructure, and demographic characteristics.

Thus, is easy to understand that **Challenge Suite 1 – Focus on Faster**, identified the lack of market-oriented strategies as a major barrier to innovation in the regional ecosystem. This implies that the strategies adopted by the regional ecosystem were not geared towards meeting the needs of the market, resulting in a significant barrier to innovation. Other main obstacles were identified, such as 1) lack of human resources; 2) short-term thinking/focus on short-term results only; 3) solutions not suitable for local features; and 4) bureaucracy. In compensation, the

idea that solutions are not suitable for local features was indicated as the major obstacle to innovation, regarding the innovation actions.

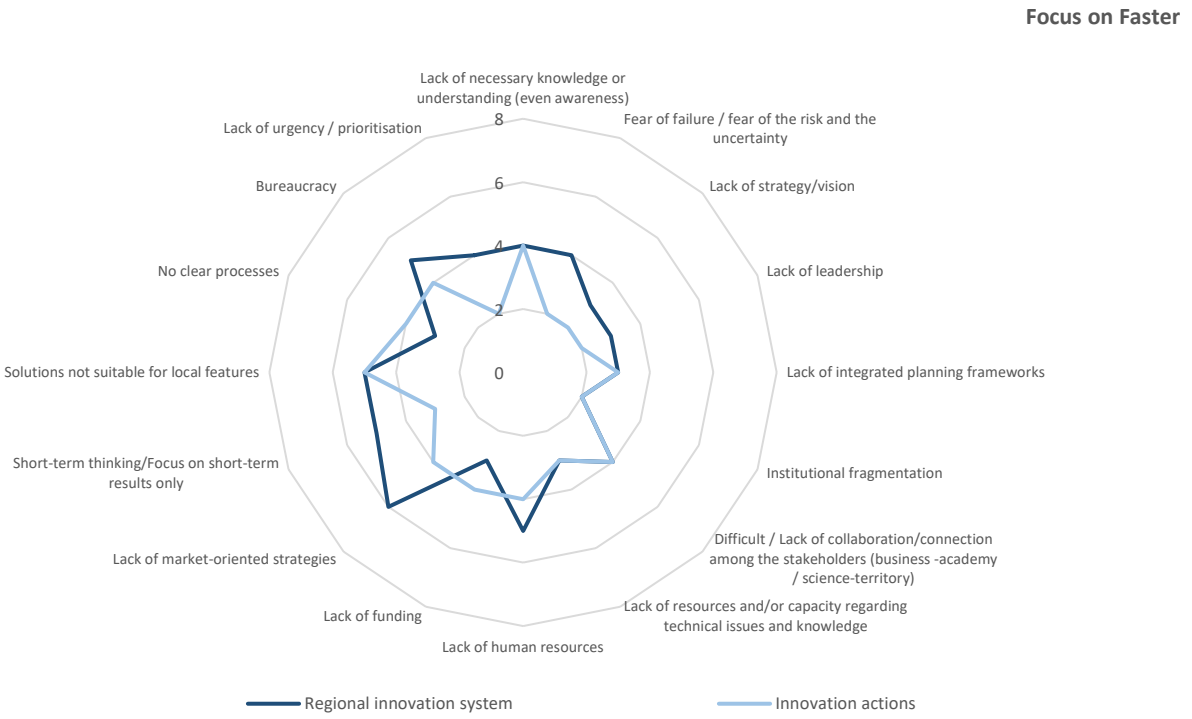

Figure 16. The most relevant obstacles to innovation in the regional innovation systems and innovation actions | Challenge Suite 1 – Focus on Faster

Source: WP6 - Questionnaire "Innovation management (T6.1)"

On the other hand, as shown in Figure 17 and regarding **Challenge Suite 2 – Focus on Smarter**[18], the major obstacles within the regional innovation ecosystem are 1) lack of leadership; 2) lack of human resources; 3) lack of urgency/prioritisation; 4) lack of funding. Regarding the specific innovation actions, the lack of human resources is also identified as a major obstacle to innovation, as well as the lack of necessary knowledge or understanding and difficulty/lack of collaboration/connection among the stakeholders (business -academy / science-territory).

[18] 11 respondents

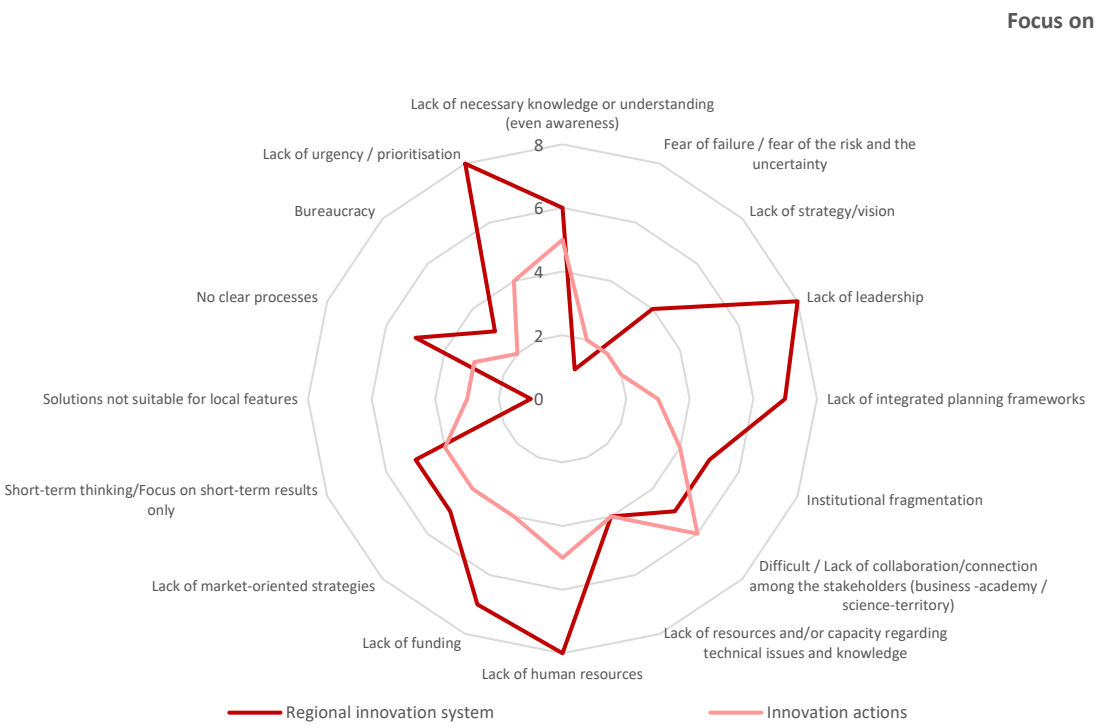

Figure 17. The most relevant obstacles to innovation in the regional innovation systems and innovation actions | Challenge Suite 2 – Focus on Smarter

Source: WP6 - Questionnaire "Innovation management (T6.1)"

Considering the **Challenge Suite 3 – Focus on More Systemic**[19], and regarding the regional ecosystem the regions highlighted the following barriers to innovation: 1) lack of integrated planning frameworks; 2) institutional fragmentation; 3) difficulty/lack of collaboration/connection among the stakeholders (business -academy / science-territory); 4) lack of resources and/or capacity regarding technical issues and knowledge; 5) lack of funding; 6) short-term thinking/focus on short-term results only; 7) no clear processes; 8) lack of urgency/prioritisation.

On the specific innovation actions, some obstacles are identical to the ones previously identified within the regional innovation ecosystem, namely: 1) lack of integrated planning frameworks; 2) institutional fragmentation; 3) difficulty/lack of collaboration/connection among the stakeholders (business-academy / science-territory); 4) lack of resources and/or capacity regarding technical issues and knowledge; 5) lack of funding (Figure 18).

