A Framework for Experimenting Co-creation in Real-Life Contexts

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The chapter describes the methodology applied throughout the experimentation, the application of co-design, the tools used and their role briefly illustrating the single cases. The underlying assumption is that design methodologies and tools are more suitable to support co-creation for the inclusion of society in science and innovation since their aim is to implement co-creation processes from the ideation of new products, services and processes to their real implementation. What differentiates design from other co-creation methodologies is the role of prototypes and their experimentation in real contexts.

1 Introduction

In the following the results of a practice-based approach are presented that aims to tackle the challenges of active actor engagement, the effective integration of co-creation in STI policymaking, and the operationalisation of RRI practices. In this context, exploring those practices in real-life opens up the possibilities to cope with constraints, identify new opportunities and explore ways to effectively embed co-creation.

The reasoning is situated in a context where many barriers are still in place, hindering the development of ecosystems of co-creation aimed at better inclusion of society in science and innovation. Still, the situation is evolving, pushed by a

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growing interest towards co-creation that led to its integration in European research and innovation policies. Looking at the bigger picture, however, some of the main obstacles need to be outlined that researchers and practitioners are encountering when addressing RRI in practice. First of all, there is a general lack of awareness and understanding of the potentialities of co-creation among researchers, innovators, intermediaries and policymakers. The STI approach to policymaking, to which RRI is bounded, is known for being "sectorialised". This hampers collaboration among sectors and organisations. However, one of the main hindrances is the shortage of competences and methodologies to rely on for filling the gap between constructing solutions and policies and their real implementation. Eventually, there is a scarcity of learning frameworks to sustain and encourage the replication of co-creation mechanisms. In consequence, the main need of a framework able to include and leverage practical knowledge on how to cope with those constraints and barriers that come along during co-creation processes and their implementation has been identified.

In many fields, Design has been already recognised as a key actor in operationalising co-creation. Especially, co-design and its iterative cycles of understanding, ideating, prototyping, and verifying, resulted in successfully supporting co-creation along the process, that is to say from the ideation of new solutions and policies to their real implementation. In doing so, especially prototypes stood for contributing in bridging the gap between co-production and its outcomes. This is made possible by prototypes' ability to trigger and feed processes of real implementation where to experience all the aspects that come along when designing solutions. On a smaller, but real scale, everything is experiences: from coping with resources available, need and interests, conflicts with opportunities and barriers, organisational cultures and values, and larger cultural, institutional and regulatory frameworks. Such an inherent feature constitutes a strong rationale for understanding the potentialities as well as the implications of co-creation as a design-driven approach for better including society in science and innovation. Moreover, in the light of the main obstacles depicted above, especially building an evidence-based learning framework becomes paramount, allowing for the integration of co-creation with larger STI governance systems.

In this volume, other than exploring the theoretical background of co-design in RRI and analysing existing cases of the application of co-design in a European context and beyond, conducting RLEs is a way for grasping concrete and situated knowledge about a complex interaction where several actors participate throughout the entire process. These actors can be either members of the organisation conducting the experimentation or external to this organisation, but are relevant actors in the context of the activity. These actors can be users of a product or service or stakeholders of its delivery. Potential stakeholders can be public institutions, enterprises or policymakers.

To advance knowledge on the topic, a set of field experimentations were conducted and monitored purposely identified as cross-disciplinary and varied in their nature. The results and outcomes obtained from such high-impact experiments in real-life contexts allowed to gather concrete knowledge on the operationalisation of RRI and the integration of co-creation in STI policymaking. By engaging citizens, local

actors, stakeholders such as policymakers and the wider scientific community, the experimentation has the objective to increase knowledge on co-creation through action research [1]. At the same time, the effectiveness of design methodologies is tested to better combine co-construction or ideation with the co-production or actual implementation of the ideated solutions and policies for the integration of society in science and innovation.

Those experiments took place in 10 co-creation labs across Europe, each of them is a member of one of three following networks that will be described in detail later on:

- The Fab City Foundation managed in part by Fab Lab Barcelona,
- The European Network of Living Labs (ENoLL), and
- The European network of Science Centres and Museums (ECSITE).

