Model of R&I Socialisation through Citizen Science

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Author(s) and Institution(s)	**Author: Luciano d'Andrea (K&I)** **Contributors: Claudia Colonnello, Fabio Feudo (K&I)**
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Acronyms

Acronym	Description
CS	Citizen Science
CSI(s)	Citizen Science Initiative(s)
CSOs	Civil Society Organisations
EC	European Commission
NGOs	Non-governmental organisations
PIs	Principal investigators
R&I	Research and Innovation

Summary

This report aims to present a conceptual and operational model for the socialisation of scientific research and innovation (R&I) through Citizen Science (CS), based on the lessons learned from the Step Change experience (in particular, mutual learning and monitoring and evaluation) and the contribution of the teams responsible for implementing the Citizen Science Initiatives (CSIs).

The report was produced through a process involving several stages: an analysis of the literature and of the elements that emerged during the mutual learning and monitoring meetings; the definition of a general theoretical approach; the sharing and discussion of this approach with the partners; a further discussion of the contents of the report in the context of an online seminar with the partners; the collection of empirical material in the context of the final evaluation workshops carried out with the CIS teams; the final drafting of the report.

The strategic core of the model is to achieve the mainstreaming of CS within European R&I organisations and systems, following the same approach successfully adopted by the European Commission (EC) for gender mainstreaming in the European Research Area or, more recently, with the Open Access approach.

The first chapter describes the context in which the CS mainstreaming proposal takes shape.

Since the 1990s, and even before, there have been profound changes in the way R&I is conducted. In contrast to the past, R&I has become an increasingly collaborative, interdisciplinary and multi-actor process, more focused on the production of knowledge that has or can have economic and social value. This shift towards an open social design of R&I is still uneven and uncertain. It is therefore necessary to develop policies aimed at the socialisation of R&I, i.e., the gradual adoption of Open R&I by all research institutions, scientists and innovators, as well as by key societal actors.

CS mainstreaming could be one of the main tools for socialising R&I. It is necessary for several reasons: to manage the non-neutrality of R&I; to access the non-scientific knowledge needed to address the increasingly complex issues that R&I is called upon to address; to better manage the increasingly intense and multifaceted relations between R&I and society; to adapt R&I to a society in which people no longer passively accept to be studied or to be recipients of new technologies.

The second chapter defines the components of the model.

CS mainstreaming is conceived as a strategy to achieve the involvement of social actors in the research process at all possible levels. This does not mean that citizens and stakeholders should always be involved in R&I, but that a participatory perspective should be integrated into every R&I policy, programme and project, to understand when and how participation is needed and when it is not.

CS mainstreaming is conceptually and operationally organised in three dimensions: the knowledge dimension (concerning the contribution of citizens and stakeholders to knowledge production), the participatory dimension (concerning the involvement and

interaction of citizens and stakeholders in R&I activities) and the institutional dimension (concerning the changes that need to be introduced in R&I organisations and systems to allow for the integration of participatory mechanisms). Each dimension has three specific components.

Finally, in Chapter 3, some emerging issues for each dimension have been highlighted and explored in more detail from a CS mainstreaming perspective.

Introduction

Step Change is a project funded by the European Commission in the framework of Horizon 2020. Launched in March 2021, it aims to implement five Citizen Science Initiatives (CSIs) in four European countries (Germany, Italy, United Kingdom, and Slovenia) and one African country (Uganda). Through the five initiatives, the project intends to investigate how citizen science can increase the quality of research and become more deeply rooted in research and society.

In the framework of the Step Change project, Task 9.3 is devoted to developing the "Model of R&I socialisation through citizen science".

The Model is aimed at collecting the new insights produced throughout the project about CS and how it can help support a better alignment of science and society, thus contributing to the socialisation of R&I. It is intended to be used both analytically and operationally and is aimed at different audiences, including administrators of research performing and funding organisations, policymakers, the research community and those involved in citizen science and participatory research.

The Model has been developed through a pathway made up of different steps.

a. An initial literature review was carried out, focusing on the current and future role of citizen science in the context of the transformations affecting science and innovation in the last decades (January-April 2023).
b. In parallel, an analysis was carried out of the results of the mutual learning sessions conducted in the framework of STEP CHANGE (which were the content of a specific report developed by ZSI; see here) and of the monitoring and evaluation sessions on the CSIs (January-June 2023).
c. A preliminary note defining the theoretical approach and the structure of the model was then drafted (April-May 2023).
d. The content of the note was presented and discussed with the project partners during a meeting in Munich (5-6 June 2023).
e. Based on the discussion, the model was further elaborated and discussed in an online meeting with the partners (23 November 2023).
f. Empirical material from the CSIs was collected during the last part of the five final evaluation workshops held between November 2023 and February 2024.
g. The Model was also presented at the project's closing event at the ECSA Conference 2024 (5 April 2024).
h. The final report was written between February and April 2024.

This report is organised into three sections:

- Mainstreaming Citizen Science
- Structure and features of the R&I Socialisation Model
- Emerging topics in CS mainstreaming.

Chapter One – Mainstreaming Citizen Science

1.1. Towards an Open R&I

Changes in R&I

Since the 1990s, and even before, there have been profound changes in the way R&I is conducted and its relations with the rest of society are also changing rapidly.

Various interpretive schemes have been developed to count for these changes (Post-academic science[1], Mode2 knowledge production[2], Post-normal science[3], Quadruple or Quintuple Helix approach[4]). Although different, these interpretative schemes converge in describing **R&I as an increasingly collaborative, interdisciplinary and multi-actor process**, more and more focused on the production of knowledge that has or can have economic and social value, transparent and open to public scrutiny and increasingly politically driven.

These changes reflect wider transformations affecting contemporary societies in the transition from modern to late modern societies[5] and can be understood as a response to the challenges posed by these transformations. Some of these challenges are identified in the box below.

EXAMPLES OF TRANSFORMATIONS CHALLENGING SOCIAL INSTITUTIONS

- **Decline in authority**. People tend to ignore, question or fail to recognise the authority and legitimacy of organisations and individuals representing institutions (in the case of science, scientists, and research organisations, but also scientific results)[6].
- **Diversification and conflicts**. Organisations representing institutions (in the case of science, for example, research organisations or research policy authorities) tend to be less aligned and consistent with each other, diversify, sometimes conflict with each other or enter into competition[7].
- **Peer-to-peer relations and negotiations**. Institutions tend to be less hierarchical and peer-to-peer relationships become more important. Institutional and organisational choices increasingly require negotiation between stakeholders at all levels[8].
- **Justification, transparency and accountability**. Institutions are increasingly required to justify themselves, prove their usefulness to the community, and be transparent and accountable for what they do and their consequences[9].
- **Blurring boundaries**. Boundaries between institutions, but also between actors, concepts, between languages, are increasingly porous and mobile. In the case of science, for example, it is increasingly difficult to define the boundaries between those inside and those outside science, the boundaries between disciplines, or the boundaries between knowledge and innovation[10].

Beyond the Standard research and innovation

For the sake of simplicity, the changes affecting R&I can be understood in terms of a shift from a **Standard** R&I to what can be referred to as **Open** R&I[11].

This shift mostly turns around the key question: who is entitled to make, speak of, decide on, and use R&I?