[19] 3 respondents (Sitia-Crete (EL) and The Nordic Archipelago (AX/SUE/FIN) didn´t respond to the questionnaire)

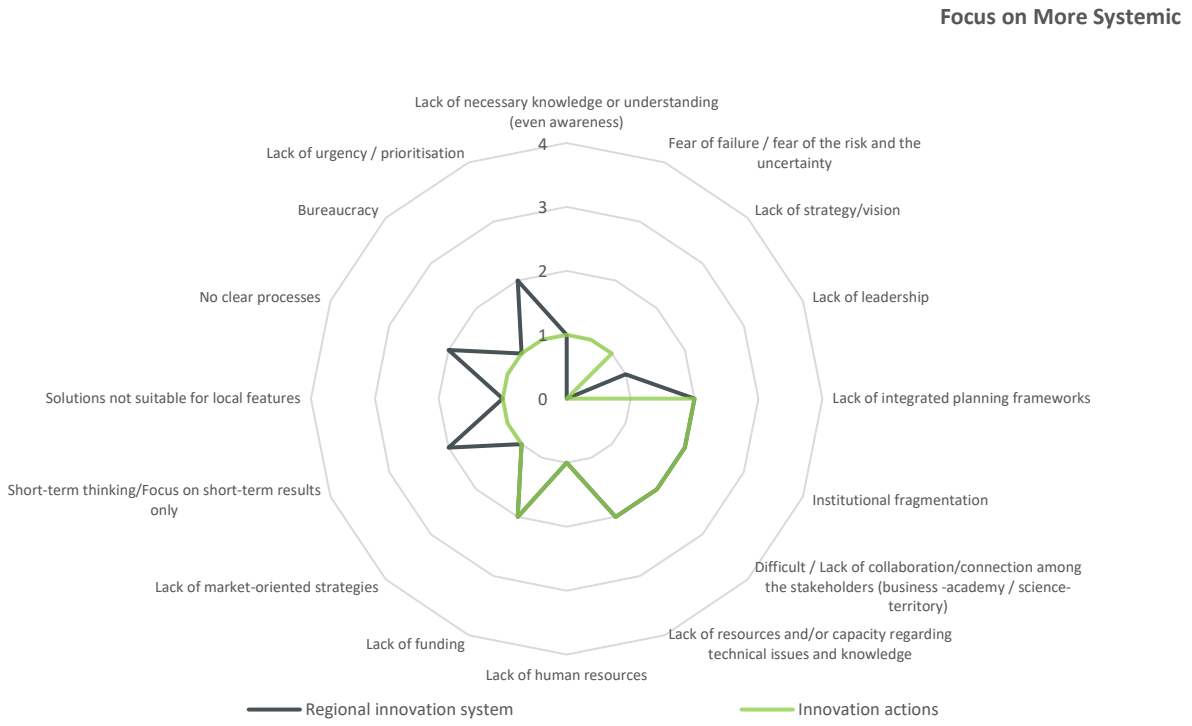

Figure 18. The most relevant obstacles to innovation in the regional innovation systems and innovation actions | Challenge Suite 3 – Focus on More Systemic

Source: WP6 - Questionnaire "Innovation management (T6.1)"

A comparative analysis of the obstacles and the challenges that were included in the questionnaire in some of the regions reinforces the idea that the engagement of citizens and relevant stakeholders is the major challenge within the project. Insufficient communication with key stakeholders and a low commitment rate of key stakeholders is also seen as the main challenge of the project. This vision is aligned with what was identified by the regions as the main barriers to innovation actions.

Another challenge is the natural context, which can act as an obstacle to raising awareness and could lead to low participation rates and dissatisfaction with the project and/or unmet expectations, as well as complications of implementation of the innovation actions due to insularity and remoteness in some regions.

Also, the main barriers regarding specific innovation actions, namely the lack of necessary knowledge or understanding, the lack of human resources and the lack of funding are related to the major challenges to innovation identified by the regions: lack of engagement/interest from local businesses/organizations, lack of initiative from local partners, lack of resources for the development of desired tools.

5. R4C Innovation Assessment

The importance and use of measuring innovation processes is directly related to the links between innovation, genuine improvements in competitiveness and sustainable development. From planning to execution, the innovation process needs to be managed. In this regard, monitoring and evaluation is an essential part of the innovation process considering that it helps to track progress and ensures that activities are on the correct path to achieve the established goals. Also, assessment must be developed as an ongoing cycle: plan, collect and analyse the data and report back to partners, stakeholders and the general public (whenever suitable or possible), informing them about ongoing and future events (to adjust or improve them).

In this context, innovation indicators can play a central role in the design and implementation of public policies including climate change mitigation/adaptation, and most importantly, in assessing them. As they provide a basis for measuring progress, identifying successes and challenges, and informing decision-making, indicators are an essential component of monitoring and evaluation. According to UNAIDS (2010), indicators are standardized measures that allow for comparisons over time, over different geographic areas and/or across programmes.

The success of the innovation process relies on selecting a group of strong indicators that may provide information about a specific phenomenon or a status quo, from which one can detect challenges in the innovation system. Therefore, they must be as follows:

- **Specific**: The indicator should accurately describe what is intended to be measured, and should not be included multiple measurements in one indicator.
- **Measurable**: Regardless of who uses the indicator, consistent results should be obtained and tracked under the same conditions. Targets must be defined (a quantified goal or objective that a programme plans to achieve by a certain date).
- **Attainable**: Collecting data for the indicator should be simple, straightforward, and cost-effective.
- **Relevant**: The indicator should be closely connected with each respective input, output or outcome.
- **Time-bound**: The indicator should include a specific time frame.

As a regional-based innovation process, R4C innovation assessment must not only focus on the **process** but also the **impact of the project in transforming the context.** These 2 dimensions are crucial to inform decision-making.

Concerning **process assessment**, customised M&E plans (under T3.2) will be developed in collaboration with representatives of each partner region and implemented jointly with innovation process monitoring. Here, several KPIs will be monitored (indicated in the following table). To cover all processes, other indicators regarding the CIF phases/steps could be assessed, including RRI accomplishment, in line with the D1.2 Ethics Management & RRI.

R4C milestones also have an important function here, as they can show progress trajectory through project life.

Table 3. KPI in R4C according to the type of assessment

KPI in R4C	Process assessment	Impact assessment
KPI 1 Policy briefs delivered	●	
KPI 2 Proportion of new policy instruments in demonstration regions employing R4C tools or new knowledge gained through the R4C project to inform local decision-making	●	
KPI 3 Adoption of R4C transition pathways and roadmaps by regional decision-makers		●
KPI 4 Population supporting the local transition towards climate change adaptation		●
KPI 5 Increase in CRML of partner regions		●
KPI 6 Workshops/joint events within R4C Challenge Suites	●	
KPI 7 Number of workshops/joint events among R4C Challenge Suites	●	
KPI 8 Number of workshops/joint events between partner regions in R4C and RESIST MISSION-CLIMA-02-02 projects.	●	
KPI 9 Local/regional/national authorities adopting R4C frameworks and tools		●
KPI 10 Local replication/ upscaling of R4C solutions	●	
KPI 11 Individuals engaged in CCACPs and R4C activities in each partner region	●	
KPI 12 Sector representation in CCACPs and R4C activities in each partner region	●	
KPI 13 Proportion of stakeholders expressing a high level of trust in governance processes in R4C partner regions		●
KPI 14 Openness of participatory processes	●	
KPI 15 Level of political commitment reflected in local vision and strategy for climate adaptation		●

Concerning **impact assessment**, several tasks will contribute to gathering valuable information:

- T3.1 Holistic vulnerability & risk assessment, by integrating and (spatially, temporally) analysing hazard, risk and vulnerability data from partner regions.
- T3.2 Integrated monitoring & evaluation, by defining a robust integrated monitoring and evaluation (M&E) framework for regional-scale M&E of climate change resilience. Also, these plans intend to assess the impact as they will collect the KPI results during the project. KPIs[20] aim to measure the significance of R4C impacts across scientific, social, and technological/economic domains in all demonstration regions.
- T4.1/T4.3 Climate resilience maturity assessment, by supporting each partner region to periodically re-evaluate their CRML, using the RRMM.

As suggested in the following table, innovation indicators may be collected within the assessment processes of R4C (in T3.1, T3.2, T4.1/T4.3). An in-depth analysis will be conducted in this context to determine the appropriate innovation metrics, under the scope of D6.2 aligned with the Just Transition framework (T2.2) and CRML (T4.1/T4.3).

[20] Climate Resilience Portal will provide KPI status along the project.

Table 4. Innovation indicators in R4C

Type of innovation assessment	**Description** – what is the purpose?	**Connection to CIF** – when and how to measure?	**Innovation indicators to assess (sources) –** what to measure?
Process assessment	It measures inputs (understanding the resources used) and the intermediate steps and outputs produced by the innovation activities.	M&E Plans (T3.2) – phase 02 and 03	• R4C KPI • RRI indicators
Impact assessment	It relates to innovation outcomes as it evaluates the actual result to which the outputs of the activities have an intended effect and also measures the direct and indirect effects or consequences in context, resulting from achieving the expected goals.	V&R (T3.1) – phase 02 and 03 M&E Plans (T3.2) – phase 02 and 03 CRML (T4.1/T4.3) – phase 02 and 03	• R4C KPI • United Nations Sustainable Development indicators • Regional innovation scoreboard • OECD STI scoreboard

R4C CIF is intrinsically connected with the **UN SDG** through the implementation of innovation indicators regarding impact assessment to reconcile local needs with global challenges, address societal challenges, and build knowledge streams at the global level, within exploitation activities. Aligning R4C innovation metrics with SDG Indicators, mainly related to innovation features, will play a critical role in achieving many SDGs.

The impact assessment also relates to the **Planetary boundaries concept**, as it contributes to identifying environmental limits (Figure 19). By recognising the limits of the Earth system, this concept guides innovation policies and actions to avoid irreparable damage to the environment and climate and to contribute to reducing the carbon footprint. and ensures the sustainability of innovation and action to address climate change. This concept serves as a guide for policymakers and societies to better understand and manage the complex interactions between human activities and the Earth's natural systems and foster innovation to guarantee a more balanced relationship between them and therefore more resilient communities and ecosystems.