The three networks as a system of trans-national collectors and areas of encounter and exchange for their member labs provided first insights on co-creative environments within their networks. They contributed already in the initial phase of the project with drivers and barriers previously identified by their members regarding the effectiveness of the above-mentioned co-creation approaches, processes and tools; during the ongoing experimentation they actively supported their respective members in their journeys.

Although the experimentation was initially supposed to last around 18 months, the period has been extended to 21 due to the manifold restriction caused by the Covid pandemic. In these experiments, each lab tackled a specific societal challenge and engaged a set of stakeholders in a co-creation process. from the stage of co-design where stakeholders will analyse the context, reframe the problem and envision alternatives, to that of co-production of prototypes within an iterative process.

The following sections detail the approach to co-creation on the base of the experimentation consisting in a learning framework and process guideline and an accompanying, modular toolbox. Furthermore, the objectives of this approach are illustrated in detail together with the single labs and networks and how their experimentations have been both supported and assessed throughout the process.

2 SISCODE Approach to Co-creation

Co-creation is approached in this volume as a design-driven and currently flourishing phenomenon across Europe occurring in bottom-up initiatives like innovation labs, social innovation initiatives, communities, and regions.

The experimentation aims to analyse significant conditions for the successful introduction, scaling and replication of co-creation practices while cross-pollinating RRI initiatives and the field of policymaking [2]. To achieve this, the approach applied throughout the experimentation is using design practices and processes as a base for the development of a process and attributive tools to build capacities and competences for the implementation of RRI and STI policymaking [3]. This approach consists in

a learning framework and a toolbox specifically developed for the RLE conducted aiming to overcome barriers and resistances to change. Both the organisation at the core of the initiative as well as all the external actors and stakeholders involved in the development are considered and targeted by this approach.

Experience-based learning framework

The way SISCODE looks at co-creation is seeing it as "a non-linear process that involves multiple actors and stakeholders in the ideation, implementation and assessment of products, services, policies and systems with the aim of improving their efficiency and effectiveness, and the satisfaction of those who take part in the process" [1, 3, 4]. The integrated core structure of the design processes can be complemented with appropriate tools associated to one or more phases to support the co-creation of new solutions while the (organisational) learning process can be complemented with appropriate structures and actions, and applied to the introduction and integration of new knowledge.

By interpreting an organisation not only as a structure closed in itself but as an actor in a greater network where other actors like municipalities, public services or enterprises play their function and relate, the learning process can be extended to all those actors being actively involved in the learning process through the application of the principles of co-design [5].

In the light of this reasoning, to develop the theoretical framework at the ground of the experimentation Kolb's cycle of experiential learning [6] has been combined with the iterative process of co-design. The scheme below represents the framework integrating experimentation and learning. This framework will be used to connect the activities conducted in the 10 co-creation labs with policymakers at local, regional, national, and EU levels (Fig. 1).

The developed learning cycle basically foresees four stages within an iterative process:

- Concrete Experience: the learner encounters a new experience or situation, or reinterprets an existing experience.
- Reflective Observation: the learner reflects on the experience on a personal basis, trying to map the gap between experience and understanding.
- Abstract Conceptualisation: the learner elaborates new ideas based on the previous reflection or on modifications of the existing abstract ideas. This phase focuses on envisioning alternatives.
- Active Experimentation: the learner applies the new ideas to his/her surroundings to see if there are any modifications in the next appearance of the experience.

Beginning from the analysis of the context to then move from the reframing of the initially defined problem and the envisioning of alternatives into an iterative cycle itself of developing and prototyping. In the following each phase is detailed, pointing out their main features and output.