In Standard R&I, science is only done or led by scientists and innovation by innovators, whereas in Open R&I, science and innovation are matters that involve a wide range of citizens and stakeholders, including, e.g., policymakers, private companies, NGOs, civil society organisations, communities of different kinds and citizens at large.

The demand for 'lay' actors, i.e., non-scientists, to be involved in the production of scientific research and innovation is based on different motivations. Some of them are given in the box below.

MOTIVATIONS TO INVOLVE LAY PEOPLE IN R&I

- **Political democratisation.** Laypeople have the right to influence the decisions about science and technology and how their results are used, especially when they are directly exposed to the effects of these decisions[12].
- **Epistemic democratisation.** Laypeople have the right to their knowledge and expertise to be recognized in the production of scientific knowledge and innovation processes. This entails a redistribution of the "epistemic authority" between lay people and scientists[13].
- **Acceleration of innovation processes**. The close collaboration between research institutions, the private sector and the state shortens the time needed to move from scientific discovery to technological development, increasing the economic and social benefits of scientific products[14].
- **Complexity.** The complexity of the challenges contemporary societies are facing requires all social actors to cooperate in sharing information and co-produce new knowledge[15].
- **Empowerment**. The involvement of laypeople increases science literacy and leads to the empowerment of the citizenry[16].
- **Accountability and transparency**. The involvement of laypeople increases the accountability and transparency of R&I[17].
- **Trust and legitimacy**. The involvement of laypeople contributes to enhancing public trust in science and technology and increases the political legitimacy of R&I[18].
- **Alignment**. The involvement of laypeople favours the alignment of R&I with societal needs, values, interests, and expectations[19].
- **Leveraging social change.** The involvement of laypeople favours their engagement in initiatives to activate social change and motivate them to action[20].

Socialising R&I

Over the last two or three decades, the process of opening up R&I has been driven by different actors (research communities, innovators, heads of research organisations, etc.) through the development of a variety of policies and interpretative frameworks (see box below), which have collectively led to the involvement of citizens and stakeholders in R&I. The increased involvement of the EU has also played an important role.

SOME OF THE APPROACHES TO R&I PROMOTING OPENING SCIENCE TO SOCIETY

- **Ethical, legal, and social implications/aspects in science (ELSI/ELSA).** A research area aimed at anticipating and addressing the ethical, legal and social implications of emerging sciences.
- **Open Access.** Set of principles and practices aimed at granting free and open online access to academic information such as publications and data.
- **Responsible Research and Innovation (RRI).** An approach aimed at promoting scientific and technological processes that take into account and anticipate their effects and potential impacts on society and the environment within a broader perspective to align R&I to the values, needs and expectations of society.
- **Informal Science Education**. Experiences, settings, or programs that are designed, implemented, and assessed by a community of dedicated, trained practitioners outside the formal settings (schools, universities, etc.), including, e.g., lifelong learning initiatives, science communication campaigns, or interactive initiatives in science centres and museums.
- **Collaborative innovation**. Approaches aimed at promoting innovations through collaborative mechanisms involving multiple players, including users and suppliers.

- **Knowledge brokerage**. Set of approaches and practices geared to favour the transfer, exchange and co-creation of knowledge among scientific and non-scientific actors.
- **Smart Specialisation Strategy (S3)**. Innovation policy concept that aims to boost regional innovation**,** contributing to growth and prosperity by helping and enabling regions to focus on their strengths. Smart Specialisation is based on partnerships between businesses, public entities and knowledge institutions.
- **Transdisciplinary research.** Institutional changes and research practices aimed at overcoming the discipline-based organisation of research institutions and culture to enable science to engage more fully with societal challenges.
- **Quadruple Helix Model**. Practices and approaches aimed at the involvement of science, policy, industry, and society in the innovation system.

However, the shift towards Open R&I is uneven[21]. The following should be considered.

- Entire areas of science and innovation have been only minimally affected by these changes.
- Many R&I researchers and organisations do not have the skills and expertise and are not organised to apply participatory mechanisms in their projects.
- Open R&I, when badly managed, can also produce (and is producing) inequalities, contradictions, risks, and unexpected consequences.
- Open R&I often meets with resistance and obstacles, elicits negative reactions, or is applied in a tokenistic manner.
- Few civil society organisations see R&I as a way to address societal challenges and have some cooperation agreements with research and innovation actors.
- Finally, although practices and experiences leading to openness are flourishing, many aspects of R&I are still to be developed, tested, and evaluated.

In such a context, there is a strong need for the **socialisation of R&I**[22], i.e., progressively bringing all research institutions, scientists, and innovators as well as the key social actors to adopt an Open social setup of research and innovation.

Socialisation approaches

As highlighted above, the transition to Open R&I is already underway and much is happening.

We can observe **two main approaches** to the socialisation of R&I.

The dominant one is the **neoliberal approach**[23]. It is based on a free market view of science and innovation and the adoption of organisational models imported from the corporate world (New Public Management). Components of this strand can be seen in many aspects of the current organisation of R&I:

- Increased competition among research institutions, research networks and researchers on a global scale for access to positions, publications and resources
- Accelerated links between science and innovation
- Adoption of competitive approaches to assessing research quality (ranking, use of impact factors as the dominant parameter, etc.)
- Creation of hybrid organisations linking research, policy and industry
- Marketing-like approach in scientific communication and language.

The less deeply rooted approach is the **responsibility-based approach**[24]. It is rooted in the idea that science and innovation can bring benefits but can also cause harm and undesirable effects that may affect certain groups of people. It is therefore important to reduce the margins of uncertainty by increasing participation and democratising R&I processes. Components of this strand include:

- Increased collaboration between scientists and citizens
- Anticipation of the impact (negative or positive) and benefits of new scientific findings and technological discoveries
- Attention to the social impact of R&I on marginalised groups and inclusion/exclusion dynamics
- Alignment of R&I objectives, processes and outcomes with societal values and expectations
- Enlarging the role of citizens and stakeholders in steering R&I
- Inclusion of social and ethical considerations in R&I assessment procedures.

Although these two strands are usually understood as opposite to each other, they intersect at several points (e.g., the priority of utilitarian research) and coexist. However, more often, they produced conflicts (e.g., open access versus the proprietary vision of research results) and short-circuits (for example, the neoliberal competitive approach leads to forms of exploitation of young researchers, especially the most vulnerable ones, thus misaligning research and innovation from European values) which have even serious consequences on R&I systems.

An R&I socialisation measure should also serve to address these problems by creating greater synergies and a better balance between the two approaches.

1.2. R&I socialisation and Citizen Science

Within the framework described in the previous section, Citizen Science (CS) could play a key role in accelerating and guiding the socialisation process.

The basic tenet of the R&I socialisation model proposed here is that such a role is so important to make it necessary to **mainstream CS in all R&I institutions and policies**.

CS mainstreaming can be understood as a strategy to achieve the involvement of social actors in the research process at all possible levels that are useful for improving the intrinsic quality of research and its capacity to produce and use scientific knowledge for innovation.

However, the need for CS mainstreaming must be explained and detailed. To this end, three issues will be considered:

- Why should CS be mainstreamed?
- Is it realistic to think about mainstreaming CS?
- Why could CS mainstreaming fail?

Why Citizen Science should be mainstreamed?