Like the UN SDG, the R4C project expects to contribute positively to respecting the planetary boundaries. Therefore, impact assessment must cover the 5 systems among Quintuple Helix, for full alignment to sustainable development - Political system, Economic system, Education system, Media-based and culture-based public and Natural environment.

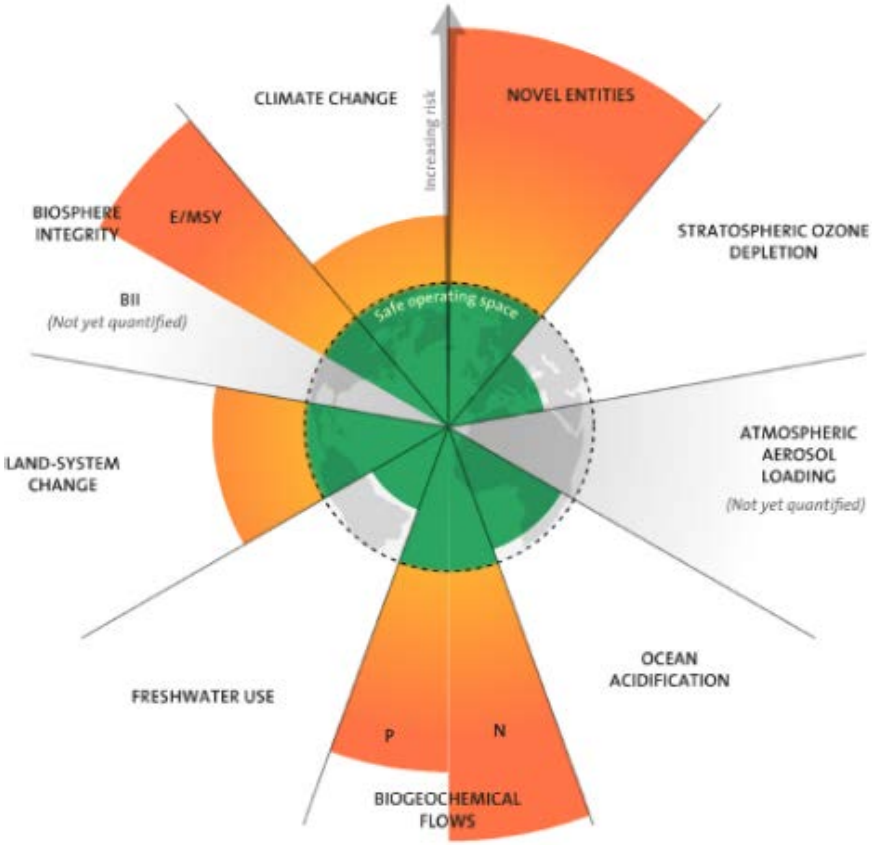

Figure 19. Schematic sketch of the safe operating space identified by the Planetary Boundaries

Source: Ferreto et al. **(**2022**)**

6. Conclusions

To accomplish a common innovation framework (CIF) for the R4C project, based on a sustainable model, leaders (regional authorities) must create a culture, dedicate resources, formalize action, and measure impacts. Thus, developing and validating a comprehensive innovation framework to support long-term regional sustainable development and more resilient communities is the right path to achieve the main goals of this project and support the rapid scalability and deployment of effective resilience solutions.

Under the scope of R4C, innovation is seen as a multi-stakeholder action dependent upon specific contexts and mechanisms and on knowledge generation and exchange. In addition, innovation that can be generated involves a high degree of complexity, can change over time, and implies a user-centred approach. Considering the complexity of this process, there is an inherent need to make explicit the assumptions, directionalities and priorities, and to identify and characterise the drivers that address transformative change at sociotechnical system levels. These drivers can act as facilitators or as enablers of innovation, and the innovation processes cannot be realised only by one of these drivers alone. We believe that achieving this requires extending the principles of RRI throughout the innovation process.

R4C will deliver innovation: new scientific insights, along with a framework of interoperable tools, methodologies and demonstrated solutions. These will enable European regions to develop their resilience plans and transformative adaptation pathways and be lighthouses of a global transformation towards climate change adaptation and mitigation, namely for developing regions across the planet that struggle and are affected by extreme events and have scarce resources to tackle or adequately react to it.

The proposed CIF has 5 phases - (i) identifying the challenge, (ii) defining leadership, (iii) designing and planning, (iv) implementing and learning, and (v) scaling up – where is possible to distinguish several steps that support them. These phases require continuous revision, learning through monitoring, and ongoing improvements; also, the process requires strong internal communication to articulate action between the partners and external communication to provide information/open data regarding ongoing results that can feed the system (context). Despite this structure, the approach is flexible enough to be adapted to changing global trends, political cycles, market needs and societal challenges that may arise.

Here, public engagement is a fundamental part of the innovation process, that should be jointly created by stakeholders and communities/individuals. However, this joint process of cocreation might face some constraints, since the most difficult challenge towards change and innovation is culture and people (Amos, 2021). This situation has a profound impact on the innovation process to the extent that, as suggested by Ozorhom (2014) resistance to change, which essentially depends on culture and people, can act as one of the main barriers to innovation. Therefore, a toolbox with tools/methods is suggested, to use in each phase during the project.

D6.1 is not a locked work as it is strongly connected to D6.2 which, as previously stated, aims to develop Innovation Roadmaps for each partner region towards achieving defined resilience innovation goals. Following the work developed in D6.1, it is expected to develop a Portfolio of Assumptions of Action for each region, including thematic elements (technological, digital, social, economic, and governance innovations), key actors and resources, anticipated climate change events and their expected impacts, and each region’s self-assessed present

capacity to address climate change vulnerabilities and risks (per pre-assessment of CRML in each region). With the strong support of the regions, SPI will co-develop detailed Regional Innovation Roadmaps for each region to identify short, medium and long-term milestones towards resilience innovation objectives and pave the way for key partnerships, ensuring post-project sustainability and alignment with RRI principles.

By covering relevant community systems, the CIF will allow the identification of the conditions of action for the development of the regional innovation package, whose details will be featured in D6.2 Regional Innovation Roadmaps (also under T6.1 Innovation Management).

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8. Appendices

8.1. Annex 1. CIF references

ID	**TRANSFORMATIVE INNOVATION**
Authors	Derk Loorbach, Niki Frantzeskaki, and Flor Avelino Derk Loorbach, Julia Wittmayer, Flor Avelino, Timo von Wirth, and Niki Frantzeskaki
Link	DOI:10.1146/ANNUREV-ENVIRON-102014-021340 DOI:10.1016/j.eist.2020.01.009

Short description

Transformative innovation refers to the introduction of innovative and disruptive technologies, processes or ideas that lead to significant and far-reaching changes in society, industries, economies and human behaviour. It involves innovations that cut across incremental improvements and instead bring radical changes, reconfiguring existing systems or creating entirely new ones. The key characteristics are related to disruptive impact, change through new ways of thinking and operating that can lead to changes in social behaviour, and multi-dimensional impacts that can extend beyond a single domain or sector. Therefore, transformative innovation often involves the deconstruction of established systems to make way for new and more efficient structures. In summary, transformative innovation is a powerful force that reshapes societies, economies and industries, leading to new eras of progress and human development.

The transformative innovation approach is the concept in which innovations have a profound and significant impact on society, industries, or individuals. The process is moving from one system state to another through a period of non-linear and disruptive change. The innovations might disrupt the existing systems or paradigms that lead to substantial changes in the way societies live, work and interact with each other. This systemic change results from a combination of different changes at diverse levels and in different domains that interact and reinforce each other, ultimately leading to a significant qualitative change in a social system. (Loorbach et al., 2017)

Three dominant approaches stand out in the field: socio-technical, socio-institutional, and socio-ecological. Each approach seeks to understand transitions with a normative goal of comprehending sustainability transitions. While they share an interest in transitions, they differ in their methods, the core subject of study, and the emphasis on explanatory drivers and mechanisms. The socio-technical approach focuses on technological aspects, the socio-institutional approach delves into institutional changes, and the socio-ecological approach emphasizes the interactions between social and ecological systems. (Loorbach et al., 2017)

Technological innovation can impede progress towards sustainability and even contribute to unsustainability. To be effective in addressing persistent societal problems, innovations must target and transform the underlying systemic causes of these problems. Transformative innovations are those that challenge, change or replace existing social structures. For innovations to have a transformative impact, they need to be applied and accessible to society. This involves processes such as mainstreaming, diffusion, scaling, institutionalisation or translation. However, during this process, innovations may lose some of their novelty and end up reinforcing the very structures they were intended to disrupt. This can potentially exacerbate societal problems. (Loorbach et al., 2017)

Theories on the relationship between social innovation and transformative change have been developed systematically, historically, institutionally and politically. Given the nature and dynamics of transformative innovation, it is essential to explore new governance approaches to foster transformative change. Policy processes typically operate within an incremental framework, focusing on incremental improvements through planning and implementation. Innovation policies often set societal goals and seek technological solutions through R&D subsidies and pilot projects, assuming that market mechanisms will ensure wider diffusion. However, from a sustainability transition perspective, the pursuit of optimisation through incremental improvements and the dominance of existing markets and socio-economic systems reinforces path dependencies. In addition, innovation policies tend to prioritise the development of new solutions rather than recognising and rewarding prevention or inaction. In the context of transformative change, current innovation policies overlook crucial aspects such as facilitating the dismantling of outdated practices, phase-out strategies and the adoption of degrowth approaches. The following table introduces the mechanism of transformative innovation (Loorbach et al., 2020).