Analysis of the context

The phase of context analysis has the scope of providing the space and instruments needed to clearly define the context in which the chosen challenge is addressed with a

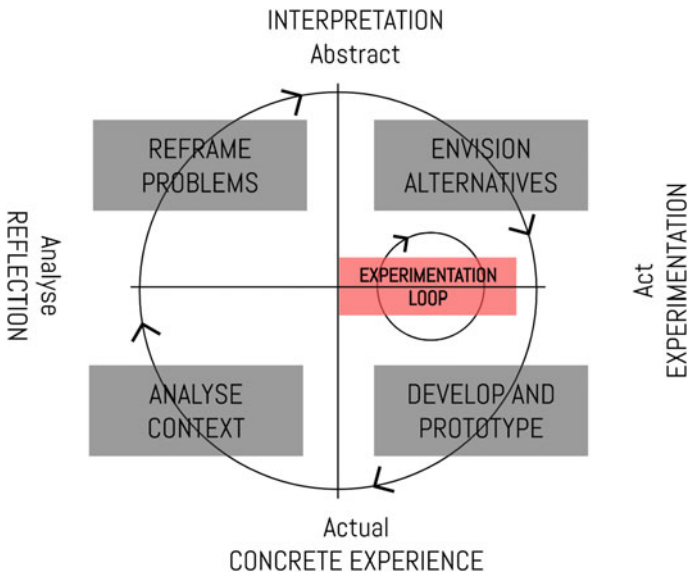

Fig. 1 The design-based learning framework

focus on specific local particularities, stakeholders, and current policies. Defining the context through research is meant to form the base to explore the relation between the context and the challenge itself, as well as to clarify the competences that the lab needs to be able to frame and define the problem. Since this first phase, the involvement of a variety of stakeholders and users is already required with them being part of the ecosystem in which the lab operates. The aim is to obtain a complete picture of the context and needs of the various actors: such knowledge is in fact key to precisely frame the problem.

Problem framing

The precise definition of the root of the problem is essential for the ideation of an efficient and effective solution. Moreover it is necessary to consider that the initial challenge might be linked to other, greater problems underneath, which have to be acknowledged and tackled all together in order to provoke real change.

This phase is entirely dedicated to the understanding of the problem, its roots and the influencing factors. As in the first phase of context analysis, the active participation of stakeholders is fundamental to explore not only influencing factors, but also different perspectives from which the problem could be seen. This is crucial to gain a multi-perspective view and a complete understanding of the problem itself.

Envisioning solutions

Moving from problems to opportunities and solutions during the third phase, the detailed challenge and needs defined previously are addressed to improve the current situation. This phase is dedicated to ideating potential solutions imagining an ideal scenario in which the problem is solved.

Building the ideal scenario itself and reasoning on its elements can already be a starting point for the gathering of new ideas. To keep the variety of points of view and needs to be satisfied the involvement of stakeholders needs to be kept consistent also throughout this step. The presence of multiple perspectives leads to shaping a value proposition from the different ideas generated.

Developing and prototyping

The last phase of the journey is dedicated to the application of the newly developed concepts to turn them into implementable prototypes. The prototypes designed are then tested and assessed through an iterative process aimed at identifying the best possible solution step by step together with users and concerned actors.

As illustrated in Fig. 2, the framework is presented as cyclical, emphasising the importance of iteration when designing and experimenting in real-life.

In addition to this learning model, a toolbox has been developed to operationalise and support the learning effect and favor capacity building in a variety of contexts.

The toolbox

The toolbox has been created as an open set of tools to operationalise the single phases of the learning framework to facilitate both the design and the implementation of the co-creation journeys of the labs while focusing on a better understanding of the particularities within each context.