CS is one of the approaches emerging from the participatory turn in R&I management. This turn is usually motivated by the pursuit of different objectives, such as promoting

democratisation and inclusiveness in science and innovation, promoting scientific literacy, raising public awareness of scientific and technological issues, or carrying out research programmes with samples and geographical scales that could not be guaranteed by professional researchers alone.

However, from the perspective of this model, CS seems to play a special role. It is the only participatory approach to R&I that **explicitly considers citizens as scientists**, i.e., as direct contributors to the generation of scientific knowledge[25]. Through CS, citizens gain access to all the basic mechanisms of scientific knowledge production, including those previously available only to professional scientists, such as identifying research needs, developing research projects, generating hypotheses, collecting data, interpreting research results and defining their scientific use.

It is precisely this equation between professional scientists and citizen scientists that is the real innovation of CS. In highly fragmented and diversified societies like ours, Standard R&I may no longer be sufficient to ensure high-quality research and innovation. Open R&I can do it. To be successful, however, Open R&I needs that citizens and stakeholders should be allowed to access all stages and mechanisms of knowledge production and innovation, whenever this proves necessary or useful to achieve better and more reliable results.

Mainstreaming CS is therefore important because citizen participation is more important for science than for citizens themselves. It is not a political or cultural question, but a question of the very quality of R&I in a changing social context.

Many arguments could be put forward in this regard. Four of these deserve particular attention.

- **R&I is not neutral**. R&I has long been seen as neutral, i.e., not based on underlying interests and prejudices, but driven solely by scientific curiosity and rational processes. There is now ample evidence that this view is wrong. R&I is not neutral at all[26]. It always operates based on non-explicit assumptions, interests and viewpoints and produces and reproduces stereotypes, prejudices and forms of discrimination, based on, e.g., gender, sexual orientation, or national belonging. The involvement of citizens and stakeholders therefore has an epistemic role. It serves to balance the often non-explicit point of view of researchers and innovators with that of other actors, be they citizens, policy-makers or private entrepreneurs, and to prevent R&I from being subordinated to particular interests or points of view. This does not mean achieving neutrality, but greatly reducing bias by incorporating multiple points of view into R&I processes.

- **R&I addresses complex issues**. R&I is increasingly called upon to address the problems facing contemporary societies. However, in an interconnected, globalised and fragmented world, these problems are inherently complex and cannot be addressed without systematically integrating other forms of knowledge (technical, experiential, socially "situated") into research and innovation[27]. There is a risk of producing unreliable or incomplete knowledge and inapplicable scientific results. In short, research and innovation address problems that are too complex to be solved by scientists and innovators alone.

- **People are no longer passive**. In late modernity, people no longer passively accept being studied or receiving new technologies without being involved. This leads to

different behaviours (participation, protest, refusal, active opposition) that often make R&I processes difficult to manage. CS mainstreaming can be useful to regulate and address these trends by systematically creating spaces for participation in all phases of R&I processes, even if this may mean tackling more complicated research and innovation pathways.

- **R&I-society relations are growing intense and unregulated**. The boundaries between science, politics, innovation and societal actors have become increasingly porous and flexible and the interactions between R&I and society are growing intense and unregulated[28]. This trend is leading to greater involvement of citizens and stakeholders in research and innovation. However, this could also make research and innovation more fragile, more vulnerable to external influences and interests, and more contested or questioned. CS mainstreaming should play a key role since it can provide tools and practices to manage this interaction in knowledge production, countering both antiscientific and positivist positions.

Is Citizen Science mainstreaming realistic?

Another issue to be considered is whether mainstreaming CS is a realistic perspective to propose or whether it is simply a kind of 'wishful thinking'. Three arguments can be used to support the thesis that CS mainstreaming is at least possible.

- **Citizens' involvement is already a powerful trend**. The first argument is that, in an increasingly technologically based society, the involvement of citizens and stakeholders is a consolidated social trend which manifests itself in many ways. Their engagement is also supported by many European policies. CS mainstreaming is therefore already rooted in existing social processes that influence research and innovation and can also be seen as a way to manage, regulate and guide them appropriately. Moreover, the new generations of researchers are more likely than their predecessors to promote and manage participatory processes and to consider citizen science or other forms of participatory science as standard practice[29].

- **Mainstreaming policies have already been implemented in the past**. The second argument is that mainstreaming processes have already been successfully implemented in the European Research Area. This is the case, for example, of gender mainstreaming policies[30], which are now leading to the integration of gender equality practices into R&I organisations and gender considerations into R&I content. Similarly, Open Access policies are increasingly being adopted at national and organisational levels. They show that mainstreaming policies are feasible and how they can be implemented.

- **There is a demand to better manage the relationship between R&I and society**. The third argument is that researchers and innovators are increasingly expressing the need for an open approach to the relationship between science and society[31]. For example, in areas such as climate change research, clinical research or research on technological change, researchers and innovators are addressing issues where the social, scientific and technological aspects are so intertwined that they require both an interdisciplinary approach and the use of knowledge held by citizens and stakeholders.

Why could Citizen Science mainstreaming fail?

Although CS mainstreaming could be considered realistic, it is not easy to achieve. Many factors could cause it to fail, and it would be useful to focus on them.

We can highlight some of them.

- **Researchers' understanding of participation**. Many researchers may not see participation as relevant, and certainly not as relevant as other aspects of research activities. Citizen participation can also be interpreted differently. For example, participation in R&I is often associated with simply communicating research results as widely as possible. The same notion of citizen science is understood in different ways and not necessarily as involving citizens and stakeholders in the most relevant parts of the research process.

- **Lack of skills and support**. Many researchers and innovators see participation as an issue that they cannot handle because they lack the appropriate skills or as a component of the research process for which they are not responsible. This leads them to resist the introduction of participatory mechanisms in R&I. This is also because they almost always have to deal with the issue alone, without the support of their organisation.

- **Conflicts between neoliberal and responsibility-based views of participation**. As mentioned above, the coexistence of a neoliberal and a responsibility-based approach to Open R&I can create tensions and conflicts between different ways of understanding and practising participation and citizen science, with the effect of slowing down or hindering the whole process[32]. Citizen science is also applied from a neoliberal perspective, although with specific motivations (e.g., to increase the efficiency and performativity of the R&I process) which are not always consistent with, for example, the understanding of citizen science as a form of democratisation that is more typical of a responsibility-based view.

- **Conflicts between different participation approaches**. As mentioned above, there are many different approaches (public engagement, knowledge brokerage, the different forms of action research, smart specialisation strategy, etc.) to citizen participation in R&I. Behind each of them there is a community of researchers and practitioners, specialised publications and journals and specific research institutions. One of the possible risks is that tensions and conflicts may arise between these communities, despite there being a strong convergence and many synergies between all the approaches highlighting the role of citizen participation. The very idea of mainstreaming citizen science may be poorly accepted precisely because it seems to privilege one approach over others. Terms such as 'mainstreaming participation' or 'mainstreaming participatory approaches' may be more acceptable.

- **Resistance from R&I institutions**. CS and participation in science can change established power relations. For example, CS leads to the inclusion of points of view different from those of researchers or research funders, thus requiring forms of compromise between the different actors involved, in defining the objectives of a project or the use of its results. For this reason, the mainstreaming of CS can generate forms of resistance precisely because it affects the power and autonomy of research and innovation institutions.