Table 5. Mechanism of transformative innovation

Development mechanism	Definition	Explanation
Growing	*The quantitative growth of a transformative innovation by attracting more participants or funding*	When a transformative innovation is developed locally, it is often in the form of an initiative, project or organization. These can stay small but also attract growing numbers of contributors or participants. From a transformative innovation perspective, growth is often achieved by increased social visibility, professionalization and communication capacities from initiators as well as their ability to generate resources.
Replicating	*The translation of the ideas, models and practices of a transformative innovation into another context*	Replication of innovative practices might ultimately be a process that contributes to systemic change, and is often 'replication through inspiration': individuals pick up ideas from media and get stimulated to start a similar initiative.
Partnering	*The pooling of resources, competences, and capacities between different transformative innovations*	This mechanism is resulting from the advantages of pooling synergies and resources but also from identified opportunities for collaboration to increase transformative impacts.
Instrumentalising	*The strengthening and embedding of a transformative innovation by exploiting opportunities in the governance context*	Depending on the actors ability to present the transformative innovation in an attractive was and being able to navigate bureaucracy, they might tap into government resources or support to become more sustainable
Embedding	*The institutionalization of a transformative innovation through mainstreaming and structural anchoring in for example regulation, physical space or funding schemes*	When a transformative innovation becomes mainstream, norm, routine or rule. Ultimately the embedding of transformative innovations also implies having achieved their transformative potential at a local level.

Source: Loorbach et al (2020)

Relevance for the project

In developing the Community Innovation Framework for the effective implementation of transformative innovation, it is crucial to create a supportive ecosystem that stimulates creativity, facilitates experimentation and provides the necessary resources and expertise. In addition, successful transformative innovation often requires collaboration between distinct entities, including industry, academia, government, customers and other stakeholders. By harnessing different perspectives and bringing together expertise from various sources, transformative innovation can thrive and bring positive change to the multiple systems that make up the innovation model. With its emphasis on facilitating experimentation and fostering collaboration with different entities, this approach is in line with the development of the CIF.

ID	**QUINTUPLE HÉLIX**
Authors	Elias G Carayannis, Thorsten D Barth, and David F J Campbell Elias G. Carayannis. Joanna Morawska-Jancelewicz
Link	http://www.innovation-entrepreneurship.com/content/1/1/2 DOI: 10.1007/s13132-021-00854-2

Short description

The Quintuple Helix model is an extension of the Triple Helix model, a framework that describes the interactions between three key actors in the innovation process: academia, industry and government. The Quintuple Helix model extends this concept to include two additional helices, making it a more comprehensive and inclusive approach to understanding innovation ecosystems. Thus, in the Quintuple Helix model, the five propellers represent (1) government, through the public institutions - policymakers and government agencies - responsible for formulating policies and regulations that affect the innovation landscape; (2) industry, through the private sector companies and organisations that drive economic activity and technological progress through innovation; (3) higher education institutions, such as universities; research institutes and other educational institutions that generate knowledge; and the (4) private sector, through the (i) private sector companies and organisations that drive economic activity and technological progress through innovation, (ii) civil society, which includes non-governmental organisations, community groups and other social organisations that play a role in shaping social and ethical values and demands for innovation, and the (5) media, as media and communication channels that influence public opinion and perceptions of innovation-related issues.

The Quintuple Helix model emphasises the importance of involving civil society and the media as active participants in the innovation process, recognising their influence in shaping public understanding and acceptance of innovation. It recognises that innovation is not only driven by academia, industry and government but is also influenced by social and cultural factors and media representation.

In the face of global warming, the innovation model of the Quintuple Helix sees global warming as both a challenge and a driver of innovation, and is, therefore, broader than the previous two, adding the helix (and perspective) of 'natural environment and society', and emphasises the importance of higher education for innovation. It also emphasises the need for a socio-ecological transition of 21st-century society and economy. Therefore, the model in Figure 20 shows that innovation, the natural environment, society and the economy should also be seen as 'drivers' of knowledge production and innovation, thus defining opportunities for a growing economy (Carayannis, 2012).

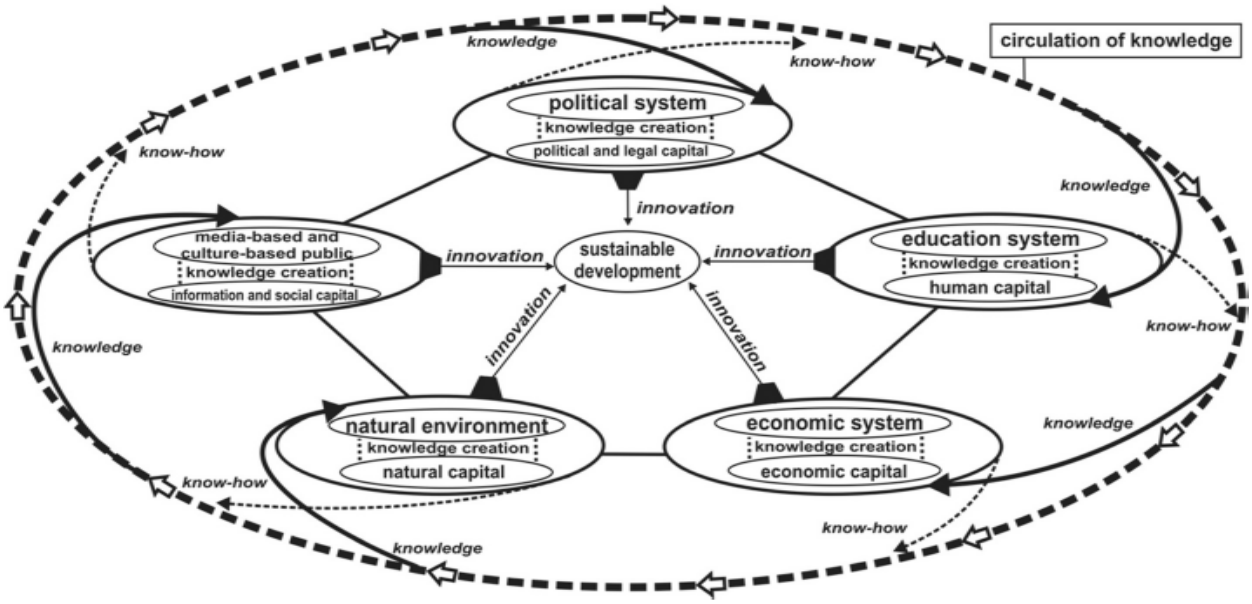


Figure 20. Schematic of the Quintuple Helix model

Source: Carayannis (2012)

The main objective of the Quintuple Helix is to include the natural environment as a new subsystem for knowledge and innovation models, so that "nature and natural ecosystems" are established as central components in the production of knowledge and innovation. A theoretical and practical model for the exchange of knowledge resources, based on social subsystems, to generate and support the sustainable growth of society. The main function and objective of the model is the generation of new knowledge, know-how and innovation in harmony with nature, constituting the new quality management for greater sustainability, where the application of sustainable knowledge and actions has a positive impact on society as a whole.

In the study by Elias G. Carayannis and Joanna Morawska-Jancelewicz, "The Futures of Europe: Society 5.0 and Industry 5.0 as Driving Forces of Future Universities" the concept of Society 5.0 and Industry 5.0 is not a simple chronological advance or an alternative to the previous paradigm. Society 5.0 aims to involve people in innovation, exploring the impact of technology and the results of the industry through technological interaction to improve quality of life, social responsibility and sustainability. It is an innovative perspective that is articulated with the UN SDG.

Incorporating the assumptions of Society 5.0 and Industry 5.0 into the policy practices of universities will help institutions and societies to fully benefit from digital transformation and achieve sustainable priorities. Therefore, in line with the current vision of the European University Association on the future and role of academic institutions, the incorporation of the aforementioned assumptions on human-centred innovation will be a hallmark of European universities to achieve the goals of sustainability through collaborative models of cooperation. In this context, the Quintuple Helix model can facilitate the process of enabling the necessary transformations, as it integrates different perspectives and prepares the ground for sustainable priorities and reflections (Carayannis, 2012).