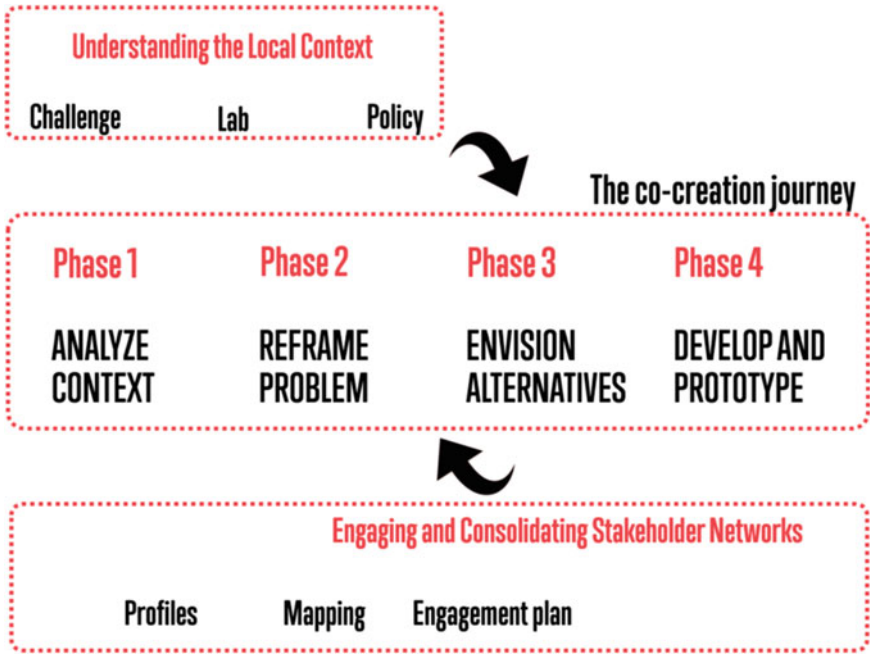

Fig. 2 Application process of the design-based learning framework

A premise to the construction of the toolbox is an extensive desk research aimed at analysing co-design in RRI in literature as well as investigating existing cases in Europe and beyond. The needs and gaps identified during this research led to the definition of a set of goals to be translated in specifications for development of the toolbox as pictured in Table 1. This toolbox was developed before the start of the experimentation, composed by a set of important instruments to use in an entirely flexible way throughout the co-creation journey. In the following, the main goals and their sub-goals are reported that were identified as key elements in the design process to be translated in specification that lead the construction of the toolbox (Fig. 3).

The learning framework and the toolbox as the two main aspects of the applied experimentation concept are meant to give a clear framework to the experimentation itself and support the process to reach the objectives stated in the following.

Table 1 Goals of the experimentation and resulting specifications for the toolbox

Goals	Details	Specifications for the toolbox design
Fill the identified RRI gaps	Complexity of societal problems	Context-based approach using systemic tools
	Engagement of stakeholders	Use of stakeholder canvases all along the journey
	Tangibility of RRI projects	Use of prototypes as boundary objects
Make the single tools modular and customisable	Context Matters	Adaptable selection of tools according to cases
	Tools appropriation	Support provided to enlarge the practical knowledge about tools. 101 methods design cards
Trigger reflexivity through the use of tools	Comparison necessities	Process characterised by common macro-phases that can be freely organised in sub-phases, and on the other hand the adoption of a limited set of common tools that synthesize the outcomes of each phase
	Common knowledge spaces	Organisation of interactive moments with partners like lab exchange day, skype call and communication spaces (social media, website…)