TO SUM UP

- A shift is occurring from the Standard to an **Open model of R&I**, i.e., an R&I open to the contribution of citizens and stakeholders.
- This process has been promoted by the actions of many actors through different strategies (ELSI, Open Access, Strategy for Responsible Research and Innovation, etc.). However, **Open R&I is still underdeveloped**: it is not widespread, it faces resistance and obstacles, and important aspects of it have not been fully developed, tested or evaluated.
- There is a need for **R&I socialisation**, i.e., the gradual adoption of Open R&I by all research institutions, scientists and innovators, as well as by key societal actors.
- **The socialisation of R&I is already taking place but in different ways**. Two main strands of socialisation are emerging: the neo-liberal strand, based on increasing competition and the adoption of organisational models imported from the business world; and the responsibility-based strand, based on the idea that R&I can bring benefits but also cause harm and undesirable effects. These two strands intersect at several points, both creating synergies, conflicts and short-circuits.
- **Citizen science could play a key role** in managing and guiding these transformations. Unlike other approaches, CS explicitly sees citizens and stakeholders as scientists and considers their involvement necessary to produce high-quality research and effective innovation.
- Hence the need for **mainstreaming Citizen Science**. It is intended as a strategy to achieve the involvement of social actors in the research process at all possible levels that are useful for improving the intrinsic quality of research and its capacity to produce and use scientific knowledge for innovation.
- **CS mainstreaming is needed for various reasons**, e.g., to manage the non-neutrality of R&I; to access the non-scientific knowledge needed to address the increasingly complex issues that R&I is called upon to address; to better manage the intense and multifaceted relations between R&I and society; to adapt R&I to a society where people no longer passively accept to be studied or to be recipients of new technologies.
- Several considerations can be put forward to make **CS mainstreaming a viable strategy**. It is based on a strong trend (citizen participation in R&I is already taking place), mainstreaming policies have already been implemented in the past, and there is a widespread demand to better manage the relationship between R&I and society.
- However, **several factors could lead to the failure of CS mainstreaming**, including different and conflicting interpretations of participation, lack of skills and support to implement mainstreaming, conflicts between neoliberal and responsibility-based views of participation, conflicts between different participatory approaches, and resistance from R&I institutions due to changes in power relations.

Chapter Two – Components of the model

This report aims to define a model for socialising R&I through Citizen Science. The first chapter presented the basic choice of the Model, i.e., the mainstreaming of CS. This chapter discusses the **components of the Model**, showing how conceptually a mainstreaming policy can be realistically developed.

The Model's components are as follows:

- The definition of CS mainstreaming
- The dimensions of CS mainstreaming.

2.1. The definition of CS mainstreaming

As we anticipated above, CS mainstreaming can be understood as a strategy to achieve the involvement of social actors in the research process at all possible levels that are useful for improving the intrinsic quality of research and its capacity to produce and use scientific knowledge for innovation[33].

This definition deserves to be commented on.

Mainstreaming means systematically addressing the issue of participation

Based on the definition above, CS mainstreaming does not mean that citizens and stakeholders should always be involved in R&I.

The mainstreaming of a participatory perspective does not necessarily mean always including participation in all aspects, policies, programmes or phases of R&I. Participation can be included only when it is relevant, i.e., useful to produce higher quality R&I. If this is not the case, involving people and stakeholders could be unnecessarily costly and risky and lead to frustration and fatigue.

More practically, all actors in research and innovation – from decision makers to individual researchers – should be helped to systematically address the issue of participation, and ask themselves whether and, if so, why the participation of citizens and stakeholders should be necessary or not necessary and, in case, which is the most appropriate way to do so.

Mainstreaming is not just about recognition

The definition given above also helps to distinguish between mainstreaming CS and recognising CS.

Over the last decade, many actors, including the European Commission, have made great efforts to promote CS. More recently, attention has been also devoted to the need to mainstream citizen science.

However, the concept of mainstreaming is largely intended as a policy action aimed at transforming "Citizen Science from an emergent field facing developmental challenges to a mature field of research and citizen practice"[34]. In other words, mainstreaming means recognising and disseminating citizen science as one of the options available within standard research and development.

The mainstreaming perspective proposed here is broader. Mainstreaming means no longer thinking of CS as an accepted way of doing R&I but as a stable component of any R&I initiative. More precisely, it is the component in which consideration is given to whether, why, to what extent and how to involve citizens and stakeholders in a given R&I project, programme or process. An 'explain and apply' approach should therefore be adopted, encouraging researchers to explain why they do or do not consider the involvement of citizens and stakeholders necessary for the specific research project they are proposing. This approach has already been taken, for example, in the case of gender and sex variables in research content or in dealing with ethical aspects of research and innovation.

Therefore, CS mainstreaming does not reflect the need to recognise the maturity of citizen science, but on the contrary, to recognise the current immaturity of Standard R&I in taking seriously the contribution of citizens and stakeholders in producing new and usable scientific knowledge.

Mainstreaming is not just Citizen Science

Thirdly, the definition given above also highlights that CS mainstreaming is not just about knowledge but, more broadly, the participation of citizens and stakeholders in R&I processes, in a peer-to-peer relationship with professional scientists and innovators.

In this sense, CS mainstreaming means mainstreaming all possible forms of engagement in R&I developed under any possible concepts and approaches such as Public Engagement with science and technology, the Smart Specialisation Strategy or Knowledge Brokerage. CS mainstreaming means mainstreaming the participation of citizens and stakeholders at any level and in any form appropriate for the advancement of science and innovation.

Indeed, the concept of CS itself is quite broad, as it considers any form of participation of citizens and stakeholders in R&I, even if limited to a specific task or phase. As such, it largely overlaps, converges or interacts with other concepts and approaches focusing on people's participation in science and innovation.

2.2. The dimensions of CS mainstreaming

In the context of this Model, the term 'dimensions' refers to specific areas of activity in which the CS mainstreaming process is considered necessary.

Three key dimensions have been identified[35]:

- The Knowledge Dimension
- The Participatory Dimension
- The Institutional Dimension.

The three dimensions are closely intertwined and partly overlap. However, they can be considered separately as they require different types of action and specific expertise to address.

Knowledge Dimension

The Knowledge Dimension concerns the identification, application and exploitation of citizens' and stakeholders' knowledge, know-how, skills and points of view in the R&I process. Thus, this dimension mainly focuses on epistemic dynamics, i.e., the dynamics involved with the production and validation of scientific knowledge. There are three main components to be addressed in this dimension.

- **Knowledge identification**. The first component is to identify and "hook" the type of knowledge that citizens can provide or contribute to generate. There is a risk that this knowledge will not be recognised as useful and relevant or will be overlooked. The main risk of this first component is to activate citizen and stakeholder involvement processes that do little to enhance the scientific or innovative quality of the R&I project. Probably the easiest way to address this aspect is to map the knowledge needs (including points of view, know-how and skills) at the different stages of the research and innovation process that the project promoters cannot secure or produce alone.

- **Knowledge management**. A second component is the management of the contribution of citizens and stakeholders in the knowledge production process. For a variety of reasons, such input may be marginalised, misunderstood, mistreated, or simply wasted throughout the R&D process. There are relevant factors to consider, such as how to manage knowledge gaps between professional scientists and citizen scientists, which approaches and techniques (among the many available) are most appropriate for knowledge sharing and co-creation, or how to modulate the use of knowledge provided by citizens at different stages of R&I.