Relevance for the project

The Quintuple Helix model, in the context of innovation and sustainable development, combines knowledge, know-how and the natural-environmental system in an interdisciplinary and transdisciplinary framework, to improve management based on the quality of development by restoring the balance with nature, allowing future generations to live in plurality and diversity on Earth.

Therefore, to develop a common European innovation framework based on an integrated vision at different levels and capable of supporting climate change resilience solutions, it is important to consider and combine the perspectives of the natural environment, society and economy for the production of knowledge and innovation systems, where (i) environmental component and sustainability are fundamental for the preservation of human life and for the application of knowledge and actions to have a good impact on society as a whole, and (ii) the generation of new knowledge, know-how and innovation in harmony with nature constitutes the new quality management for greater sustainability.

ID	**EXPERIMENTAL GOVERNANCE**
Authors	Hooman Farzaneh José Manuel Leceta & Totti Könnölä Nicolas Rocle and Denis Salles Steven Bernstein and Matthew Hoffman
Link	DOI:10.1007/978-981-13-0782-9 DOI:10.1080/13511610.2019.1612737 DOI: 10.1007/s11077-017-9279-z DOI: 10.1007/s11077-018-9314

Short description

Experimental governance is a cyclical process of setting temporary goals and adapting them based on lessons learned from alternative approaches in different contexts. It operates within a multi-level framework comprising a central authority, such as a national government or agency, and local entities, such as federated states, municipalities, regulated private actors or contracted service providers. These entities work together iteratively to set and revise goals and the strategies to achieve them (Farzaneh, 2018).

The governance structure can take the form of public, private or hybrid partnerships, particularly in regulatory regimes such as energy or the environment, involving private companies and territorial authorities. The process involves four key elements: setting targets, allowing flexibility for local implementation, regular reporting and peer review, and periodic revision of strategies based on evaluation and alternatives. Different institutional arrangements can fulfil these elements, and the governance architecture remains impartial towards specific mechanisms or policy instruments

The experimental model includes decentralisation, signals and norms, incentive design and stakeholder participation. It combines decentralised control with central coordination, emphasises continuous rule revision, and incorporates learning through monitoring and continuous improvement (Figure 21).

Different institutional arrangements can fulfil these elements, and the governance architecture remains impartial towards specific mechanisms or policy instruments. The experimentalist approach includes decentralisation, signals and norms, incentive design and stakeholder participation. It combines decentralised control with central coordination, emphasises continuous rule revision, and incorporates learning through monitoring and continuous improvement. Rather than relying on decentralisation alone, central units provide essential guidance and support to local units. (Farzaneh, 2018).

Figure 21. Schematic of the experimental method

Source: Farzaneh (2018)

Relevance for the project

This approach highlights the emerging strategic practice of central authorities in monitoring and guiding decentralised authorities. Positive feedback from local entities and participants acts as drivers for the experimental process. The experimental governance framework proves valuable in understanding the link between subnational experiments and Nationally Determined Contributions (NDCs).

The results of the case studies suggest that experiments can directly or indirectly influence the stringency and potential for strengthening NDCs. The application of this framework can provide a deeper understanding of this relationship. It is therefore likely that the implementation of an experimental governance approach will contribute to the development of a Common Innovation Framework (CIF).

ID	**OPEN INNOVATION APPROACH**
Authors	Henry W. Chesbrough and Melissa M. Appleyard Peter Angsbo Eva van Genuchten, Alicia Calderón González and Ingrid Mulder
	DOI:10.2307/41166416
Link	https://www.climate-kic.org/wp-content/uploads/2019/03/Open-Innovation-White-Paper-v2-003.pdf
	DOI:10.3390/SU11123310 [3]

Short description

Open innovation is a concept and approach that was introduced by Henry Chesbrough and Mellisa Appleyard in 2007. It challenges the traditional closed innovation model, which suggests that organizations should conduct their research and development internally and keep their intellectual property (IP) protected. Instead, open innovation encourages organizations to collaborate with external partners, share knowledge, and leverage external ideas and technologies to accelerate innovation and achieve competitive advantage.

Open innovation advocates active collaboration with external partners, with key elements including acquiring external knowledge, creating and maintaining collaborative networks and ecosystems, open intellectual property, spin-in and spin-out activities, applying crowdsourcing platforms and open innovation challenges to harness the collective intelligence of the public and external contributors, and involving end-users in the innovation process to ensure that innovation meets its needs.

The theory of open innovation has been widely adopted by businesses, governments, and research institutions as a way to foster innovation and address complex challenges more efficiently and effectively. It has also led to the emergence of innovation ecosystems and platforms that facilitate open collaboration and knowledge sharing across political, economic, educational, and environmental sectors.

Openness in innovation revolves around sharing knowledge for innovative purposes, where contributors have access to each other's inputs and cannot claim exclusive rights to the resulting innovation. In its purest form, the value generated by an open process resembles that of a public good, where consumption by one person does not diminish the experience of others, and anyone can access it without restrictions.

In the regional and local context, open innovation presents an efficient approach to addressing complex challenges such as sustainable waste management, flood protection, renewable energy generation, and climate action. These problems are often difficult to tackle due to the intricate socio-economic systems prevalent in cities. By adopting an open approach, cities can engage the public more extensively, broaden their economic base by supporting entrepreneurs, start-ups, and small and medium-sized enterprises (SMEs), and tap into the most current knowledge and competencies available (Angsbo, 2017).

Relevance for the project

In the Open Innovation model, participatory processes and open access to data play a crucial role in fostering collaboration, creativity and collective problem-solving among different stakeholders, involving a wide range of actors, including individuals, organisations and communities in the process. Emphasis is placed on the involvement of external partners to draw on a wider range of knowledge, experience and perspectives to generate innovative solutions. By combining the participatory process with open access to data, the open innovation approach harnesses the collective intelligence of diverse

stakeholders, stimulates the interculturality of ideas and accelerates the development of innovative solutions to address societal challenges and drive progress.

Due to its potential, the open innovation approach has driven continuous innovation and reduction of R&D costs. It encourages stakeholders to break down traditional silos and foster a collaborative culture and knowledge in terms of open-source data or platforms for exchanging, sharing, and adopting innovation without borders.

In the development of this CIF, the open innovation concept is the core of circulatory knowledge that can drive the innovation process. In addition, it also nurtures the possibility of replication to other regions or worldwide scope. Therefore, this approach will be included in the development of CIF for the Regions4Climate project.

ID	**BOTTOM-UP APPROACH**
Authors	Ajay Gajanan Bhave, Ashok Mishra, and Narendra Singh Raghuwanshi Erlend A. T. Hermansen & Göran Sundqvist
Link	DOI:10.1016/J.JHYDROL.2013.08.039 DOI:10.1007/s10584-022-03309-y

Short description

The Bottom-Up Approach is a strategy used in various contexts, including decision-making, problem-solving, and organizational management. In this approach, initiatives, ideas, or solutions originate from individuals or stakeholders at lower levels of the system and are later presented or aggregated to influence decision-making processes at higher levels. The emphasis is on involving and empowering individuals or groups at the local level. These individuals may have unique perspectives, expertise, and local knowledge that can inform and enrich the decision-making process, instead of being dictated by centralized authority or top-level management.

The bottom-up approach is often associated with decentralized decision-making and participatory processes. It fosters collaboration, engagement, and ownership among those directly affected by the decisions or changes under consideration. This approach is particularly effective in addressing complex and diverse challenges that require a deep understanding of local contexts and the involvement of multiple perspectives.

In climate change, the bottom-up approach focuses on understanding social or community vulnerability and qualitatively characterizing the factors that make it susceptible to impacts. On the other hand, the identification and evaluation of adaptation options through participatory processes involving stakeholders in decision-making also generate legitimacy for the solutions to be implemented. As a participatory process, it ensures that adaptation options are relevant and acceptable to the community. The process is shown schematically in Figure 22 (Bhavem et al., 2014).

Some studies combine bottom-up and top-down approaches for climate change mitigation policy, and a similar approach is proposed here. The disadvantage of the bottom-up approach is that it may not give sufficient weight to the physical factors associated with climate change. Therefore, the top-down approach appears to effectively complement the bottom-up approach in defining viable measures.