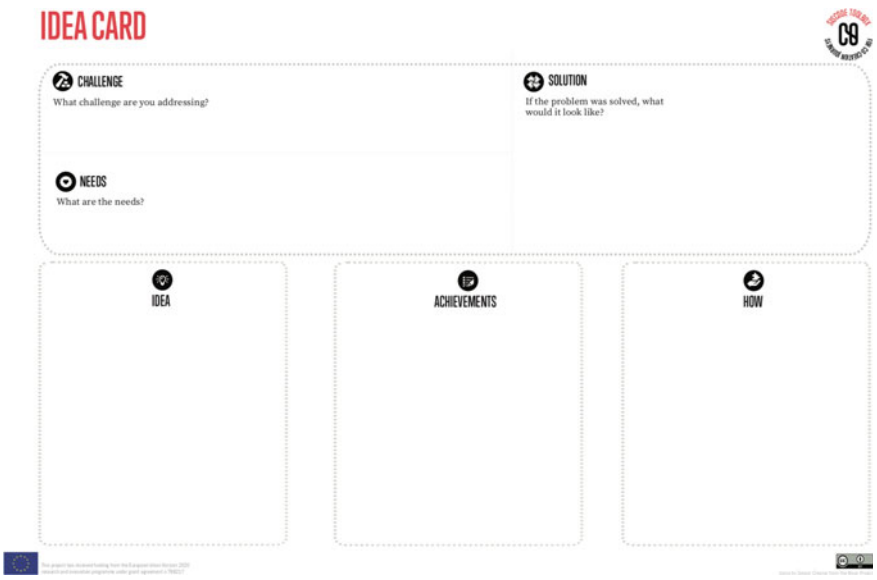

Fig. 3 Idea card—an example from the toolbox

3 Key Objectives and Originality of the Approach

As anticipated, each experimentation aims at the conduction of high-impact investigations in a real-life context. Through the direct engagement of a variety of users and actors in a process of action research as well as the tackling of a relevant societal challenge it aims to influence current organisational structures and policies at a wider scale. In this, the effectiveness of design methods is tested in an RRI context to move from sheer ideation to implementation.

Prototypes as a means to move from co-design to co-production

Having identified the issue to move from ideation to implementation [7], bridging this gap is one of the main objectives in the experimentation. The underlying assumption is that design methodologies and tools are suitable to support co-creation for the inclusion of society in science and innovation and exploit their practical orientation to bridge the aforementioned gap between ideation and implementation. What differentiates design from other co-creation methodologies is the role of prototypes and their experimentation in real contexts [8]. Prototypes can provide support in shortening the distance between "co-construction and its outcomes as they are refracted through practicalities embedded in existing institutions and interests" (SwafS-13-2017 topic) [9].

The experimentation of this potential in a real context is crucial to explore the possibilities of bridging the gap between ideal and real outputs that the application of co-creation and RRI can produce.

Prototyping all revolves around giving people the space and time to materialize and concretize their ideas, it brings an experience to a vision by creating objects of dialog and designs that can afford interaction with people and place, to evoke debate to capture the potential and risks involved in innovation.

Prototyping arouses empowerment, dialog, acts of creation and intents of empiricism and allows practitioners to connect with realities and representations when navigating towards the unknown.

Prototypes are objects manifesting the interconnection between ideas, matter, theory and practices, bringing together soft systems and Hard Technologies. In the approach, it is hypothesised they can create bridges between projects, scales and stakeholders to support innovation.

Implementing RRI

While the potential of RRI as a new approach has been widely discussed in theory, a lack of its translation into practice has been identified [7]. With its attitude of previously evaluating impacts on the entire ecosystem of operation and society RRI involves a variety of actors, including users and stakeholders, in the entire development process from the very beginning. The experimentation concretely explored the engagement of a variety of stakeholders using techniques and processes from the field of design to operationalise this element of RRI involving actors from an early stage keeping them engaged throughout the process.

Therefore, material is being produced to feed theoretical studies with experiences in practice and application in real life. Concretely, theoretical concepts found during the desk research on how RRI are experimented and verified for their implementability to undermine or confute the research statements from a practical point of view.

This new approach together with the active participation is also meant to provoke a learning process within the world of policymaking. The objective is to create a fertile ground where to show possibilities and functioning of different approaches opening up policymaking as a field that has been found to be often restricted and closed in itself creating a safe playground for policymakers to experiment further, acquire new knowledge and build themselves capacities in applying this knowledge.

Capacity building and organisational change through co-design

The objectives of capacity building within the pilots' ecosystem are twofold: On one hand, the capacity of co-creation within the lab leading the pilot is aimed to be enhanced through the training provided during the project and the frequent and iterative application and use of co-design tools. This knowledge generation on co-creation is planned to go beyond the members of the labs involved, extending beyond that to the application in other projects and to their spread over the entire organisation as a means to co-create and lead co-creation initiatives themselves. On the other hand, a further learning effect is meant to be provoked in the entire ecosystem, including all actors and stakeholders involved in the activities of the experimentation. In a learning-by-doing process their knowledge on the use of design methodologies and their capacities to cope with barriers and constraints that may occur in the process

are expected to be built in consequence of practical activities. In this case, this means developing knowledge because of their involvement in the co-design and the prototyping of specific solutions.