- **Knowledge application**. This component is concerned with the processing, brokerage and communication of the knowledge produced so that it can be used for scientific purposes or to promote change at societal, technological or policy levels. This component also addresses how the contribution of citizens and stakeholders to the R&I process is recognised, e.g., through scientific publications or patenting of newly developed solutions.

Participatory Dimension

The Participatory Dimension concerns the involvement and interactions of citizens and stakeholders in R&I activities. Therefore, this dimension focuses mainly on the configurations of actors generated in and around the R&I process. In this dimension, too, three main components are worthy of consideration.

- **Mobilisation**. This component concerns the mobilisation process, i.e., the identification, recruitment and retention of citizens and stakeholders. The risks associated with the mobilisation process are many, including a lack of continuity in participation, low levels of participation with negative impacts on the quality of outcomes, prolonged implementation times of R&I initiatives, a reduction in the quality of citizen scientists' contribution to the R&I process or the difficulties to involve all the relevant citizens' groups and stakeholders. Mobilisation is linked to a wide range of variables, such as means of communication, languages used, trust in the promoters of R&I initiatives, motivations and expectations of citizens and stakeholders, incentives for participation, recruitment procedures, and ethical and legal issues related to participation.

- **Social configurations**. This component refers to the interactions between the different groups of stakeholders in research and innovation initiatives and the resulting social configurations. There is a risk that these interactions may create tensions and conflicts, lead to complex and time-consuming negotiations or, in any case, be poorly collaborative and not very productive. The introduction of participatory mechanisms in R&I inevitably affects existing power relations, especially those between professional scientists and citizen scientists. This could particularly affect vulnerable groups, who may find it more difficult to participate and make their voices heard.

- **Impact management**. This third component concerns the production and management of the impact (actual or potential) of research and innovation. The risk is that the results of the research and innovation initiative are not usable or, if usable, are not used to achieve the expected social, economic or political objectives. This can happen mainly because the interests of the different actors involved tend to diverge. Professional scientists are mainly interested in the scientific exploitation of the results (production of scientific publications), citizens and stakeholders are usually more interested in their social and political exploitation, while companies are more interested in their economic exploitation. This dimension is closely related to that of "knowledge application". However, while the latter is concerned with how the knowledge produced is linked to possible applications and scientific exploitation, the "impact management" dimension focuses on how the different actors involved (and other possible new actors) are involved in the political, social or economic use of the knowledge produced by the CS project.

Institutional Dimension

The Institutional Dimension concerns the changes that need to be introduced in research organisations, research funding systems and research policies to allow for the mainstreaming of participatory mechanisms in R&I.

Therefore, if the Knowledge Dimension focuses on epistemic dynamics, and the Participatory Dimension on social configurations, this dimension focuses on organisational and policy-related issues. In this dimension, too, three main components are worthy of consideration.

- **Culture**. The first component concerns the interpretation, perception and visibility of CS. Despite the many advances made in recent years, also thanks to EC support policies, CS in R&I is still not considered a structural aspect of research and innovation activities, but a marginal one, or it is often completely ignored. Changing these interpretations is necessary to make the CS mainstreaming perspective realistic, e.g., by changing the narratives of R&I, and the images and symbols used to describe R&I (science is symbolically represented by people in lab coats and innovation by engineers in helmets, and very rarely as a collective endeavour involving lay people), or by increasing the visibility of CS in public communication (e.g., on the websites of research institutes or research funding bodies) and in scientific and policy communication.

- **Practices**. Many approaches, tools and methods have been developed and tested to facilitate and manage citizen participation at all stages of research and innovation. This component concerns their dissemination and integration into standard R&I activities, in particular for researchers and innovators who are not sensitive to or interested in citizen participation. The risk is that CS and participatory practices will ultimately circulate only within a few circles of interested researchers and innovators. This process

can take place through a variety of means, such as formal and informal teaching, the exchange of practices between research groups, access to resources, guidelines and toolkits, the integration of these practices in research groups and the inclusion of CS practitioners in research and innovation teams.

– **Structures**. The third component of the institutional dimension concerns the introduction of new structures that allow for the institutional embedding of CS mainstreaming in R&I institutions. This component takes into account any form of long-term change affecting structures at any level of the R&I systems (new offices, roles, tasks, norms, protocols, procedures, etc.).

An overview of CS mainstreaming dimensions

The proposed model of R&I socialisation through CS comprises three dimensions, which are conceptually autonomous but closely interlinked. Each dimension includes three components. This organisation of the model is shown in the diagram below.

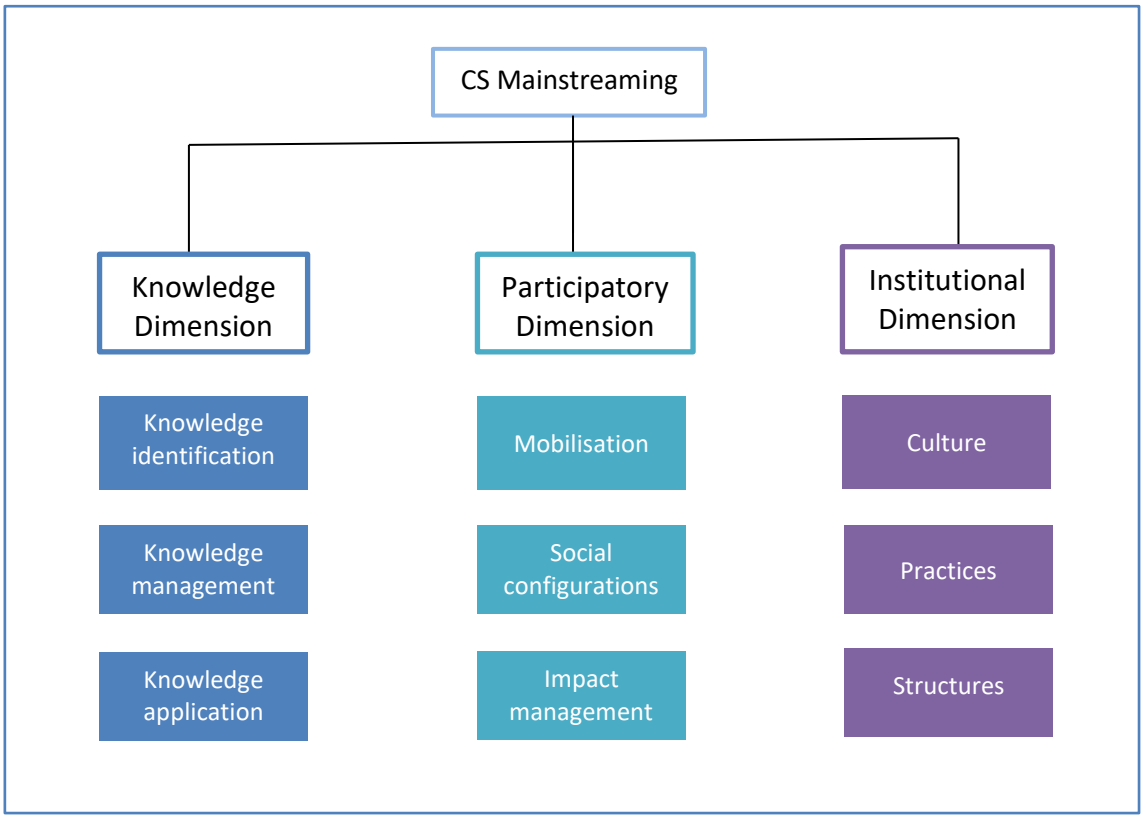

Figure 1 – Structure of the CS Mainstreaming Model (Source: K&I, 2024)