The top-down approach focuses on macro-level analysis, resource allocation, and cost-effectiveness. This approach tends to rely on economic principles and models to guide decision-making. On the other hand, the bottom-up approach emphasizes a more localized and context-specific understanding of problems and solutions. It takes into account the technical aspects of implementing strategies and the social dynamics involved. (Hermansen and Sundqvist, 2022)

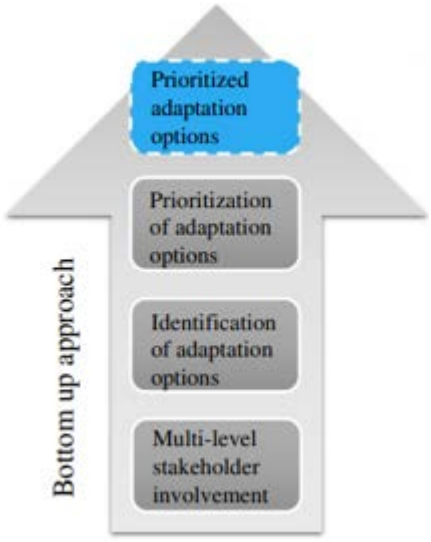


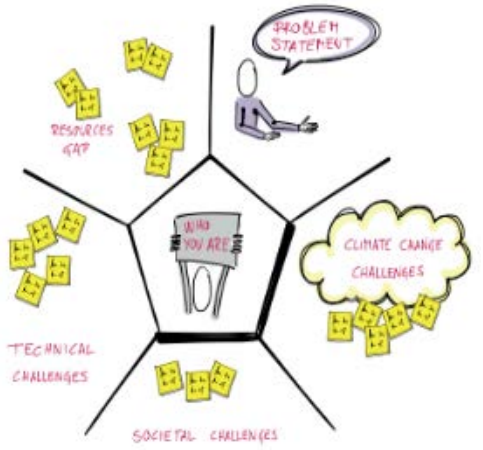
Figure 22. Schematic of the bottom-up approach

Source: Bhave et al. (2014)

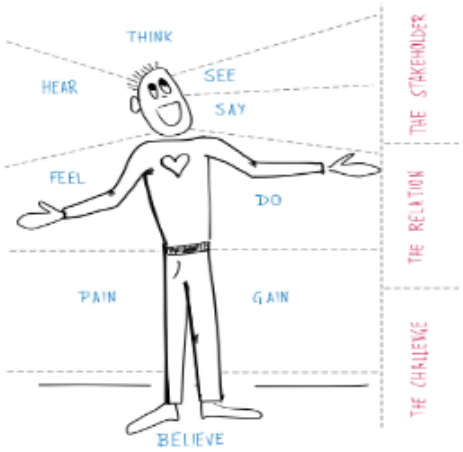
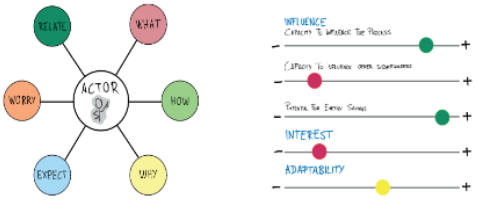
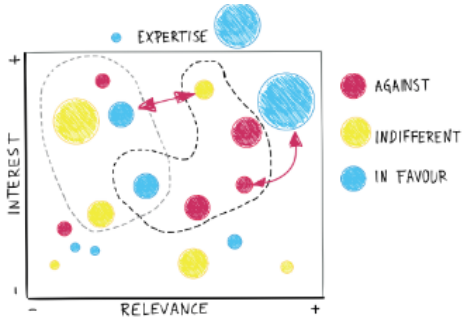
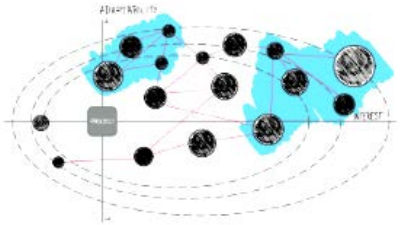
Relevance for the project

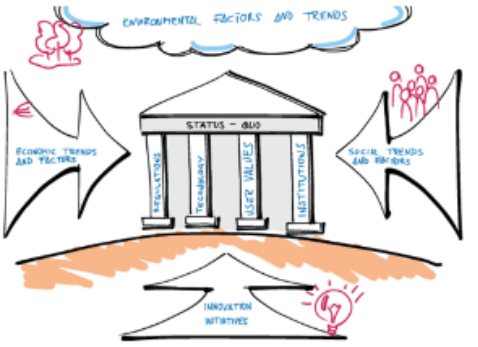
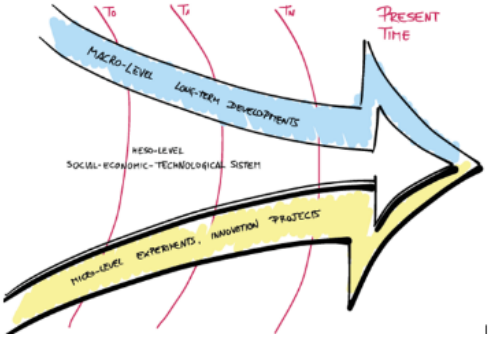
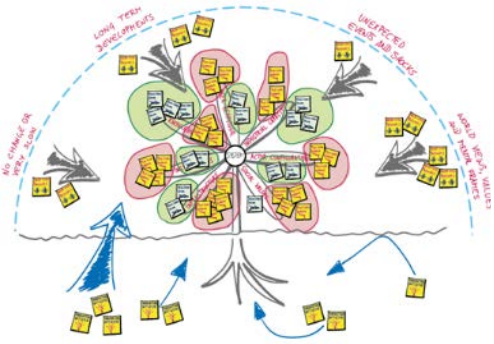
The bottom-up approach contributes to the development of the model and the Common Innovation Framework as an integral part of the hybrid approach (top-down and bottom-up). Only in conjunction with the top-down approach does it provide a better and more efficient contribution to the success of the expected results, as the methodology takes into account the decentralization of the decision-making process from the bottom-up while mitigating the rigidity of the top-level decision-making hierarchy. By utilizing both approaches together, it is possible to achieve a more comprehensive and effective decision-making process. This allows for a more comprehensive assessment of the proposed measures and increases the likelihood of achieving effective and successful crosscutting outcomes in combating climate change.

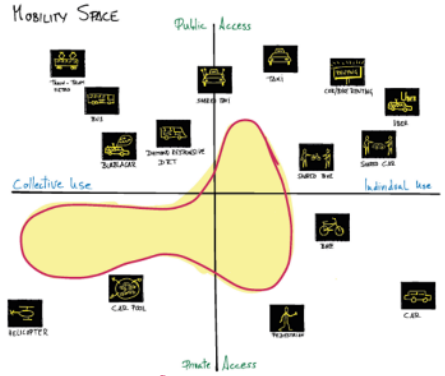
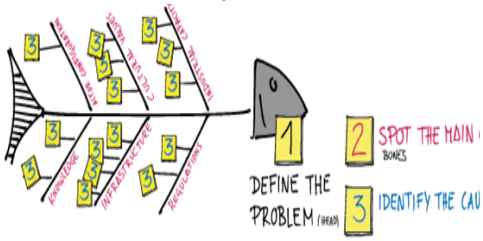
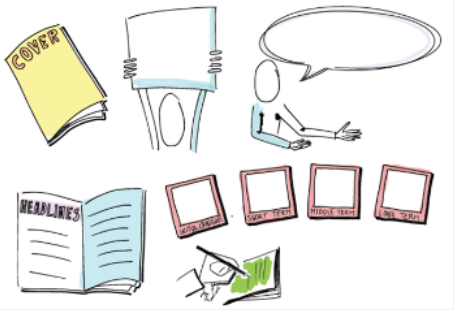
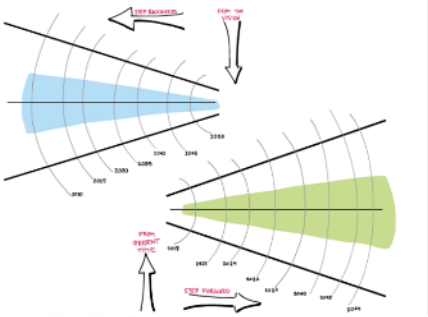
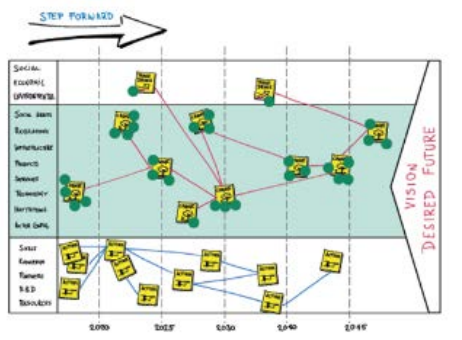
8.2. Annex 2. CIF toolbox

00 IDENTIFYING THE PROBLEM		
Tools	Short description	
Pentagonal problem	This tool is essential in identifying and gaining a deep understanding of the problem at hand. It provides a comprehensive and visual representation of the main systemic components of the issue, which helps teams search for holistic solutions. Additionally, creating and simulating various scenarios can anticipate future challenges. These scenarios are detailed descriptions of potential future issues, emphasizing how events and decisions can impact one another. Local community members are encouraged to participate in discussions and decision-making during workshops to develop a communal plan of action. This method aims to facilitate dialogue among policy-makers, experts, and citizens for more effective problem-solving. *Source*	