To support and further exploit the bridges built between policymakers and practitioners as well to give other interested policymakers the tools and possibilities to experiment with new approaches, the best practices, learning outcomes and direct feedback from policymakers are to be analysed and used to produce an open repository of material, tools and instruction that have been proven successful in introducing design into policymaking to spread and disseminate precious evidences collected throughout the project.

4 The Networks and Labs

The cases of application of new processes and visions to involve actors that have not been considered in the development process of new initiatives to date are constantly growing. Greater, international networks function as a collector for those often smaller initiatives and labs to provide support and foster the exchange among different realities in local contexts and challenges to provide a broader view on small-scale experiments and reflect on interconnections, scalability and replicability in diverse contexts.

Description of networks and labs involved
The experimentation took place in 10 co-creation labs spread across Europe. All 10 labs are members of one of the three networks mentioned in the following.

The Fab City Foundation

The community of Fab Labs spreads over more than 78 countries with approximately 1000 members including fabricators, scientists, educators and professionals of labs of all sizes from community-based small labs to research centers. Their common goal is the democratization of access to the tools for technical inventions and the spread of the culture of making. They are also experimenting with new approaches and engagement of stakeholders to create new urban models within the Fab City initiative.

European Network of Living Labs (ENoLL)

The European Network of Living Labs with headquarter in brussels, Belgium is composed of more than 400 recognised Living Labs as environments for open innovation and promoting co-creation, stakeholder participation and active actor involvement in real contexts.

European Network of Science Centres and Museums (ECSITE)

Ecsite connects science communication professionals from more than 400 institutions located in 50 countries. It connects member institutions through projects and activities facilitating collaboration and the exchange of ideas and best practices on current issues. Their members engage citizens in science fostering creativity and critical thinking to inspire and empower society (Table 2).

Table 2 Overview of the labs taking part in the experimentation

Lab	Description
Maker *Copenhagen (Denmark)* *Fab Lab*	*Maker* is a non-profit association with the core objective of connecting and supporting communities of makers and their methodologies to the public and new sectors to facilitate new relationships and collaborations among makers, civil society, private and public organisations as well as policymakers
Fab Lab Barcelona *Barcelona (Spain)* *Fab Lab*	*Fab Lab Barcelona* is a part of the Institute for Advanced Architecture of Catalonia supporting a variety of education- and research programs related to the human habitat on different scales. Its mission is the provision of access to knowledge, tools and financial means to foster technology-based and digital innovation and invention for the improvement of life quality
Polifactory *Milan (Italy)* *Fab Lab*	*Polifactory* is the makerspace inside Politecnico Milano as a multidisciplinary research lab between design, mechanical engineering, electronics and bioengineering. By the promotion of a new culture of making new ways of manufacturing and production systems are explored including areas like research, experimental and peer-to-peer education and cultural dissemination
PA4ALL *Novi Sad (Serbia)* *Living Lab*	Applying a multidisciplinary approach, *PA4ALL*, part of the Biosense Institute, is focused on Precision Agriculture operating between the fields of ICT, Agriculture, Environmental Engineering and Ecology Involving multiple stakeholders *PA4ALL* combines user needs with technology and innovative methodologies bring together users, public institutions, researchers and technology
ThessAHALL *Thessaloniki (Greece)* *Living Lab*	The Thessaloniki Active and Healthy Ageing Living Lab (*Thess-AHALL*) is governed by the Laboratory of Medical Physics of the Aristotle University of Thessaloniki operating in real community settings with a wide network of collaborators in Greece and the Balkan region. Adopting co-creation approaches they enable user-driven innovation in the field of Activity & Health
KTP *Krakow (Poland)* *Living Lab*	The Krakow Technology Park is a key actor in the development and implementation of Regional Innovation Strategies promoting user-driven innovation and smart specialisation. With an ecosystem of 300 companies they support innovative technology-oriented businesses at different stages of development with a variety of services testing their products and services in a Living Lab environment involving end users and a variety of stakeholders