TO SUM UP

- The model for socialising R&I through citizen science comprises **two elements**: a **vision** of CS mainstreaming and **three dimensions** of CS mainstreaming.
- CS mainstreaming can be defined as a strategy to **achieve the involvement of social actors in the research process at all possible levels that are useful** for improving the intrinsic quality of research and its capacity to produce and use scientific knowledge for innovation.
- Based on this definition, CS mainstreaming does not mean simply recognising CS as a mature field of research and civic practice, but rather recognising CS as a stable component of any R&I initiative. Moreover, CS mainstreaming does not only refer to citizen science, but to any possible concept and approach that promotes the participation of citizens and stakeholders in R&I. Rather, **CS mainstreaming means systematically addressing the issue of participation in R&I projects, programmes or policies**, even if the final decision does not include participatory mechanisms.
- **Three dimensions** of a CS mainstreaming action have been identified: the knowledge dimension, the participatory dimension and the institutional dimension.
- The **Knowledge Dimension** concerns the contribution of citizens and stakeholders in knowledge production). Three main components can be singled out: **Knowledge identification** (identification of the type of knowledge that citizens can provide or contribute to the production of new scientific knowledge); **Knowledge management** (management of the contribution of citizens and stakeholders in the knowledge production process); **Knowledge application** (processing, brokerage and communication of the knowledge to be applied and the recognition of the contribution given of citizens and stakeholders to the R&I process).
- The **Participatory Dimension** concerns the involvement and interaction of citizens and stakeholders in R&I activities. This dimension includes three components: **Mobilisation** (the identification, recruitment and retention of citizens and stakeholders); **Social configurations** (the interactions between the different groups of stakeholders in research and innovation initiatives and the resulting social configurations); **Impact management** (the management of the actual and potential impact of R&I).
- The **Institutional Dimension** concerns the changes that need to be introduced in R&I organisations and systems to allow for the integration of participatory mechanisms in R&I. This dimension has three components **Culture** (changes concerning the interpretation, perception and visibility of CS in R&D by all actors concerned); **Practices** (changes concerning the inclusion of CS-related practices in the usual practices adopted in R&D); **Structures** (the introduction of new structures that allow the institutional embedding of CS mainstreaming in R&D institutions).

Chapter Three – Emerging topics in CS mainstreaming

Under Step Change, five CS initiatives in as many countries (Germany, Italy, Slovenia, Uganda, and the UK) have been implemented. Although different in approach, objectives and content, these initiatives faced similar problems and developed comparable solutions. This has provided an opportunity to draw some lessons and develop some common reflections on how the CS mainstreaming process might take shape and what obstacles it might encounter.

This chapter aims to highlight some of the topics related to CS mainstreaming that have emerged from Step Change's experience, also interpreted in the light of the current debate on the present and the future of citizen science[36]. It is organised according to the three dimensions of CS mainstreaming presented in the previous chapter, i.e., Knowledge Dimension, Participatory Dimension, and Institutional Dimension.

3.1. Emerging topics in the Knowledge Dimension

Epistemic added value

There is a tendency to think of citizen scientists as ordinary citizens. However, citizens are rarely ordinary. They usually have professional expertise, experience and knowledge that is often extremely important for the implementation of the R&D project. Their potential contribution also depends on the social groups they belong to, the professional roles they play and the direct knowledge they have about specific conditions, facts or events. This means that citizens and stakeholders should not be selected at random or because of their desire and interest to be involved, but also based on the type of knowledge and skills they potentially have. This requires the promoters of R&I projects to define an engagement strategy, starting from the identification of the knowledge needs of the project and the assessment of the epistemic added value that each citizen, group of citizens or stakeholder can provide in the different phases of the R&I project. This also means taking into account social groups that are rarely considered valuable knowledge bearers and producers, such as people at risk of exclusion or socially marginalised. From a CS mainstreaming perspective, the inclusion of an engagement strategy as an integral part of each R&I project could be particularly beneficial in helping researchers understand what the scientific benefits associated with CS could be.

Scientific quality of data

For favouring the mainstreaming of citizen science, it is of pivotal importance to ensure that the quality of the scientific and innovation process is not negatively affected by the involvement of citizens as scientists. However, it is also important to consider the reverse, i.e., how a lack of citizens' and stakeholders' involvement can lead to the production of unreliable scientific results or bad innovations. Indeed, in many cases, the expertise of non-scientific actors is pivotal to preventing the project from producing, for example, incomplete data or partial interpretations. From the perspective of CS mainstreaming, it would be necessary to apply the mechanisms for verifying the quality of the research and innovation process, making use of those already in place, to detect both situations, i.e., those where its quality is low due to the involvement of citizens and those where it is low due to their lack of involvement.

Peer-to-peer knowledge exchange

The underlying assumption of CS is that professional scientists and citizen scientists can engage in a peer-to-peer relationship to produce scientific knowledge. Step Change's CS initiatives show that this kind of relationship does not happen automatically, but requires certain conditions to be met. Some of them are proposed below.

- **Training**. One of the conditions is that citizen scientists are able to understand the scientific questions addressed by the CS project and processional scientists are able to interact with citizens and stakeholders. The best way to ensure this is to provide appropriate training. However, two important aspects should be emphasised. The first is that training is always an exchange and often offers professional scientists the opportunity to learn new and unexplored aspects of the topics of their project. The second is that training is not always necessary. Often, the citizens involved are already aware of the problems to be addressed and are prepared to handle the scientific or technical concepts used to address them. Similarly, professional scientists often have direct experience of communicating and working with citizens and stakeholders.

- **Time management tailored to citizen scientists**. Another condition is that the organisation of project activities is tailored to the needs of citizen scientists. Typically, citizen scientists are volunteers and the time they can devote to the project is usually limited. Professional scientists, on the other hand, are paid to carry out research and may be able to devote as much time as necessary to the project. This imbalance in the intensity of commitment often makes it difficult to establish a peer-to-peer relationship between professional scientists and citizen scientists. The key issue, therefore, is to organise the project timeline from the outset in a way that allows for knowledge exchange between them, and, if necessary, to identify specific moments (workshops, co-creation sessions, living-lab sessions) in which this process can take place.

- **Shared control over the results of the project**. If control over the scientific quality of the results inevitably remains in the hands of professional scientists as a matter of competence, citizen scientists must also be able to exercise control over the use of the knowledge produced with their contribution. This can be done in different ways. For example, workshops or other types of meetings are often organised to allow citizen scientists to discuss the results of the project with professional scientists and their use. In other cases, citizen scientists contribute to the peer review of the scientific reports and articles produced or participate directly in their production.

Interdisciplinarity and citizens' involvement

There is a strong link between interdisciplinarity and CS. Both interdisciplinarity and CS require professional scientists to be open to dealing with knowledge based on assumptions, concepts and even values different from their own. Both are necessary to address major societal challenges. This is not to say that CS always requires an interdisciplinary approach. However, there is no doubt that CS is greatly facilitated by an interdisciplinary approach and, in turn, the inclusion of participatory mechanisms as a standard requirement of R&I programmes may favour the interdisciplinary approach. This link between interdisciplinarity and CS can play a key role in mainstreaming CS in science and innovation and should be better explored.