01 DEFINING LEADERSHIP		
Tools	Short description	
Actor tree	This tool is a useful tool for identifying, listing, and categorizing the various stakeholders involved in your project, and helps to gain a better understanding of the challenge and its context by identifying the actors and institutions that are playing a role or may be impacted by the project. *Source*	

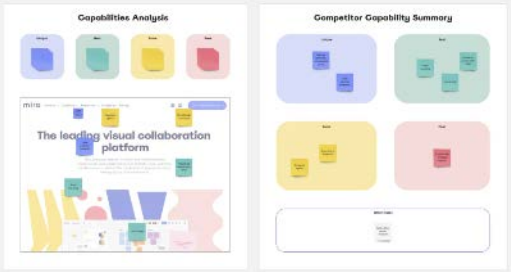
Enlarged empathy map	Is a useful tool for engaging with stakeholders and gathering relevant information and offers a visual representation of stakeholders' profiles including their needs, motivations, expectations, behaviour, and information sources. *Source*	
Credential cards	Useful tool to characterise a stakeholder's stance about the challenge and how they relate to that challenge, by allowing a visual depiction of how stakeholders relate to the project and its context. They are an example of a tool that can be applied to pick up the most relevant stakeholders. *Source*	
Stakeholder mapping	This tool helps identify power relationships, conflicts, and affinity groups, by understanding stakeholders' influence and expertise Stakeholders are rated based on criteria like relevance, interest, and attitude. Engage stakeholders with high expertise and medium to high relevance or high interest, even if their relevance is low. *Source*	
Stakeholder universe	This is a tool used for quick and easy visual network analysis and helps understand the core of the challenge by examining the relationships between stakeholders and how they interact and change over time. *Source*	

02 DESIGNING AND PLANNING		
Tools	Short description	
Context map	Utilizing the Context Map is crucial in comprehending the system's operations concerning a particular challenge or project. Its insights into the current situation and direction of change within the project environment allow for identifying potential opportunities and threats. When exploring new countries, regions, or markets, making assumptions can be detrimental, but the Context Map helps prevent such mistakes. It expands your perspective and overall awareness, enabling informed decisions, effective strategies, and successful navigation within the system. Source	
Pentagonal problem	This tool is essential in identifying and gaining a deep understanding of the problem at hand. It provides a comprehensive and visual representation of the main systemic components of the issue, which helps teams search for holistic solutions. Additionally, creating and simulating various scenarios can anticipate future challenges. These scenarios are detailed descriptions of potential future issues, emphasizing how events and decisions can impact one another. Local community members are encouraged to participate in discussions and decision-making during workshops to develop a communal plan of action. This method aims to facilitate dialogue among policy-makers, experts, and citizens for more effective problem-solving. Source	
Trajectories change	Activities to understand and analyse the external macro-environment around the project or specific topic. To depict the evolution of the system, or meso-level, in which a challenge is embedded over time. The system evolves due to incremental innovations and the influence of the macro and micro levels. This method focuses on the horizontal temporal evolution of the system, examining the vertical relationships between levels and within them to understand its development. Source	
Flourishing multi-level	This tool simplifies the complex interactions of a socio-technical system, providing a visual representation of the micro, meso, and macro levels. It helps identify multi-level components, evaluate their impact, and gain insights into the system's significance for specific cases. Innovation projects can be better positioned within the broader societal context using this tool. Source	

Ocean of opportunities	This tool's purpose is to discover potential market gaps that could serve as opportunities. Ocean of Opportunities evaluates existing solutions using two key dimensions and allows the team to chart the full spectrum of current options based on these variables. This tool can be utilised to warm up and stimulate creativity. It helps identify market gaps first and then allows focusing on those gaps to envision new ideas and solutions. Additionally, the tool represents the dominant market system through two dimensions, helping identify relevant dimensions for designing effective solutions. Source	
Fishing for barriers	Analysing the external environment around a project can reveal hidden issues. A tool can help identify primary barriers and prioritize urgent problems. This aids in developing a short-term strategy to prevent derailment and improve the project's success. Source	
Visual story	This tool provides a visual story that shows simplicity and the ability to introduce disruptive ideas that are completely unrelated to the present time. It aligns with these characteristics, making disruptive thinking more accessible and straightforward. By disconnecting from the present, it encourages disruptive thinking, potentially leading to radical innovation. However, it's essential to recognize that this creative process doesn't consider feasibility or probability as criteria for vision-building. To ground the vision in reality, a backcasting process is recommended before developing concrete plans and projects based on the vision. Source	
Future radars	To travel forward in time to the envisioned ideal future, and from that vantage point, to reflect on the journey that led to the success. This tool aids in developing action plans with a comprehensive view of the milestones needed to achieve the defined goals, considering their feasibility and your influence on making them happen. The milestone pathway allows for a more robust plan, including contingency alternatives to address unforeseen events. Source	
Socio-technical roadmap	The Socio-Technical Roadmap (STRM) enables the creation of innovation pathways for the future by identifying chains of change and helps to outline various pathways to bridge the gap between future and present time as a result of the envisioned perspectives of stakeholders. It also helps uncover opportunities and risks in the market, technologies, and social environments. The visual representation of future changes provided by STRM makes it easier to develop an actionable plan. Source	

Other tools:

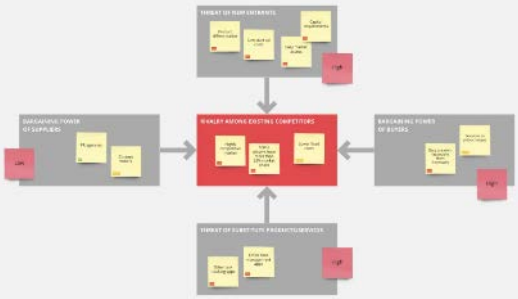
Competitor analysis
Competitor analysis is the process of identifying competitors in your industry and researching their different marketing strategies. You can use this information as a point of comparison to identify your company's strengths and weaknesses relative to each competitor.
Source

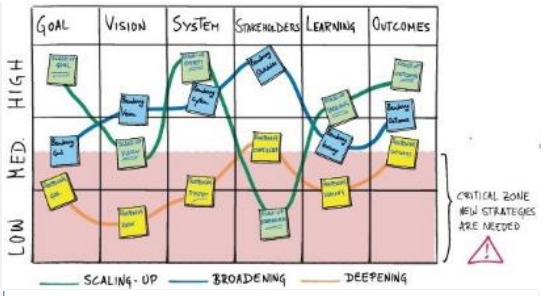
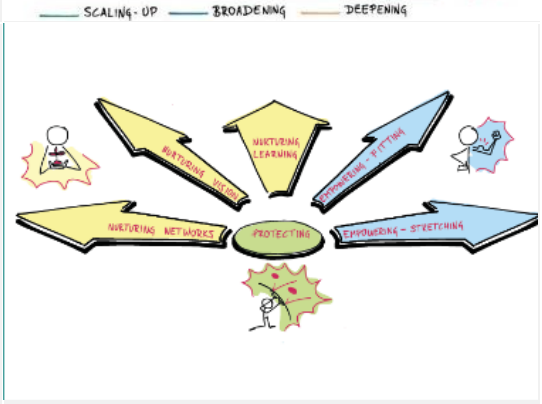


PESTEL analysis
PESTEL analysis is a management tool that examines the effect that events or influences from outside may have on the performance of a company or organisation.
This tool helps managers identify their market positioning and strengths and could be described as a strategic tool or framework to identify market trends, business status, and potential opportunities or challenges. As such, the PESTEL analysis will provide valuable input into any strategic SWOT analysis.
Source

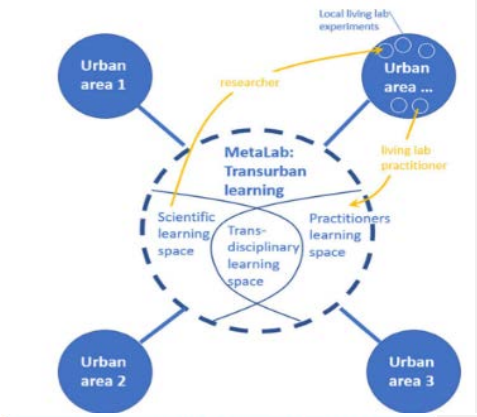
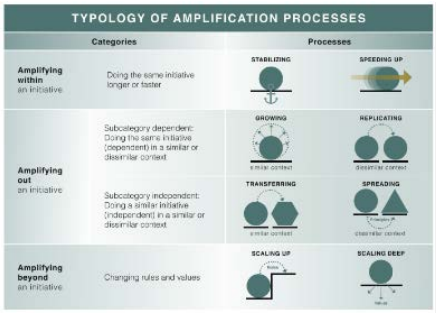
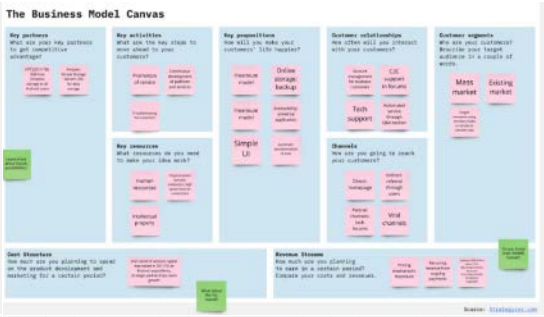
SWOT analysis
A SWOT analysis is a strategic tool used by innovators to objectively measure and evaluate their performance and that of competitors. It involves assessing internal factors like strengths and weaknesses, which can be controlled by the organization, and potential outcomes like positive outcomes in terms of opportunities and threats as the negative outcomes, which are beyond their control. By understanding these potential outcomes, innovators can make informed decisions and adapt strategies to succeed in their competitive environment. It is recommended to perform a SWOT analysis regularly; it should be done bi-annually or whenever a significant decision needs to be made.
Source