(continued)

Table 2 (continued)

Lab	Description
Cube design museum *Kerkrade* *(Netherlands)* *Science Centers & Museums*	*Cube design museum* is part of Stichting Museumplein Limburg, a foundation that tells the story of the earth, sustainability, science, technology and design, in the context of society and education Cube's exhibitions are dedicated to design for human needs and ambitions including a lab to co-create with the public to provide open access to design tools and enhance their use for society
TRACES *Paris (France)* *Science Centers & Museums*	As a non-profit association between participatory science engagement and social inclusion and a strong orientation towards innovation in research *TRACES* aims to create space for reflection, experimentation and innovation for science in society, science education and communication
Ciência Viva *Lisbon (Portugal)* *Science Centers & Museums*	The Portuguese agency for public awareness of science and technology is a non-profit association in the fields of science awareness, science education and open science. One of its main focus is on ocean literacy
SGD *Dublin (Ireland)* *Science Centers & Museums*	*Science Gallery Dublin (SGD)* is a living experiment by Trinity College Dublin to encourage young people in an encounter of art and science. Unique exhibitions that allow participation and social connections of visitors while exploring different aspects of one topic

5 Support and Assessment Procedures

During their co-creation journey, the labs have received support from the various project members and partners of SISCODE to fully exploit all present capacities to combine the knowledge and abilities of practitioners and research partners. Apart from active support to acquire knowledge on co-creation and its potential application during the co-creation journey a peer-to-peer learning among labs and other interested partners has been fostered to enhance exchange on experiences, practices, issues and identified opportunities not only to confront with other, similar realities, but also to self-reflect on current practices and how they could be improved in the future.

One of the main struggles that RRI is facing when moving from theory to practice is the assessment of its impact within the context on application. To tackle this in the specific project, an assessment framework has been set up to gather, mainly qualitative data, from the pilots during their journey to monitor and evaluate their progress. Initially planned to measure solely the success of the single pilots, the assessment framework soon turned into an instrument to measure impact on a greater level retrieving data on changes and transformations caused in the pilots' organisations and ecosystems beyond the single prototype.

The assessment explores three different dimensions to be explored specifically, namely the ones of:

1. **Stakeholder engagement**, previously named as a fundamental aspect of the entire project being both a crucial part of RRI and co-design identifying and involving a variety of actors
2. **Co-creation,** the means for operationalisation and the base for the methodology applied in the overall project investigating the effectiveness and appropriation of the techniques and tools used
3. **Dissemination**, the opportunity and capacity to share successes and failures, practice knowledge exchange and foster capacity building beyond the project's borders.

Three tools have been developed to assess the dimensions throughout the process:

- **Excel spreadsheet** focused on the reporting of activities conducted and numbers of actors involved to keep track of direct outputs in the process
- **Self-assessment questionnaire** a questionnaire exploring the outcomes on a broader dimensions and from a qualitative point of view triggering self-reflection on current practices in the organisation as well as organisational change
- **Scenarios** to illustrate possible near futures to create an outlook on how the pilot could impact the organisation and the ecosystem in the long-term.

The goal of the monitoring and assessment activity is the evaluation of the single cases applying the three tools described previously either in a continuous way throughout the experimentation like done with the spreadsheet or accurately at specific points of the journey.

Its results are not only meant to assess the single prototypes, but also allow a comparison among them and feed broader reflections on the application of co-creation in RRI contexts and its impact assessment that is elaborated in the final chapter of this book.

To allow this comparison and further evaluation of the cases, it has been decided to elaborate them singularly as case studies after the conclusion of the prototyping phase. The following chapter goes in detail on the choice of the methodology and the guidelines developed to guide and regulate the writing.

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