IT technologies and citizens' participation in knowledge production

It has often been highlighted how the recent diffusion of CS approaches is also due to the use of IT technologies. In many R&I projects, citizens are involved through specific applications that allow them to act as "sensors" or data collectors. The use of web-based platforms allows thousands of individuals to be involved in R&I, to propose ideas and to contribute to the interpretation of data. These technologies could play a key role from a CS mainstreaming perspective, but their potential should be better analysed: they allow two-way communication at a distance between professional scientists and citizens, thus facilitating the engagement of the latter; they give citizens direct access to knowledge, information and training resources that could facilitate their engagement in R&I projects; they also now make it possible to carry out complex forms of online knowledge exchange involving many people from different backgrounds, thus saving time and reducing costs.

3.2. Emerging topics in the Participatory Dimension

Complexity of the recruitment process

One of the most problematic aspects of citizen participation in R&D is the recruitment of citizen scientists. It can be lengthy, involves a lot of communication and networking activities, and requires skills and know-how that CS project promoters may not have. From a CS mainstreaming perspective, the complexity of the recruitment process can be a real barrier and discourage researchers and innovators from involving citizens and stakeholders. There is a need to develop effective strategies to make the skills and capacities for mapping stakeholders and planning the recruitment process widely available.

Incentives to participate

Another key aspect is the incentives for citizen scientists to participate. Citizens are expected to participate in the R&I project voluntarily, without monetary or non-monetary compensation, driven only by their motivations, whatever they may be. However, from a CS mainstreaming perspective, the whole issue should be explored further. If citizen and stakeholder participation were to become, if not systematic, at least much more widespread and intense, it might be considered necessary to also consider paid forms of citizen participation. This is even more important for the participation of members of marginalised groups who, compared to other groups, have more obstacles to overcome in order to participate in CS initiatives. New solutions should be developed to prevent citizens from becoming "professional citizens", but also to prevent them from being exploited or burdened with responsibilities for which they are not paid.

Expansion of citizens' roles

A third aspect to consider is the role of citizen scientists in R&I projects. In the majority of cases, citizens are mainly involved in the data collection phase, while they are less involved in the project design and data analysis phases. There are certainly objective conditions that limit citizens' involvement in the project design and data analysis phases (e.g., lack of adequate scientific skills). However, this is also due to the way CS projects are initiated and funded. To submit a proposal, applicants are asked to provide a detailed research plan, including a description of how citizen scientists will be recruited and involved. In this way, citizen scientists can only start to participate at a fairly advanced stage of the project, i.e., when its objectives, research questions, research methods and exploitation of results are

already defined. In this context, it may also be difficult to encourage the involvement of citizen scientists in data analysis, as the methods for doing so are already established. Therefore, to promote CS mainstreaming, it is necessary to broaden the role of citizen scientists and to find practical solutions that allow their involvement from the beginning of the R&D project.

Trust-based relationships

As highlighted in Chapter One, the authority of science is increasingly being questioned for a variety of reasons. A more intensive and systematic involvement of citizens in R&I could also have as a by-product an increase in trust in science and innovation. However, this will only be possible if trust-based relationships are established within R&I projects between all actors involved (research organisations, researchers, citizen scientists, stakeholders, policymakers, etc.). This is an issue that deserves particular attention, especially for mainstream CS. Based on Step Change's experience, we can identify some factors (in addition to the reputation of the promoting organisation) that could foster trusting relationships, such as:

- Making explicit the benefits that citizen scientists can gain from participating in the project (e.g., learning, contributing to environmental change, meeting new people)
- Ensuring transparency about objectives and how results will be used
- Defining clear procedures for recognising the contribution of citizen scientists
- Respecting privacy requirements
- Taking into account the needs of individual citizen scientists (e.g., when organising workshops or scheduling meetings)
- Ensuring sufficient time and opportunities for citizen scientists to express their opinions and to discuss with each other or with researchers
- Including citizen scientists in feedback loops so that they can understand how and to what extent their contribution has been taken into account
- Creating opportunities for citizen scientists to express criticisms about how the project is organised and involving them in the project monitoring and evaluation process.

Languages and cognitive frames

One of the most recurrent difficulties in CS projects is that the different actors involved use different languages and different cognitive frames. For example, a solar panel has different meanings and is described in different ways by a researcher, a technology developer, a local administrator, an environmental activist and a user of electricity services. This is also the case when their R&I interests converge (e.g., they all agree to promote the diffusion of solar panels). From a CS mainstreaming perspective, this type of problem should be addressed systematically, with activities aimed at promoting the diffusion and use of knowledge brokering skills among researchers and innovators, or the involvement of professional knowledge brokers. Equally important, the R&I process could include opportunities for discussion to identify and address linguistic and interpretive differences between the actors involved.

Intermediary organisations

Step Change's experience shows that in many cases the implementation of CS-based R&I projects is facilitated by what could be called "intermediary organisations", i.e., organisations that, in a given social environment or geographical area, are able to mediate

relationships between social actors and mobilise citizens and relevant actors to develop R&I projects. These organisations can contribute in various ways, such as providing useful knowledge for defining research questions and interpreting data, identifying citizens interested in participating in the project, increasing the visibility of the project in the sector or local dimension concerned, promoting an attitude of trust towards the project promoters, and facilitating contacts with the social, political or institutional actors concerned by the projects. From a CS mainstreaming perspective, tools should be developed to facilitate the identification of and contact with intermediary organisations (e.g., the creation of local or national CS mainstreaming networks). This could also promote the use of CS within civil society or the business community as a strategy to bring about social, cultural, political or economic change.

Involvement of societal actors as promoters

In addressing CS mainstreaming, attention has mainly focused on R&I actors such as universities, research centres and technology development centres. Increasingly, however, CS projects should also be promoted by other types of organisations, such as local authorities, civil society organisations or enterprises. This is still rarely the case. In the vast majority of cases, CS projects are promoted by research institutions. This means that there tends to be a top-down approach to citizen science, with scientific interests dominating over others. This aspect is also problematic, as it can lead in the long run to social dissatisfaction not only with science but also with citizen science. Supporting the proactivity and initiative of societal actors is therefore one of the objectives that the CS means-streaming strategy should pursue.

3.3. Emerging topics in the Institutional Dimension

Funding schemes

To facilitate the mainstreaming of CS, funding systems should be changed. Some proposals are provided below.

- Systematically include assessment criteria for project proposals requiring the applicants to explain how citizen participation and CS are considered and, in case, why the use of participatory mechanisms is not planned.
- Introduce a two-step approach in calls for proposals, the first of which is funded to establish a research team involving citizen scientists and professional scientists and a network of stakeholders, and the second to jointly design the R&I project proposal.
- Insert R&I project management and administrative mechanisms that are flexible enough to deal with the uncertainties arising from the involvement of citizen scientists and stakeholders in the R&I process.
- Adopt a longer time horizon to facilitate better management of the recruitment and mobilisation of citizen scientists and to allow more time for the social or political impacts of the project to emerge.
- Provide a specific budget heading dedicated to the recruitment and involvement of citizen scientists.
- Facilitate access to R&I funds from civil society organizations and non-R&I organisations as promoters of CS projects.
- Include civil society representatives and people experienced in participatory mechanisms in the committees in charge of selecting R&I projects for funding.