Porter 5 Forces analysis
The purpose of Porter's Five Forces model is to evaluate the competitive environment, as all of these forces represent a crucial aspect of designing a business strategy in light of the market.
Porter's five forces framework should be used when building a marketing and business strategy, so you don't miss any information that might influence your business success.
Source



03 IMPLEMENTING & LEARNING		
Tools	**Short description**	
Transition waves	This sequential tool evaluates on three levels the goal established, the vision defined and the way the system works with all the elements that compose it. Transition waves allow a deep and continuous evaluation of the project, through a systemic approach between strengths and weaknesses, highlighting weaknesses so that they can be overcome, and forcing the project to maintain a linear path of innovation without the influence of conventional approaches. *Source*	
Six systemic strengths	The tool aims to promote systemic thinking, which involves considering the broader context and interconnection of elements when addressing challenges, towards new outcomes contributing to novel approaches, new regulations, new technologies, and other new opportunities to explore. Therefore, the team should be aware of trends and new funding opportunities and should hold meetings with national/sectoral bodies and industry to put the results in the context of innovation (regulation, technology, etc.). This visual tool is based on a framework that focuses on identifying six key strengths that contribute to the overall effectiveness and resilience of a system. The core strengths are linking and connecting strength, adaptive strength, robustness, transformative strength and coherent strength. *Source*	

04 SCALING UP		
Tools	**Short description**	
Roadmap of exploitable results	This tool facilitates the successful exploitation and adoption of results and benefits within research communities and policy advisers. Exploitation ensures the longevity of the project's results through either policy uptake, further research or commercial applications. In this sense, developing a roadmap plan to outline achievable business opportunities derived from analysed business models, technology/solutions gap assessment, and comprehensive evaluations of both current and potential future markets for R4C is mandatory. *Source*	

Innovation Labs	Innovation labs are dedicated spaces or initiatives within organisations that foster creativity, collaboration and experimentation to drive innovation. These labs act as incubators for new ideas, products and services, providing a supportive environment for exploring and developing innovative solutions to challenges and could provide access to resources, mentorship, and a supportive environment to explore and develop new opportunities and new approaches, new regulations, and new technologies, as well as new opportunities to explore. *Source*	
Networking events	Tools like networking and expo events bring together professionals, entrepreneurs, experts and industry leaders to build relationships, exchange ideas, explore potential markets and disseminate media for the tried and tested solutions of innovation. Both replication and scaling up play a key role in strengthening knowledge, disseminating information, and achieving the desired results to apply/replicate in other regions. *Source*	
Business Model Canvas	This tool is used for the definition of the market size and growth potential, potential users and customers, value chain, key players, and relevant target groups, as well as the political, economic, sociocultural, technological, environmental, and legal conditions required. *Source*	
Growth experiments	A growth experiment is a systematic method for testing a strategy to scale a business or project. Growth experiments allow us to test the strategies before fully committing, saving time and money. *Source*	

8.3. Annex 3. IA geographical coverage per Challenge Suites

Challenge Suites	R4C Regions	Country[21]	NUTS 1[22]	NUTS 2	NUTS 3	LAU 1[23]
Cluster 1 Focus on Faster Adaptation	**Basque Country (ES)**	**España (Spain)**	Noroeste [ES1]	Pais Vasco [ES21]	-	-
	South Aquitaine (FR)	**France (France)**	Nouvelle-Aquitaine [FRI]	Aquitaine [FRI1]	Pyrénées-Atlantiques [FRI15]	Saint Jean de Luz [64483]
	Toscana (IT)	**Italia (Italy)**	Centro [ITI]	Toscana [ITI1]	Livorno [ITI16]	Piombino [049012]
	Azores (PT)	**Portugal (Portugal)**	Região Autónoma dos Açores [PT2]	Região Autónoma dos Açores [PT20]	Região Autónoma dos Açores [PT200]	-
Cluster 2 Focus on Smarter Adaptation	**Køge Bay (DK)**	**Danmark (Denmark)**	Danmark [DK01]	Hovedstaden [DK01]	Byen København [DK011]	København [101]
						Dragør [155]
						Tårnby [185]
					Københavns omegn [DK012]	Brøndby [153]
						Hvidovre [167]
						Ishøj [183]
						Vallensbæk [187
				Sjælland [DK02]	Østsjælland [DK021]	Greve [253]
						Køge [259]
						Solrød [269]
					Vest- og Sydsjælland [DK022]	Stevns [336]
	Burgas (BG)	**Bulgaria (Bulgary)**	Severna i Yugoiztochna Bulgaria [BG3]	Yugoiztochen [BG34]	Burgas [BG341]	Burgas [BGS04]
	Uusimaa (FIN)	**Suomi (Finland)**	Manner-Suomi [FI1]	Helsinki-Uusimaa [FI1B]	Helsinki-Uusimaa [FI1B1]	-
	Parnumaa (EE)	**Eesti (Estonia)**	Eesti [EE0]	Eesti [EE00]	Lääne-Eesti [EE004]	Pärnu linn [624] /

[21] National name/English name
[22] NUTS (Nomenclature of Territorial Units for Statistics)
[23] LAU (Local Administrative Units)

						Pärnu County[24]
Cluster 3 **Focus on More Systemic Adaptation**	**Sitia, Crete (EL)**	**Elláda (Greece)**	Nisia Aigaiou, Kriti EL4]	Kriti [EL43]	Lasithi [EL432]	Municipal Commune of Sitia [72040101]
	Castilla y León (ES)	**España (Spain)**	Centro [ES4]	Castilla y León [ES41]	-	-
	The Nordic Archipelago (AX/SUE/FIN)	**Sverige (Sweden)**	Östra Sverige [SE1]	Stockholm [SE11]	Stockholms län [SE110]	-
				Östra Mellansverige [SE12]	Uppsala län [SE121]	-
					Södermanlands län [SE122]	-
					Östergötlands län [SE123]	-
		Suomi (Finland)	*Manner-Suomi [FI1]* Manner-Suomi [FI1]	Etelä-Suomi [FI1C]	Kymenlaakso [FI1C4]	-
				Helsinki-Uusimaa [FI1B]	Helsinki-Uusimaa [FI1B1]	-
			Åland [FI2]	Åland [FI2]	Åland [FI200]	-
	Troodos (CY)	**Kýpros (Cyprus)**	Kýpros [CY0]	Kýpros [CY00]	Kýpros [CY000]	Troodos [5356]

Legend:

IA implementation – geographical coverage

[24]According to Pärnu County Development Centre, the pilot innovation action will take place in the City of Pärnu, the administrative centre of Pärnu County, and depending on the outcome of the pilot and its suitability/adaptability to smaller municipalities, it will be replicated in rural municipalities of Pärnu County (Tori Parish, Saarde Parish, Häädemeeste Parish, Põhja-Pärnumaa Parish, Lääneranna Parish and Kihnu Parish).

8.4. Annex 4. Administrative authorities in R4C Consortium per Challenge Suites

Challenge Suites	R4C Regions	Administrative authorities (regional/local) in the R4C Consortium, *per* administration units		
		NUTS 2	NUTS 3	LAU 1
Cluster 1 Focus on Faster Adaptation	Basque Country (ES)	Eusko Jaurlaritza-Gobierno Vasco		
	South Aquitaine (FR)		Communauté d'Agglomération Pays Basque	
	Toscana (IT)	Regione Toscana		
	Azores (PT)			
Cluster 2 Focus on Smarter Adaptation	Køge Bay (DK)		Region Hovedstaden Region Sjaelland	
	Burgas (BG)			Burgas Municipality
	Uusimaa (FIN)		Helsinki-Uusimaa Regional Council	
	Parnumaa (EE)			Parnu Linnavalitsus
Cluster 3 Focus on More Systemic Adaptation	Sitia, Crete (EL)			Municipality of Sitia
	Castilla y León (ES)	Junta de Castilla y Leon		
	The Nordic Archipelago (AX/SUE/FIN)		Region Stockholm Allmanna Forvaltningen	
	Troodos (CY)			

Legend:

IA implementation – geographical coverage

Regions
4Climate