Participatory infrastructures

From a CS mainstreaming perspective, there is a need to move from an artisanal to a systematic approach to citizen participation. R&I organisations should develop infrastructures (e.g., databases of citizens interested in participating in R&I activities, websites promoting the rapid dissemination of information on CS projects and initiatives, knowledge exchange platforms, etc.) that speed up and facilitate the procedures (e.g., recruitment procedures, administrative procedures, ethical approvals, etc.) necessary to mobilise citizens and stakeholders when needed. Web-based platforms could also be developed to allow interested citizens to stay in touch with each other and with researchers when they are not directly involved in R&I projects. This type of action can simplify the engagement process, support researchers, innovators or even external stakeholders, as each research and innovation activity relates to specific themes and issues that refer to well-defined social actors, and foster the creation of stable networks of stakeholders and citizens interested in tackling specific problems.

Training and knowledge exchange

As mentioned above, many researchers and innovators lack the necessary skills to design R&I projects that incorporate citizen science or that rely on the use of participatory approaches. Clearly, and quite trivially from a CS mainstreaming perspective, these skills should be rapidly disseminated, for example by including courses in university curricula, conducting training activities, producing guidelines, manuals and toolkits, organising workshops and peer learning activities, or identifying platforms for exchanging information and experiences. Basic training activities should be accessible to all researchers and students. Specific training activities should also be designed to support civil society organisations, NGOs, businesses and other social actors involved in or wishing to promote CS projects. More in-depth training activities could instead be of interest to Principal Investigators (PIs), managers of research institutions and decision-makers. Faculty or professional training courses could also be included in the curricula of those wishing to pursue a profession related to the design and management of CS and participatory R&I.

Dedicated organisational units

CS mainstreaming would be greatly accelerated if R&I organisations could create organisational units (pools of expertise, resource centres, support teams, etc.) dedicated to CS and participatory processes, equipped with the necessary skills and expertise to support PIs, research and innovation teams and, if necessary, also external organisations in setting up highly participative R&I projects.

Recruitment of researchers and career progression

To further the process of mainstreaming CS, skills and prior experience in the area of citizen participation should be rewarded and recognised for recruitment and career advancement in R&I institutions. To some extent, this process is already taking place, albeit informally and unevenly. However, it needs to be supported and accelerated so that it becomes standard practice throughout R&I. This includes the implementation of specific training activities for members of recruitment and selection committees.

Monitoring and evaluation

For the implementation of CS mainstreaming, it could be necessary to introduce monitoring and evaluation tools for R&I projects that also cover participatory aspects. The first two dimensions (knowledge and participatory dimension) are mainly concerned. Similarly, it could be also important to include new evaluation criteria related to CS mainstreaming (Institutional Dimension) to assess research institutions.

Data and statistics

The collection of data and statistics on citizen participation in R&I activities should be important to measure progress, bottlenecks and shortcomings at the level of individual R&I organisations or a national level. These data and statistics could form the basis for the development of indicators to be included in the current performance indicators and could also be used for the presentation of the activities carried out (e.g., on the websites or in specific reports).

Awareness-raising

Awareness-raising activities should also be promoted. To be effective, they should be tailored to the different possible target groups within R&I organisations (students, young researchers, senior researchers, managers, etc.) and in society (CSOs, NGOs, local authorities, businesses, etc.).

CS-mainstreaming action plans

To accelerate CS mainstreaming, specific action plans can be promoted within R&I organisations to define CS mainstreaming pathways adapted to the specificities of the organisation and based on an assessment of the baseline situation.

New ethical and legal practices

The widespread involvement of citizen scientists raises new ethical issues, such as how to apply current codes of conduct for professional scientists, data ownership, privacy, recruitment methods for citizen scientists or safety at work. In order to promote the mainstreaming of CS, these issues should be addressed at the different levels where they arise.

Dedicated budget lines

Dedicated budget lines aiming to support CS mainstreaming should be included in the budget structure of R&I organisations and research systems. They should cover the different kinds of activities mentioned that the organisation is responsible for, such as training activities, a dedicated pool of expertise, or participatory infrastructures.

TO SUM UP

- A series of **emerging topics** deserve to be highlighted and explored in depth to encourage and accelerate CS mainstreaming.
- As for the **Knowledge Dimension** of CS mainstreaming, the following topics can be considered:
  - ✓ Favour the involvement of citizens and stakeholders in R&I projects also based on the **epistemic added value** (i.e., in terms of knowledge and skills) they can generate
  - ✓ Prevent the risk that the **quality of data** is low both when this is due to the involvement of citizens and when is due to their lack of involvement
  - ✓ Identify effective actions to foster **peer-to-peer knowledge exchange** between citizen scientists and professional scientists
  - ✓ Exploit the strong links between **interdisciplinarity and citizen science**
  - ✓ Exploit the opportunities offered by **IT technologies** to foster knowledge exchange and sustain CS mainstreaming.
- As for the **Participatory Dimension**, the following topics are worth deepening:
  - ✓ Properly address the **complexity of the recruitment process** of citizen scientists
  - ✓ Identify **new incentives** (monetary and non-monetary) to engage citizens, preventing them from becoming paid "professional citizens" but also from being burdened with responsibilities for which they are not paid
  - ✓ Expand **the roles of citizens** in R&I projects to cover all the phases of R&I projects
  - ✓ Develop practices fostering **real peer-to-peer relationships** between professional and citizen scientists
  - ✓ Use knowledge brokerage to identify and address differences in **language and cognitive frames** between professional scientists, citizen scientists and stakeholders
  - ✓ Identify and mobilise **intermediary organisations**, i.e., organisations that can mobilise citizens and relevant actors to develop R&I projects
  - ✓ Support the **involvement of societal actors as promoters** of R&I projects.
- Concerning the **Institutional Dimension**, the following topics can be highlighted:
  - ✓ Modify the research **funding scheme**s to adapt them to the specific features of highly participatory R&I projects
  - ✓ Create **participatory infrastructures** such as databases of citizens interested in getting involved in R&D activities, websites promoting rapid dissemination of CS projects and initiatives, or knowledge exchange platforms to speed up and facilitate procedures for mobilising citizens when needed
  - ✓ Develop a set of **training and knowledge exchange activities** to transfer knowledge and build capacities on how CS projects can be designed and implemented
  - ✓ Establish specific **organisation units** within R&I organisations dedicated to CS and participatory processes
  - ✓ Reward the experience gained in CS projects and the skills and abilities related to participatory processes in the **recruitment of researchers and their career progression**
  - ✓ Introduce **monitoring and evaluation** tools also covering participatory aspects
  - ✓ Systematically collect data and statistics on citizen participation in R&I activities and develop specific performance indicators based on these
  - ✓ Promote **awareness-raising activities** tailored to the different target groups
  - ✓ Promote specific **action plans** to accelerate CS mainstreaming in R&I organisations
  - ✓ Develop appropriate ethical and legal practices to support CS mainstreaming
  - ✓ Establish **dedicated budget lines** in the budget structure of R&I organisations and research systems to support the CS mainstreaming process.

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